Introduction

The late 18th century was considered the main era in the evolution and development of hernia surgery, when surgeon/ anatomists first began to publish their studies of the abdominal wall and the inguinal and femoral canals. It became known as the age of the dissection and many of the surgical successes of the subsequent periods can be traced back to the anatomical knowledge gained from 1750 to 1800 **(Rutkow , 2003).**

By the first decade of the 19th century, magnificent hernia atlases were exemplified by those of Astley Cooper (1768-1841), Franz Caspar Hesselbach (1759-1816), Antonio Scarpa (1752-1832) and Jules Germain Cloquet (1790-1883) (**Rutkow, 2003).**

Inguinal Hernia repair is the most elective performed operation in general surgery. Following the introduction of the Bassini repair in the late 19th century, the methods for Inguinal Hernia repair remained little changed for over a century **(Winehouse and Taylor, 2005)**.

The shouldice technique is historically recognized as the gold standard for hernia repair **(Danielsson et al., 1999).** Until 1984 when the Lichtenstein hernia Institute introduced open tension free hernioplasty using synthetic mesh **(Lichtenstein et al., 1989).**

This was followed in 1991 by laparoscopic mesh hernioplasty initially in the form of a transabdominal preperitoneal repair (TAPP) and later, in 1992, with a totally extraperitoneal repair (TEP) which potentially reduced the likelihood of intraperitoneal complications and adhesions **(Felix et al., 1995).**

Femoral and pelvic hernias are less common than inguinal hernias. They form about 2-4% of all groin hernias **(Ruktow, 1998).** They remain amenable to laparoscopic repair through the same approach (TEP or TAPP) as inguinal hernia. Reduction of the hernia contents followed by mesh insertion, with or without fixation, is an appropriate management **(Ahmed and Beckingham, 2004).**

Ventral hernia encompasses incisional, epigastric, paraumbilical, umbilical, spigelian and traumatic hernias. Incisional hernias form the largest group of ventral hernias and remain the most difficult to treat. About 3-20% of all laparatomy patients will develop incisional hernias **(Ahmed and Beckingham, 2004).**

In the past 4 decades, the surgical techniques for ventral hernioplasty have gone through three stages. The first stage began before 1960, when most ventral hernias were repaired primarily, and that was by direct suture technique. This was probably adequate for small, uncomplicated hernias, but the overall experience with the repair of ventral hernias was unsatisfactory and the recurrence rate ranged from **30%** to **50% (Larson, 2000) (Luijendijk et al., 2000).**

The second stage started when the mesh prosthesis for hernia repair began in the early 1960s, when Usher first demonstrated the clinical usefulness of a knitted polypropylene mesh for use in the repair of complex hernia **(Usher, 1970).** Recurrence rate with prosthetic mesh closure decreased to **10-20 % (Larson, 2000).**

The common techniques of attaching the mesh have led to unacceptable recurrence rates **(Thoman and Phillips, 2002).** Rives , stoppa and wantz popularized placing mesh on top of the peritoneum but behind the rectus muscle with at least **5**cm overlap in all directions . The large mesh distributes the tension over a greater area and the posterior placement tends to hold the mesh in position. Stoppa reported a **14.5 %** recurrence rate with this technique in **368** patients carefully followed over **5.5** years, **(Rives, 1989) (Stoppa, 1989) and (Wantz, 1991).**

The third stage started in 1991, when LeBlanc reported the first successful series of laparoscopic ventral hernia repair**.** Several large series has shown low recurrence rates (0-9%), faster postoperative recovery and shorter hospital stay, with low complication rates and higher patient satisfaction rates **(Le Blanc et al., 2001) and (Heniford et al., 2003).**

Umbilical hernias repair by primary suture rather than using a mesh was the standard technique used to repair umbilical hernias. Arroyo et al randomized 2000 elective patients to either primary suture or mesh repair. The vast majority (98%) of procedures were undertaken under local anaesthetic. Hernia recurrence rates were 10 fold higher with suture repair (11% versus 1%) at a mean follow-up of 64 months. No significant difference was seen in duration of operation; mean postoperative stay, mean pain scores, or early complication rate **(Arroyo et al., 2003).**

AIM OF THE WORK

The aim of this work is to evaluate the best modality of management of different types of abdominal wall hernias with the least complications and least recurrence rates using the more recent techniques and facilities.

Anatomy of the anterior abdominal wall

The abdomen can be defined as the region of the trunk that lies between the diaphragm above and the inlet of the pelvis below **(Snell, 2000).** The anterolateral abdominal wall consists, from the outside in, of the skin, superficial fascia, external and internal abdominal oblique, transverse abdominis and associated aponeuroses, rectus abdominis and pyramidalis, as well as the transversalis fascia **(Arslan, 2005).**

Skin of the abdominal wall:

The skin of the abdominal wall varies in texture, tending to be thin anteriorly and thick posteriorly. Distribution of hair varies with sex, age and race. Natural tension lines of the skin are very constant and are of tremendous importance to the cosmetic appearance of healed incisions. An incision along a tension line will heal as a hair line scar, virtually invisible. While an incision across the lines will tend to heal with either a wide or a heaped up scar. The tension lines run almost horizontally around the body wall **(Sinnatamby, 1999).**

Fasciae of the abdominal wall:

There is no deep fascia over the trunk, only the superficial fascia. (If there were, we would presumably be unable to take a deep breath or enjoy a large meal!) This, in the lower abdomen, forms a superficial fatty layer **(of Camper)** and a deeper fibrous layer **(of Scarpa).** The fatty layer is continuous with the superficial fat of the rest of the body, but the fibrous layer blends with the deep fascia of the upper thigh, extends into the penis and scrotum (or labia majora), and into the perineum as **Colles' fascia**. In the perineum it is attached behind to the perineal body and posterior margin of the perineal membrane and, laterally, to the rami of the pubis and ischium. Because of these attachments, a rupture of urethral bulb may be followed by extravasation of blood and urine into the scrotum, perineum and penis and then into the lower abdomen deep to the fibrous fascial plane, but not by extravasation downwards into the lower limb, from which the fluid is excluded by the attachment of the fascia to the deep fascia of the upper thigh **(Ellis, 2006).**

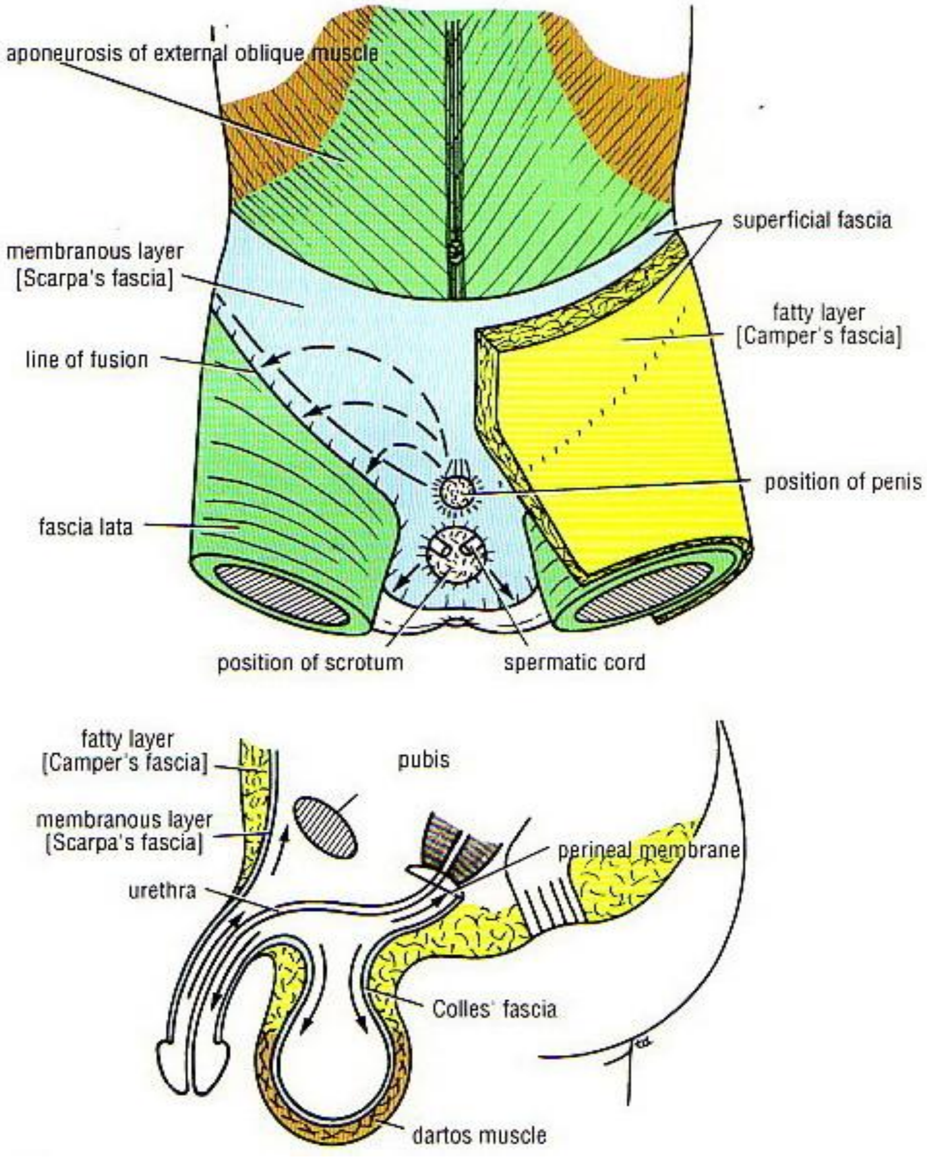


Fig. 1: *Arrangement of the fatty layer and the membranous layer of the superficial fascia in the lower part of the anterior abdominal wall*

(Snell, 2000)

Blood supply, nerve supply and lymphatic Drainage of the skin and subcutaneous tissue

Blood supply:

The venous return from the subcutaneous tissue does not follow the arteries. The blood collected by an anastmosing network of veins that radiate away from the umbilicus. Below the umbilicus they pass to the great saphenous vein in the groin; above the umbilicus they run up to the lateral thoracic vein and so to the axillary vein. From the umbilicus a few paraumbilial veins accompany the ligamentum teres and drain to the left branch of the portal vein; they may distend in portal obstruction, giving rise, if the distension spreads to subcutaneous veins, to the caput medusa **(sinnatamby, 1999).**

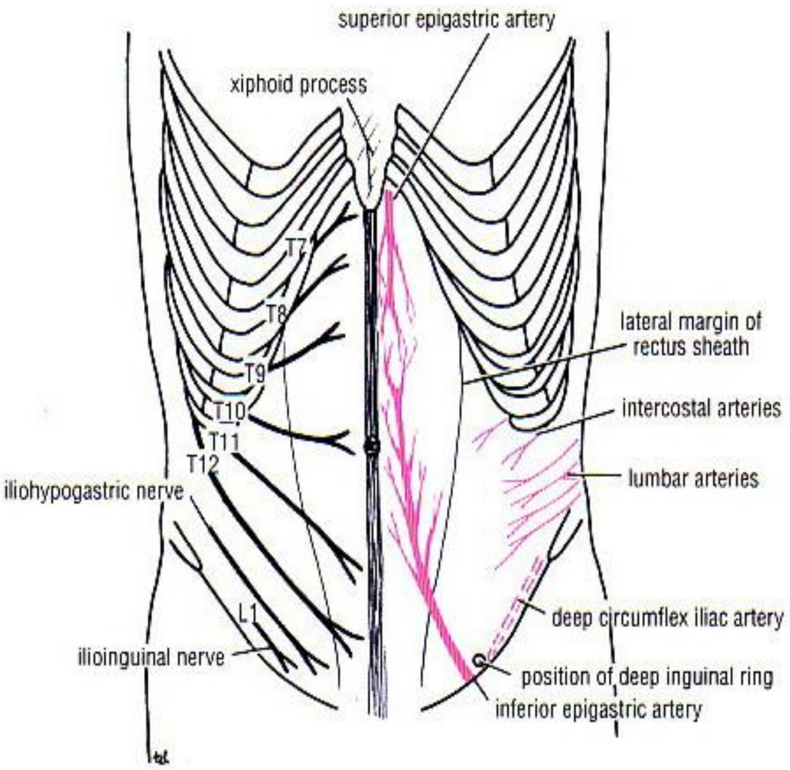


Fig. 2: *Segmental innervation of the anterior abdominal wall (left) and arterial supply to the anterior abdominal wall (right).*

(Snell, 2000)

The skin near the midline is supplied by branches of the superior epigastric artery, a branch of the internal thoracic artery, and the inferior epigastric artery, a branch of external iliac artery. The skin in the flanks supplied by branches from the intercostal, lumbar and deep Circumflex iliac arteries **(Snell, 2000)**

Nervy supply:

The segmental nerve supply of the abdominal muscles and the overlying skin is derived from **T7** to **L1**. This distribution can be mapped out approximately if it is remembered that the umbilicus is supplied by **T10** and the groin and scrotum by **L1** (via the ilio-inguinal and iliohypogastric nerves **(Ellis, 2006).**

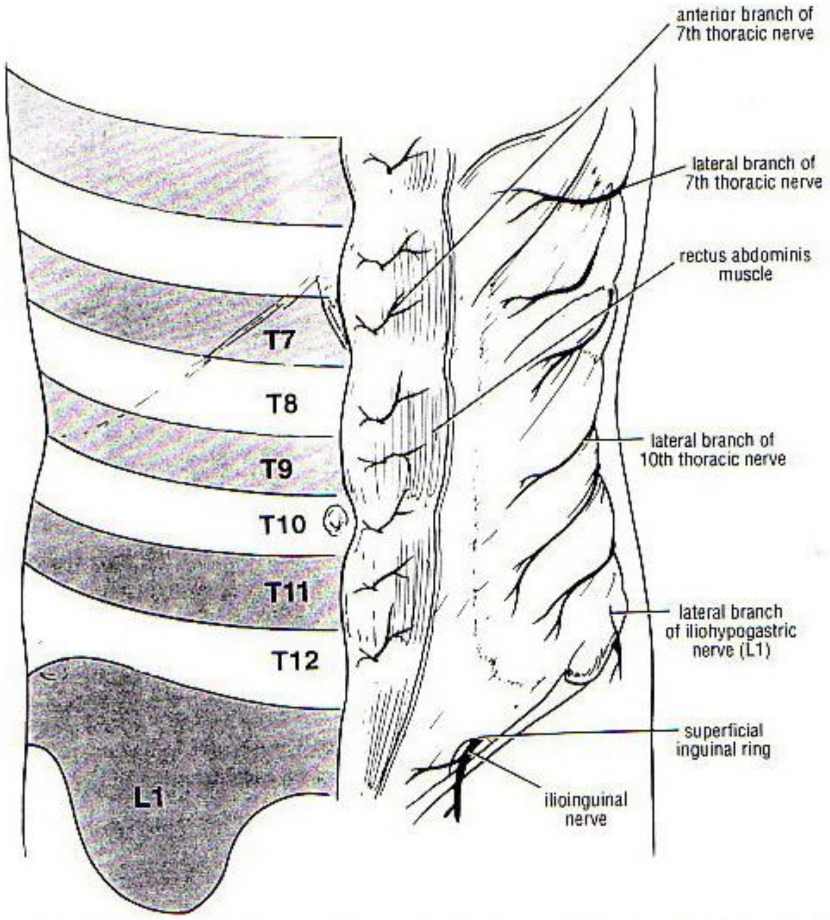


Fig. 3: *Dermatomes and distribution of cutaneous nerves on the anterior abdominal wall.*

(Snell, 2000)

Lymphatic Drainage:

Lymphatic channels from the subcutaneous tissue and skin follow the veins to the axillary and superficial inguinal nodes. From above the level of the umbilicus, lymph from the front of the body goes to the anterior (pectoral) group of lymph nodes. From the umbilicus downwards lymph from the anterior aspect of the abdominal wall goes to medial group, and from the lateral aspect of the abdominal wall the lateral group of superficial inguinal nodes (**Sinnatamby, 1999).**

Muscles of the Anterior Abdominal Wall:

The Anterolateral abdomen consists of the external and internal abdominal oblique, transverse and rectus abdominis, pyramidalis, as well as the cremasteric muscles **(Arslan, 2005).**

External oblique muscle:

The external oblique muscle arises from the outer surfaces of the lower eight ribs and fans out into the xiphoid, linea alba, the pubic crest, pubic tubercle and the anterior half of the iliac crest. From the pubic tubercle to the anterior superior iliac spine its lower border forms the aponeurotic inguinal ligament of Poupart **(Ellis, 2006).**

The posterior border of the muscle is free, and from the anterior boundary of the lumbar triangle of Petit that is floored in by internal oblique and bounded behind by the anterior border of latissmus dorsi and below by the iliac crest .The triangle may be the site of a rare lumbar hernia **(Sinnatamby,1999)**.

Internal Oblique Muscle:

The Internal Oblique Muscle arises from the lumbar fascia, the anterior two-thirds of the iliac crest and the lateral two-thirds of the inguinal ligament. It is inserted into the lowest six costal cartilages, linea alba and the pubic crest **(Ellis, 2006).**

The part of the muscle that originates from the inguinal ligament becomes aponeurotic and arches over the Spermatic cord in the male, or the round ligament in the female .It joins the aponeurosis of the transverse abdominis muscle anterior to the rectus abdominis muscle to form the conjoint tendon (flax inguinalis).It attaches to the pubic crest and for a variable distance to the medial part of the pectin pubis. The loosely arranged fasciculi of the internal oblique muscle and its aponeurosis, which extend around the spermatic cord and testis, constitute the cremasteric muscle and fascia that invariably receive fibers from the transverse abdominis. Exposure of the inguinal canal and deep inguinal ring in hernial repair is greatly enhanced by careful dissection of the cremasteric muscle and fascia (**Arslan, 2005).**

Transversus Abdominis Muscle:

The transversus abdominis arises from the lowest six costal cartilages (interdigitating with the diaphragm), the lumbar fascia, the anterior two-thirds of the iliac crest and the lateral one-third of the inguinal ligament; it is inserted into the linea alba and the pubic crest **(Ellis, 2006).**

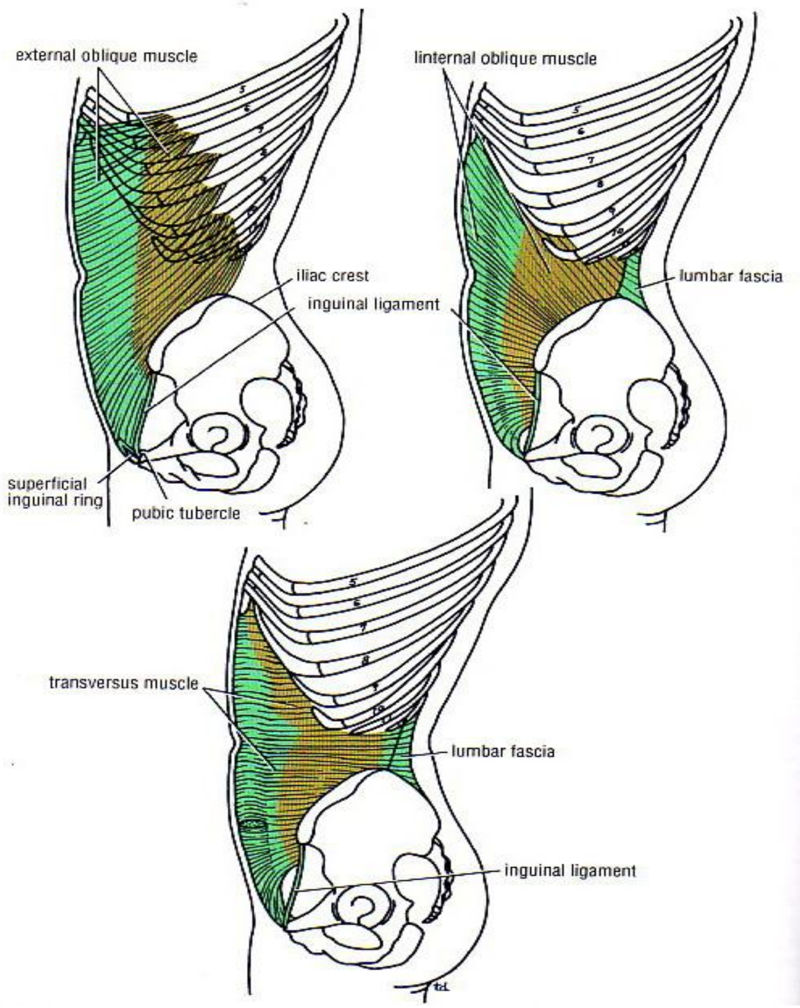


Fig. 4: *External oblique, internal oblique, and transversus muscles of the anterior abdominal wall.*

(Snell, 2000)

Rectus Abdominis:

The rectus abdominis arises on a **3** inches **(7.5cm)** horizontal line from the **5th, 6th** and **7th** costal cartilages and is inserted for a length of **1**inch **(2.5cm)** into the crest of the pubis. At the tip of the xiphoid, at the umbilicus and half-way between, are three constant transverse tendinous intersections; below the umbilicus there is sometimes a fourth. These intersections are seen only on the anterior aspect of the muscle and here they adhere to the anterior rectus sheath. Posteriorly they are not in evidence and, in consequence, the rectus muscle is completely free behind. At each intersection, vessels from the superior epigastric artery and vein pierce the rectus **(Ellis, 2006).**

Since this muscle receives innervation through its lateral border by piercing the tendinous intersections, incisions immediately lateral to the rectus abdominis near the linea semilunaris can carry a great risk of denervation and atrophy. Therefore, the rectus abdominis can surgically be transected any where other than the sites of these fibrous intersections, without possible threat of herniation (**Arslan, 2005).**

Pyramidalis Muscle:

The pyramidalis, an inconstant small muscle which is absent in approximately **25%** of the population, originates from the symphysis pubis and pubic crest and inserts into the linea alba as far as one-third of the distance to the umbilicus. This triangular muscle lies anterior to the lower end of the rectus abdominis and becomes smaller and pointed as it ascends towards the junction of the linea alba and the arcuate line. Although the significance of this muscle is not clear, it is thought to tense the linea alba (**Arslan, 2005).**

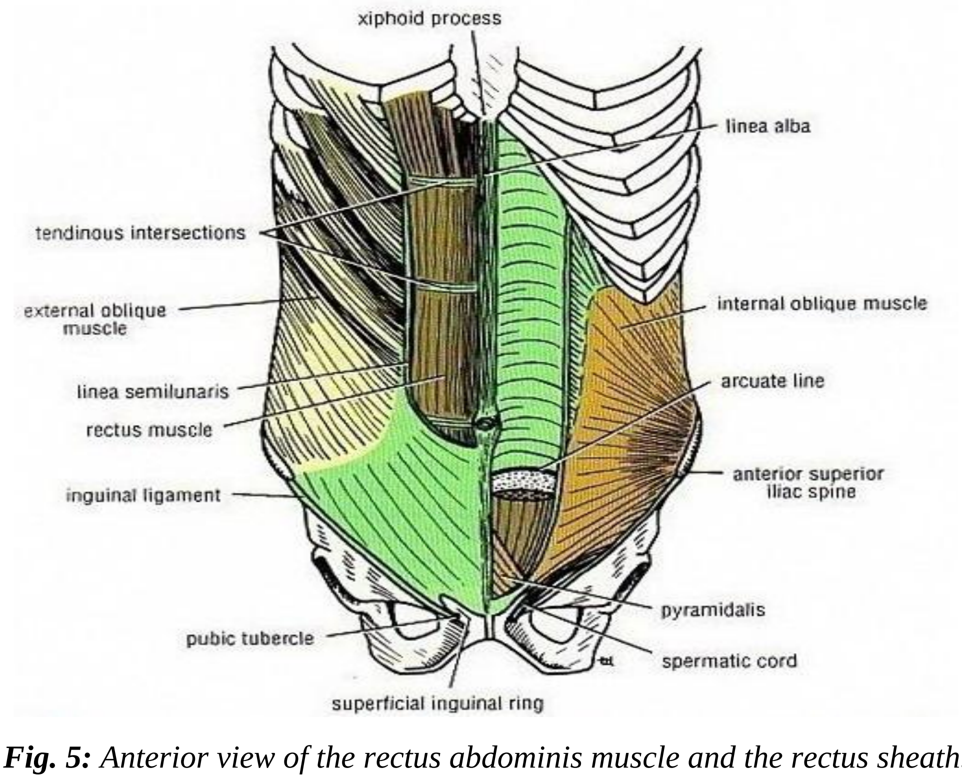


Fig. 5: *Anterior view of the rectus abdominis muscle and the rectus sheath.*

(Snell, 2000)

The transversalis fascia:

The transversalis fascia is a segment of the endoabdominal fascia that forms the lining of the entire abdominal cavity. It contributes to the posterior wall of the rectus sheath and contains the deep inguinal ring midway between the anterior superior iliac spine and the symphysis pubis. It lies between the transverse abdominis and the extra peritoneal fat and continues inferiorly with the iliac and pelvic fascia and superiorly with the fascia on the inferior surface of the diaphragm. Although it is a very thin layer on the inferior surface of the diaphragm, it shows some thickening in the inguinal region. In the posterior abdominal wall it joins the anterior layer of the thoracolumbar fascia (**Arslan, 2005).**

Veins of the anterior abdominal wall:

The superficial veins are described in venous drainage of skin and subcutaneous tissue. The superior epigastric, inferior epigastric and circumflex iliac veins follow the arteries of the same name and drain into the internal thoracic and external iliac veins. The posterior intercostal veins drain into the azygos veins, and the lumbar veins drain into the inferior vena cava (**Snell, 2000)**.

Arteries of the Anterior Abdominal Wall:

The abdominal wall receives blood supply through Branches of the femoral, external iliac, subclavian and intercostal arteries as well as the abdominal aorta. These branches include the superficial epigastric, superficial circumflex iliac, superficial external pudendal, deep circumflex iliac, superior and inferior epigastric, posterior intercostal, subcostal, musculophrenic, and lumbar arteries (**Arslan, 2005).**

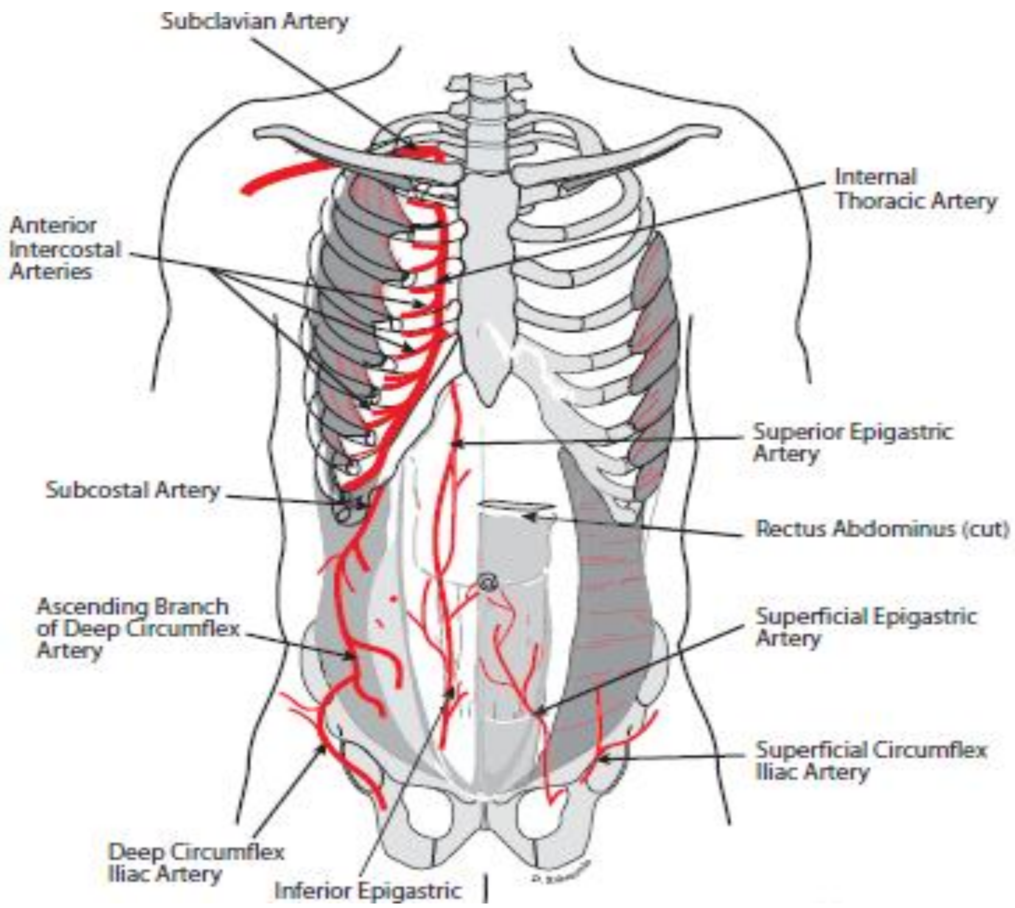


Fig. 6: *The diverse origin of the arterial supply to the abdomen.*

(Arslan, 2005)

Aponeurotic sheets of the anterior abdominal wall:

Traditionally each antero-lateral muscle was regarded initially forming a single unilaminar aponeurosis, that was confined to its ipsilateral side and ended in the median linea alba. At the lateral margin of the rectus abdominis the internal oblique aponeurosis divides: one lamina passing anterior to the rectus and blended with external oblique aponeurosis; one behind it blending with that of transversus. These laminae blend at the medial border, helping to form a linea alba. This is mentioned to exist from the costal margin to a variable level downwards, usually midway between the umbilicus and symhysis pubis, at which point the posterior wall of the sheath ends in a curved margin, called the arcuate line, whose concavity points downwards (**peter et al, 1989).**

However, it is suggested that the anterior abdominal wall aponeuroses are intricately interwoven sheets, the threads of which are the fine tendons of insertion of the anterior abdominal wall muscles. These fine tendons pass freely from one side of the abdominal wall to the other, across the midline anteriorly constituting a fairly complicated digastric pattern between the muscles of the two sides. This digastric pattern is apparently necessary for the coordinated functioning of the entire anterior abdominal wall. In fact, an individual muscle or the muscles of one side cannot work separately, and all the muscles in the anterior abdominal wall seem to work together as one unit. Accordingly, the aponeurotic sheets on the anterior abdominal wall are functionally linked **(Askar, 1984).**

1) The rectus sheath

A. The anterior rectus sheath:

The anterior rectus sheath forms the major and the most conspicuous portion of the anterior abdominal wall aponeuroses. Three strata of tendinous fibers can be identified in this sheet. They can be easily seen by the surgeon if the knife is drawn gently on the anterior rectus sheath while a paramedian incision is made. In the most superficial stratum, the tendinous fibers will be seen directed downward and laterally. These, when followed, come from the external oblique of the opposite side. In the middle stratum, the tendinous fibers are directed downwards and medially at right angles to those of superficial stratum; these are the tendinous fibers of the external oblique on the same side. In the deep stratum, the tendinous fibers are directed upwards and medially these are the tendinous fibers of the anterior lamina of the internal oblique aponeurosis. They lie at right angles to the fibers of middle stratum and parallel to those of the superficial stratum. A triple –layer criss-cross pattern similar to plywood is thus formed. The tendinous fibers in these three strata are bound together by loose areolar tissue which facilitates their movement over each other. The aponeurotic fibers of one external oblique muscle, as they approach the midline, divide into two sets of fibers, a superficialal and deep set .The deep fibers cross the midline and continue as the tendinous fibers in the anterior lamina of the internal oblique of the opposite side. The superficial fibers, after they cross the midline, become the superficial stratum of the triple-layer criss-cross pattern of the contralateral rectus sheath. They proceed along the whole extent of the contralateral external oblique aponeurosis, cross its musculo- aponeurotic junction, and end by dipping in between the muscle bundles **(Askar, 1984).**

B. The posterior rectus sheath:

A triple-layer criss-cross pattern, similar to that seen in anterior rectus sheath, can also be seen in the posterior rectus sheath above the level of the umbilicus. It is formed by the posterior lamina of the internal oblique aponeurosis together with two other strata derived from the transversus aponeurosis **(Askar, 1984).**

Thus, recent studies indicate that the aponeurosis of the external oblique, internal oblique and transversus abdominis are each bilaminar, giving six layers in all; three from the anterior and three from the posterior layers of the rectus sheath ***(*Sinnatamby, 1999**).

The triple-layer criss-cross pattern offers firmness to the texture of the aponeuroses of both the anterior and posterior sheaths and makes them less liable to herniation. It also makes them more suitable for incision than the midline, as they hold sutures better. The mobility of the tendinous fibers in the three strata of both anterior and posterior sheaths offered by the loose areolar tissue binding these fine tendons, allows for changes in the shape and dimensions of the whole aponeurosis in adaptation to movements of the trunk and the abdominal wall with respiration. Fibrosis caused by scarring incisions through the rectus sheath is liable to disturb this adaptability **(Askar, 1984).**

At the upper and lower ends of rectus muscle the posterior rectus sheath shows some difference from the previously mentioned description. Superiorly the posterior rectus sheath is attached to the costal margin (seventh, eighth and ninth costal cartilages).Thus, the upper part of rectus muscle lies directly over the costal margin to become attached to the fifth, sixth and seventh cartilages. Thus above the costal margin there is no posterior rectus sheath and also in this region the anterior layer of the sheath consists only of the external oblique aponeurosis (**Sinnatamby, 1999).**

Inferiorliy, at a point midway between the umbilicus and symphysis pubis the posterior rectus sheath ceases. From this level downwards all laminae pass in front of the rectus muscle. Thus, there is a free lower margin of the posterior layer which is concave downwards and known as the arcuate line or semicircular line of Douglas **(Peter et al, 1999).**

The spliting of the internal oblique aponeurosis along the lateral border of the rectus muscle forms a relatively shallow groove, the semilunar line. It curves up from the pubic tubercle to the costal margin at the tip of the ninth costal cartilage in the transpyloric plane (**Sinnatamby, 1999).**

Contents of the rectus sheath include both the rectus and pyramidalis muscles, ends of the lower six thoracic nerves and their accompanying posterior intercostal vessel and lastly the superior and inferior epigastric arteries (**Sinnatamby, 1999).**

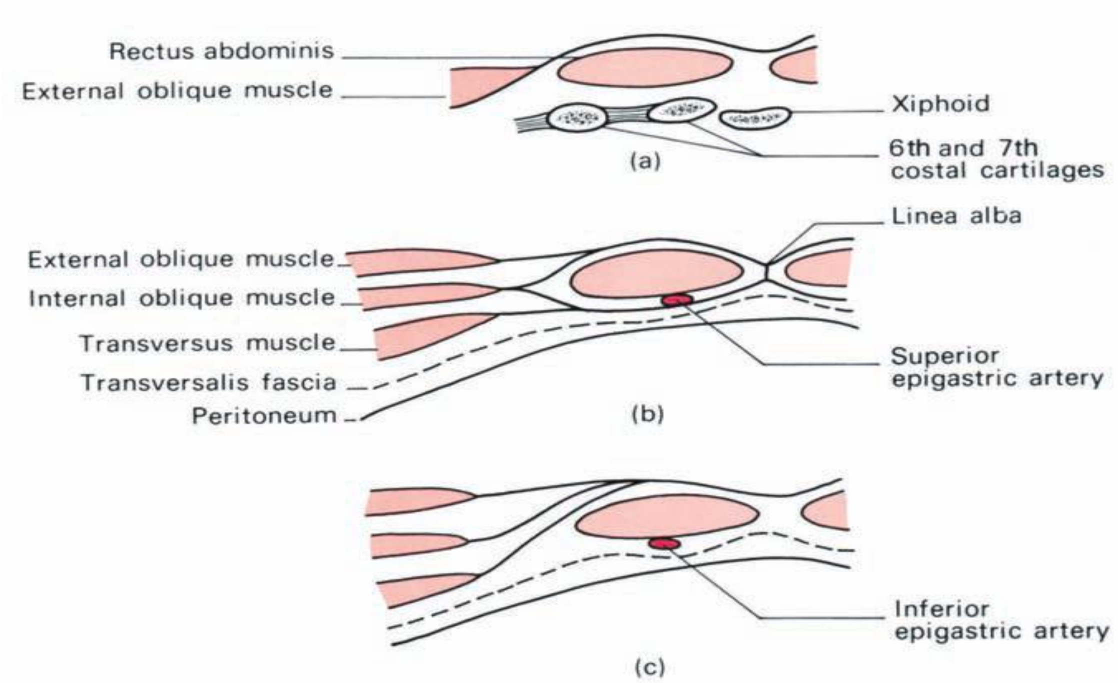


Fig. 7: *The composition of the rectus sheath shown in transverse section (a) above the costal margin, (b) above the arcuate line and (c) below the arcuate line* ***(Ellis ,2006).***

2- Mid line aponeurotic zone "Linea alba"

Between the two recti all the aponeuroses fuse to form the linea alba, a strong mid line fibrous structure which is firmly attached to the xiphoid process above and the pubic symphsis below. Above the symphsis it is very narrow, for here the two recti are in contact with one another behind it. From just below the umbilicus to the xiphisternum it broadens out between the recti, here the fibres form a tough felted membrane **(McMinn, 1995).**

As the tendinous fibres from all the strata of the anterior and posterior rectus sheath approach the midline they decussate with the fibres from the opposite side ,This result in the formation of a whitish aponeurotic zone “The mid line aponeurotic zone” ,the linea alba . This decussation can be seen on both the anterior and posterior surfaces of linea alba. In some 30%, the decussation was observed to take place along a single line at the mid line. In 70% there was two additional lines of decussation, one on either sides of the mid line decussation forming a triple pattern of decussation which was observed above the level of the umbilicus. Below that level only a single pattern was observed. The two additional lines of decussation in a triple decussation seem to reinforce the midline decussation and to produce a firmer aponeurotic texture that would be more resistant to herniation. This may be the answer to why mid line subumbilical incisions are more prone to post operative herniation, the subumbilical portion of linea alba being of the weaker single mid line decussation type**(Askar,1984).**

In the patients with a single line of decussation, the hernial orifice is situated at the midline. In a patient with a triple decussation, the hernial orifice lies to one side of the midline; the midline here seems immune to herniation.The obliquity in which the fine tendinous fibres are placed in the anterior abdominal wall aponeurosis allows for the changes in the shape and diameter of these sheets, as well as for the production of the rounded contour of the abdomen. The midline aponeurotic zone, being limited on both sides by the medial edges of both rectus sheaths, can only offer changes in length. To be elongated, the midline aponeurotic zone has to get thinner, and when shortened it gets broader. In abdominal distension, the midline aponeurosis is required to increase both in length and breadth, and this can occur only at the expense of tearing open the little rhomboid spaces between the aponeurotic fibres **(Askar,1984).**

Functional anatomy of the abdominal wall:

It is crucial during dealing with the ventral abdominal wall hernial defects and their repair to understand the functional anatomy of the abdominal wall. Reconstruction should be as close to normal as possible in order to restore the normal function of its separate parts and of the abdominal wall as a whole **(Abrahamson ,1997) .**

Integrated function of the abdominal wall muscles:

It is of prime importance to emphasize how the different muscles of the anterolatral abdominal wall act together in an integrated manner with each other and with other muscles of the back **(Blondeel, et al., 1997).**

The rectus abdominis muscle action is usually mentioned to be flexion of the trunk; however the role of rectus abdominis muscle in trunk flexion is generally over estimated. Although the recti primarily flex the lumber spine, they are only responsible for the first 30 degree of flexion of the upper body; as an initator of movement. The iliopsoas muscles then take over and are the strongest flexors responsible for trunk flexion over the largest part of the trajectory. In daily life the rectus muscles are hardly ever used as pure flexors because in an upright position gravity flexes the upper body. The flexing function of the rectus muscles is mostly needed to get up from a supine position, which may be done once or twice a day (**Blondeel et al., 1997).**

The rectus abdominis muscles are far more important in daily life for stabilization of the upper body not only they form a dynamic and flexible muscular pillar as a counter part of the rigid bony spine, but they are also important site of insertion and action for all the oblique muscles. In this way they assist in rotatory movements and are essential for normal function of the oblique muscles **(Blondeel et al., 1997).**

The flat muscles of the abdominal wall are normally in a state of tonic contraction, which tends to shorten them. However, since the muscles of one side are fixed to those of the other side along the midline of the linea alba, they are not able to shorten, instead ,they pull against each other in a balanced fashion so that they act as a dynamic girdle , flattening the abdominal wall and holding back the contents of the abdomen **(Abrarhamson, 1997).**

The oblique muscle fibers are mainly responsible for the lateral flexion and rotation of the trunk, with unilateral contraction of external oblique muscle causes rotation to the contralateral side supported by the control lateral internal oblique .It is evident that a rigid and dynamic central pillar is necessary for the oblique muscles to be able to exert their forces without laxity at insertion line. Also vertically oriented muscle fibers of both the internal and external oblique muscles assists in flexing the trunk synergistically with the rectus muscles (**Blondeel et al., 1997).**

Together with the transversus muscles the recti are responsible for raising intra-abdominal pressure; a crucial function for lifting heavy objects, bowel movement, forced expiration (cough, sneeze etc…) **(Blondeel, et al., 1997*)*.**

With the vertical splitting of the midline at operation and failure of the wound to heal postoperatively the two halves separate as the hernia develops (**Flament and palot, 2002).**

The abdominal muscles act as anterior brace for the spine, when the subject is standing. Accordingly weakness of these muscles, especially of the recti abdomini, will lead to exaggeration of lumber lordosis. During flexion of the spine, the contraction of the recti muscles relieves the strain on the spine by “the compression of an inflatable structure” created by the closure of the glottis and contraction of the abdominal muscles. This static function is compromised in cases of major incisional hernia, and many of these patients thus suffer from spinal pain (**Flament and palot, 2002).**

The edges of the hernial opening are largerly destroyed when the original sutures tore out and are not suitable for use in repairs **(Abrahamson, 1997).**

Anatomy of the inguinal canal:

This canal represents the oblique passage taken through the lower abdominal wall by the testis and cord in male, the round ligament in female .The canal is 1.5 inches (4 cm) long. It passes downwards and medially from the internal to the external inguinal rings and lies parallel to and immediately above, the inguinal ligament (**Ellis, 2006).**

In the new born child, the deep ring lies almost directly posterior to the superficial ring so that the canal is considerably shorter at this age. Later, as the result of growth, the deep ring moves laterally **(Snell, 2000).**

The deep inguinal ring is an oval opening in the fascia transversalis, lies about 1/2 inch (1.3cm) above the inguinal ligament midway between the anterosuperior iliac spine and the symphysis pubis. Related to it medially are the inferior epigastric vessels, which pass upward from the external iliac vessels. The margins of the ring give attachment to *the internal spermatic fascia* (or the internal covering of the round ligament of the uterus) **(Snell, 2000).**

The superficial inguinal ring is a triangular-shaped defect in the aponeurosis of the external oblique muscle and lies immediately above and medial to the pubic tubercle. The margins of the ring, sometimes called the crura**,** give attachment to *the external spermatic fascia* **(Snell, 2000).**

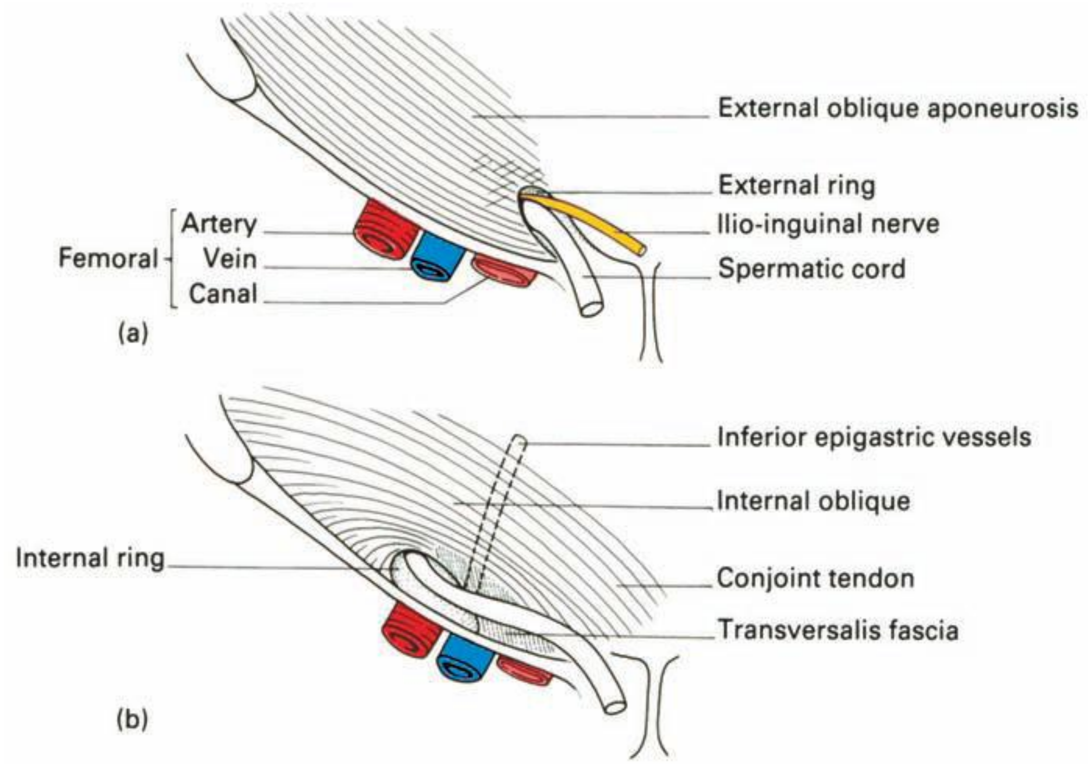


Fig.8: *The right inguinal canal (a) with the external oblique aponeurosis intact, (b) with the aponeurosis laid open* ***(Ellis, 2006).***

Walls of the inguinal canal:

The anterior wall is formed by the external oblique aponeurosis, assisted laterally by the internal oblique muscle. **Its floor** is the inrolled lower edge of the inguinal ligament, reinforced medially by the lacunar ligament. **Its roof** is formed by the lower edges of the internal oblique and transversus muscles, which arch over from in front of the cord laterally to behind the cord medially, where their conjoined aponeuroses, constituting the conjoint tendon, are inserted into the pubic crest and the pectineal line of the pubic bone. **The posterior wall** of the canal is formed by the strong conjoint tendon medially and the weak transversalis fascia throughout **(Sinnatamby, 1999).**

Function of the Inguinal Canal:

The inguinal canal allows structures of the spermatic cord to pass to and from the testis to the abdomen in the male. (Normal spermatogenesis only takes place if the testis leaves the abdominal cavity to enter a cooler environment in the scrotum.)

In the female the smaller canal permits the passage of the round ligament of the uterus from the uterus to the labium majus. In both sexes the canal also transmits the ilioinguinal nerve **(Snell, 2000).**

Mechanics of the Inguinal Canal:

The presence of the inguinal canal in the lower part of the anterior abdominal wall in both sexes constitutes a potential weakness. It is interesting to consider how the design of this canal attempts to lessen this weakness.

1. Except in the newborn infant, the canal is an oblique passage with the weakest areas, namely, the superficial and deep ring, lying some distance apart.
2. The anterior wall of the canal is reinforced by the fibers of the internal oblique muscle immediately in front of the deep ring.

3. The posterior wall of the canal is reinforced by the strong conjoint tendon immediately behind the superficial ring.

4. On coughing and straining, as in micturition, defecation, and parturition, the arching lowest fibers of the internal oblique and transversus abdominis muscles contract, flattening out the arched roof so that it is lowered toward the floor. The roof may actually compress the contents of the canal against the floor so that the canal is virtually closed (shutter mechanism).

5. When great straining efforts may be necessary, as in defecation and parturition, the person naturally tends to assume the squatting position; the hip joints are flexed, and the anterior surfaces of the thighs are brought up against the anterior abdominal wall. By this means the lower part of the anterior abdominal wall is protected by the thighs (**Snell, 2000).**

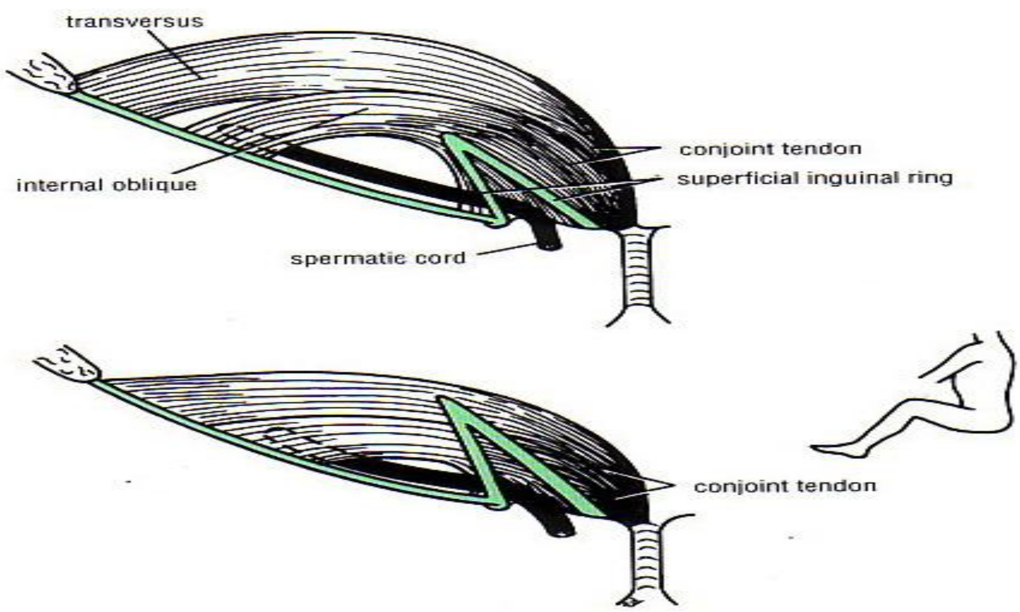


Fig. 9: *Action of muscles on the inguinal canal.*

(Snell, 2000)

Anatomy of the femoral sheath:

The femoral vessels, passing beneath the inguinal ligament, draw around themselves a funnel-shaped prolongation of the transversalis fascia in front and the psoas fascia behind. This prolongation of fascia, the femoral sheath, fuses with the adventitia of the artery and vein about 3 cm distal to the inguinal ligament **(Sinnatamby, 1999).**

The femoral artery, as it enters the thigh beneath the inguinal ligament, occupies the lateral compartment of the sheath. The femoral vein, as it leaves the thigh, lies on its medial side and is separated from it by a fibrous septum and occupies the intermediate compartment. The lymph vessels, as they leave the thigh, are separated from the vein by a fibrous septum and occupy the most medial compartment **(Snell, 2000).**

The medial and smallest compartment is the femoral canal, containing the lymph vessels and a lymph node embedded in areolar tissue, probably to allow the vein to distend. This canal is conical, about 1.25 cm in length; its proximal end is the outer femoral ring. The ring is filled by condensed extraperitoneal tissue, the femoral septum, covered by the parietal peritoneum. The femoral septum is traversed by numerous lymph vessels connecting the deep inguinal to the external iliac lymph nodes ***(*Giorgio G, 1995).**

The femoral sheath is adherent to the walls of the blood vessels and inferiorly blends with the tunica adventitia of these vessels. The part of the femoral sheath that forms the medially located femoral canal is not adherent to the walls of the small lymph vessels; it is this site that forms a potentially weak area in the abdomen. A protrusion of peritoneum could be forced down the femoral canal, pushing the femoral septum before it. Such a condition is known as a femoral hernia **(Snell, 2000).**

The femoral ring has four boundaries. Anteriorly lies the medial part of the inguinal ligament, medially the crescentic edge of the lacunar ligament, posteriorly the pectineal ligament and laterally the femoral vein **(Sinnatamby, 1999).**

The lower end of the canal is normally closed by the adherence of its medial wall to the tunica adventitia of the femoral vein. It lies close to the saphenous opening in the deep fascia of the thigh (**Snell, 2000).**

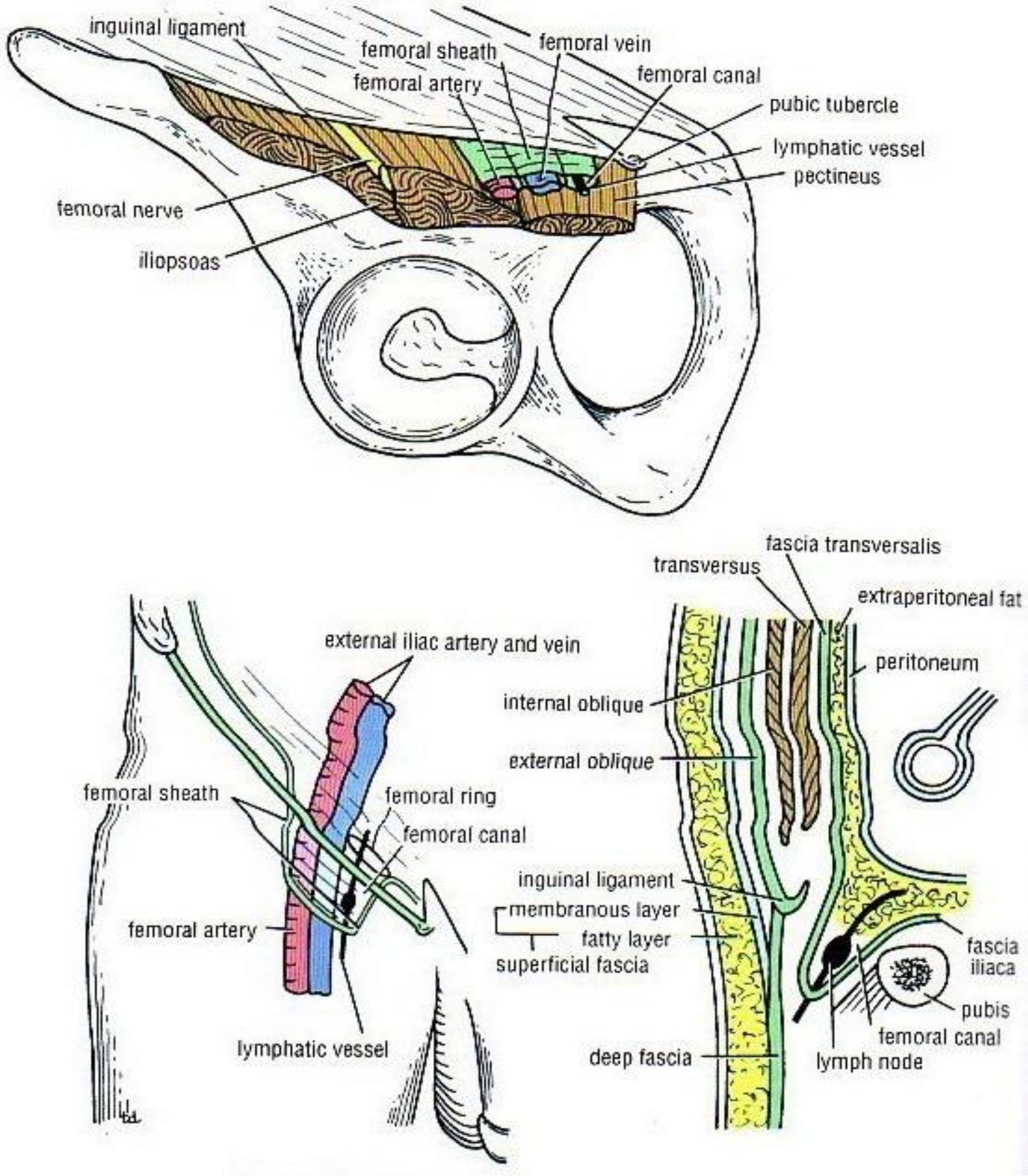


Fig.10: *Right femoral sheath and its contents.*

(Snell, 2000)

Anterior abdominal wall hernias

The term ventral hernia, however, is applied to any protrusion through the anterior abdominal wall, with the exception of those in the inguinofemoral region **(Toy et al., 1998) (Holzman and pappas, 2000).**

A- Ventral hernia:

Incisional hernia:

A postoperative ventral abdominal wall hernia, more commonly termed incisional hernia, is the result of a failure of fascial tissues to heal and close following laparotomy. Such hernias can occur after any type of abdominal wall incision, although the highest incidence is seen with midline and transverse incisions. Laparoscopic port sites may also develop hernia defects in the abdominal wall fascia. As the approximated fascial tissue separates, the bowel and omentum herniates through the opening, covered by a peritoneal sac. These hernias can increase in size to enormous proportions, and giant ventral hernias can contain a significant amount of small or large bowel. At the extreme end of the ventral hernia spectrum is the giant incisional hernia that leads to loss of the abdominal domain, which occurs when the intra-abdominal contents can no longer lie within the abdominal cavity **(Zinner and Ashley, 2006).**

Incidence:

Incisional hernia is a common and often debilitating complication after laparotomy. More than 2 million laparotomies are performed annually in the United States, with a reported 2% to 11% incidence of incisional hernia. It is the most common complication after laparotomy by a 2:1 ratio over bowel obstruction and is the most common indication for reoperation by a 3:1 ratio over adhesive small bowel obstruction.

Approximately 100,000 hernia repairs are performed annually in the United States **(Andrades et al., 2008).**

The incidence seems to be lower in smaller incisions, so that laparoscopic port site hernias are much less common than hernias following large midline abdominal incisions. While it was once believed that the majority of incisional hernias presented within the first 12 months following laparotomy, longer-term data indicate that at least one-third of these hernias will present (5 -10) years postoperatively **(Zinner and Ashley, 2006).**

Etiology:

Many factors singly or in various combinations, may cause failure of the wound to heal satisfactorily and may lead to the development of a postoperative hernia. The two main causes are poor surgical technique and sepsis. There are two types of post operative ventral hernias, early and late **(Abrahamson, 1997).**

Early ventral hernias:

The early incisional hernia, which appears soon after the original laparotomy closure, often involves the whole length of the wound, grows rapidly and becomes large. This early failure usually is the result of technical failure on the part of the surgeon **(Abrahamson, 1997).**

Poor surgical technique:

1-Non anatomic incisions

Non anatomic incisions are typified by the vertical para-rectus incisions along the outside of the lateral border of the rectus sheath, which destroys the nerve and vascular supply to the tissues medial to incision, causing them to atrophy. The more lateral the incision the greater the damage. Generally speaking, the best and simplest access to the abdominal cavity is through the midline or transverse incisions **(Abrahamson, 1997).**

It’s commonly believed that incisional hernias and recurrent incisional hernias are more common in vertical midline incisions and less common in transverse or oblique incisions. This is due to the fact that most muscle and aponeurotic fibres of the abdominal wall run in an oblique or transverse orientation, with lines of force oriented horizontally. Transverse incisions run parallel to these natural lines of force in the abdominal wall and the net effect of abdominal wall tension is to reinforce the transverse wound. Vertical incisions, on the other hand, run perpendicular to the lines of force and the wound edges are distracted by abdominal wall tension (**Larson and Vandertoll, 1984).**

It is mentioned that carefully controlled trials have shown that, when all wounds are closed by mass technique, there is no difference in the incidence of burst abdomen, eventration, postoperative hernia or recurrent postoperative hernia when comparing paramedian and transverse incisions to median incisions **(Ellis et al, 1984).**

In comparing the lateral paramedian with the midline incision, it was mentioned that the lateral paramedian may prove to have low incidence of post operative hernia that was unrelated to the suture material used (Prolene, Dexon, and catgut). There was no significant difference between the three suture groups. It appears that the lateral paramedian incision is an inherently strong incision. This strength may be due to splintage of the wound by the rectus abdominis muscle and the wide shutter mechanism that this provides **(Donaldson et al, 1982).**

It appear that it is not the type of incision that is the important factor in hernia occurrence but rather the technique of closure and the type of suture material used **(Abrahamson, 1997).**

2-Layred closures:

Anatomical closures are usually followed by a greater incidence of postoperative hernias. This may be owing to the fact that many sutures are used, which are closely placed, and because insufficiently sized bites of each thin layer are taken (**Abrahamson, 1997).**

3-Inappropriate suture material:

The development of wound complications may be related to functional changes in the wound during the healing process. It is mentioned that the process of wound healing, collagen formation, and maturation, the laying down of the collagen fibres in parallel lines according to the lines of stress, until the wound gains its maximal strength takes about 1 year. Approximately 80%of the final wound strength is reached after 6 months. It follows, therefore, that the wound must be supported for at least this time (**Israelsson, 2002).**

The sutures are entirely responsible for the integrity of the wound for the first 6 months, so any material that does not survive and maintain most of its strength for this time is not suitable for wound closure. Reliable trials have shown that wound closed with non absorbable suture material are followed by a far lower incidence of post operative hernias than wounds closed with absorbable material (**Abrahamson ,1997)**

The use of synthetic absorbable materials for abdominal wound closure therefore requires careful monitoring. In most circumstances this strength is suffecient to hold the fascia together, but with delayed healing due to infection or raised intra abdominal pressure due to postoperative chest infection or abdominal distention, the strength of the wound without suture support may be insufficient, leading to formation of an incisional hernia **(Bucknall, 1980).**

Non absorbable suture materials (Nylon) allow support of the wound during the entire healing period and have been used with good results, with slowly absorbable monofilament suture materials that retain an acceptable strength for at least 6 weeks (Polydioxanone); the rate of incisional hernia has been similar to non absorbable (**Israelsson and Jonsson, 1994).**

The ideal suture material for abdominal wound closure , especially of midline incisions , is monofilament polymide or polypropylene sutures used in the form of intrupted mass closure, taking large bites of the musculoaponeurotic layers of the abdominal wall **(Abrahamson, 1997) .**

A good alternative is mass closure with a continous heavy monofilament polymide or polypropylene as a single thread or preferably, in the form of a commercially available loop **(Rubio, 1991).**

4-Suturing technique:

It is still widely but erroneously believed that, when closing an abdominal incision , many small sutures each taking a small bite of tissues and closely placed and tightly tied, and suturing each anatomic layer separately are nearer and better than fewer, widely spaced, loosely tied sutures that take a large mass bite of the tissues. Small sutures enclose only a small amount of tissue close to edge of the sutured layer, often within the area of the normal collagenolysis of a cut wound, and easily cut out. Each small, tightly tied suture causes a triangular area of ischemia and necrosis of the tissues it encircles, together with an area on each side of the suture .When these sutures are placed close to each other, their ischemic areas overlap and cause a strip of necrosis along the sutured edges, which separate from the rest of the tissues together with the sutures so that the apposed and sutured structures separate and cause the hernia to recur **(Abrahamson, 1998).**

Continous suturing techniques have a great wound bursting pressure than simple, interrupted methods. A continous suture may be perceived as a spiral, giving a better distribution of tension along the entire length of the approximated tissues **(Abrahamson, 1998).**

In this way, 1-cm bites of fascia on either side of the incision are taken with each pass of the suture and the suture is advanced 1 cm at a time along the length of the incision **(Zinner and Ashley, 2006).**

With interrupted techniques, tension is focused on each individual stitch so that dehiscence begins at the stitch when the tension exceeds the suture holding capacity of the tissue **(Israelsson, 2002).**

5-Tension:

The approximation of tissues under tension is a cardinal, if not the most important; factor in the failure of a wound repair. Tissues sutured under tension tend to pull apart but are prevented from doing so by the sutures; however , the tissues pulling on the sutures create an area of ischemic pressure necrosis where the sutures meets the tissue. This process of ischemic pressure necrosis progress until there is no longer any tension, which usually occurs when the tissues have returned to their previous unsutured position. In more extreme cases in which the tension is greater than the strength of the tissues, the sutures simply cut through the tissues leading to wound dehisence (**Abrahamson, 1998).**

6-Sepsis:

Numerous authors have suggested that most common factor responsible for the development of incisional hernia is postoperative wound infection **(Deitel et al, 1990) (Mannien et al 1991) (Baker, 1989).**

Bucknell and colleagues , in their seris of 1129 laparotomy closures, found that 48% of their patients with incisional hernia had a previous wound infection, and those with a wound infection developed hernia almost four times more **(Bucknell et al, 1982).**

Sepsis, The Second major cause of early wound failure, is a contributing factor if not the most important one, in more than 50% of post operative hernias that develop in 1 year after operation.

Wound infection may range from frank acute cellulites, with fascitis and necrosis of tissues on each side of the incision, to a low grade chronic sepsis around sutures such as braided or twisted silk. The later case is very difficult to overcome, since the infecting organism lurks in the spaces between the fibres of the suture thread and constantly reinfect the tissues (**Abrahamson, 1997).**

The inflammation and oedema of the tissues brought about by the infection causes them to swell so that a larger volume of tissue is enclosed within the unyielding ring of the suture, leading to pressure necrosis of the tissues. The final result is that, even though the wound may heal and sinuses close, the sutures no longer give the vital support to the tissues. The repair heals with scar tissue that is unable to withstand the stress of rise and fall of the intra-abdominal pressure and finally gives way to recurrent hernia (**Abrahamson, 1998).**

7-Drainage Tubes:

Drainage tubes brought out through the operation wound are a potent cause of postoperative hernias **(ponka, 1981).**

Since the tissue planes along the track of the drain are not sutured, an open and weak passage is present through all the layers of the wound through which a hernia may develop. Furthermore, after the first 24 hours, there is a rapid rise in the wound infection rate. Since the drain allows for two-way traffic of secretions outwards and organisms inward to the wound and abdominal cavity. Also, the irritation caused by drain causes oedema or softening and tearing of the tissues and cutting out of sutures (**Abrahamson, 1997)**

8-Obesity:

Obesity is one of the leading causes of the development of incisional hernia. Ellis' group found that obesity was associated with a three-fold increase in herniation and recurrence **(Bucknell etal, 1982) (Eubanks, 2001).**

The bulk associated with a fatty omentum and excessive subcutaneous tissue provides increased strain on the operative wound during early healing. Many of these individuals have an associated loss of muscle mass and tone and therefore they have inadequate strength at the fascial level to compensate for the added strain **(Eubanks, 2001).**

9-General Condition:

The general condition of the patient influnces the rate of postoperative ventral hernia. The factors include age, generalized wasting, malnutrition and starvation, hypoprotinemia (especially hypoalbuminemia), avitaminosis (especially vitamin C), malignant disease, anemia, jaundice, diabetes mellitus, chronic renal failure, liver failure, prolonged steroid therapy immunosuppressive therapy and alchoholism **(Abrahamson, 1997).**

10-Postoperative complications:

Postoperative complications increase the incidence of postoperative hernias. They especially include increase intra-abdominal pressure due to vomiting, the development of postoperative chest infection resulting in coughing, and gross distention from paralytic ileus which places enormous vertical tension on the wound by increasing its length and, at the same time, raising the lateral pull on the sutures by increased girth of the abdomen (**Abrahamson,1997).**

11-Type of operation:

Certain types of operations have a tendency to be followed by hernia. These include laparotomy for generalized or localized peritonitis in patients with perforated peptic ulcer, appendicitis, diverticulitis, and acute pancreatitis. Also included are operations for intra-abdominal malignant disease, chronic inflammatory bowel disease, and reoperation through the original wound, especially within the first 6 months after the initial procedure. The cause of wound failure is not in the operation itself but in presence of many of the factors previously mentioned **(Abrahamson, 1997).**

12-Postoperative wound dehiscence:

Postoperative wound dehisence or burst abdomen, whether covered by skin or with frank evisceration, is often followed by postoperative hernia whether resutured or treated by open method. This is because all the conditions mentioned previously are also the causal factors in burst abdomen **(Abrahamson, 1997).**

Late Hernias:

The late incisional hernia, which appears later on after the original laparatomy closure, often involves part of the length of the wound, and grows slowly over a years. Some studies showed that about two thirds of incisional hernias appear within the first five years and that at least another third appear 5 to10 years after the operation **(Abrahamson, 1997).**

1-Tissue Failure:

The etiology of the late incisional hernia is not clear. The hernia develops in what apparently is a perfectly healed wound that has functioned satisfactorily for 5, 10, or even more years of the operation **(Abrahamson, 1997).**

It's difficult to understand why some mature collagen that has held out for many years suddenly fails. Aging of the tissues, weakning of the muscles, and loss of body vigor are advanced as the reasons for late recurrences, but the basic mechanisms are not known. It is assumed that for as yet unknown reasons, there is a breakdown in the metabolic system responsible for the balanced integrity of collagen. This may be the factor responsible for alterations in the resistance of the transversalis fascia and abdominal wall scar tissue **(Read, 1995).**

2-Collagen abnormalities:

Abnormal collagen production and maintenance have been shown to be associated with recurrent hernias in certain patients **(Abrahamson, 1997).**

There is a defeciency of collagen and abnormalities in its physicochemical structure, manifesting in reduced hydroxyl-prolene production and in changes in the diameter of the collagen fibres. These changes have been demonstrated in these patients in other sites such as skin, lung and pericardium, and may be associated with the imbalance between proteolytic enzymes and their inhibitors and the other enzyme abnormalities found in patients with emphysema and those who smoke (**Sorensen et al, 2002).**

Read has investigated the normal and abnormal metabolism of collagen and its relation-ship to the caustion of hernia, especially in smokers. He found that substances in cigarette smoke inactivate antiproteases in lung tissue and so upset the protease /antiprotease system, which is responsible for the integrity of the lung tissue leading to its destruction and emphysema. The free, unbound and active- protease and elastase compounds are also found in the serum of smokers. These circulating unopposed enzymes upset the protease /anti protease system in the blood and bring about destruction of elastin and collagen of the rectus sheath and fascia transversalis and so cause their attenuation and predispose to herniation in cigarette smokers **(Abrahamson, 1998).**

Anatomy of incisional hernia:

Hernias may develop in any abdominal incision, but most are in midline or paramedian incisions. They are also commonly seen in subcostal incisions for cholecystectomy, or scars following closure of colostomy. In recent years high epigastric hernia following sternal splitting incisions for cardiac operations and lower abdominal hernias through incisions for dialysis catheter have become more common (**Abrahamson, 1997).**

The hernial opening may vary in size since the original incision may have been a short one or only part of a long incision may have failed to heal. Several defects may exist along one incision, making for multiple hernias in one scar. In early appearing hernias, all of a long incision may have parted, leaving a long and wide defect. The sac of the hernia is often quite large and long and multiloculated, even with small hernial defects.

It protrudes forward, downwards, and to the sides, burrowing into the subcutaneous fat, and may even over hang the pubis and thighs. These hernias may reach enormous proportions and constitute a serious surgical challenge. The hernia may contain omentum, transverse colon, loops of small bowel, and even stomach. Adhesions between the contents and the sac wall are common and may be responsible for the hernia being incarcerated and irreducible **(Abrahamson, 1997).**

Umbilical hernia:

Umbilical hernias are the most common type of midline fascial defect. Umbilical hernias occur in both children and adults, but the mode of presentation, natural history, and treatment strategy are different in the two groups **(Bennett, 2002)**.

Umbilical hernia occurs when the umbilical scar does not close completely in the child or fails and stretches in later years in the adult. The hernia appears when the abdominal contents move through the umbilical opening. Midline hernias abutting on the umbilicus superiorly and inferiorly are called paraumbilical hernia **(Zinner and Ashley, 2006).**

Incidence:

In children, umbilical hernias are the third most common surgical disorder after hydrocele and inguinal hernias (**Bennett, 2002).**

The incidence of umbilical hernia present at birth has a wide range. In Caucasian babies, the incidence has been reported at 10-30%, although for unknown reasons it may be several times greater in African-American children **(Zinner and Ashley, 2006).**

Premature infant commonly have umbilical hernias, even up to 70%or more (**Abrahmson, 1997).**

Umbilical hernias are also common in children with Down syndrome, hypothyroidism or other syndromes (**Bennett, 2002).**

The majority of congenital pediatric umbilical hernias are known to close over time, as the infant becomes a child. In this way, by school age, only 10% of umbilical hernias remain open on physical examination **(Zinner and Ashley, 2006).**

The incidence of umbilical hernia in the adult is largely unknown but most cases are thought to be acquired rather than congenital. It's more common in adult females with a female to male ratio of 3:1 **(Zinner and Ashley, 2006).**

The pathophysiology of umbilical hernia in adults is disputed. It is generally believed that these hernias do not represent persistence from childhood but arise denovo in adult life. A retrospective review of adults with umbilical hernias found that only 10.9% recalled having hernias from childhood (**Bennett, 2002).**

Etiology:

The embryo develops a head, tail, and two lateral folds that grow towards each other to form the abdominal cavity. At about the sixth week of gestation, the rapidly growing intestinal tract cannot be contained by the abdominal cavity and prolapses out through the future umbilical ring. By the tenth week, the midgut rotates and enters the abdominal cavity and the four folds meet to form a narrow umbilical ring which, at birth, is only wide enough to allow the passage of the umbilical arteries and veins. When the cord is ligated, the arteries and vein thromboses, the umbilical ring continues to contract and to close by scar tissue. If this process is halted before complete closure of the umbilical ring, an umbilical hernia will be produced. The cord will separate normally and the granulation tissue covering the umbilicus will be epithelialized. If bowel or omentum prolapses through the incompletely closed umbilicus before or after birth, an umbilical hernia is formed. The hernia opening varies between a few millimeters in diameter to up to 4 cm**. (Abrahamson J, 1997).**

Most adult umbilical hernias are acquired and are called Paraumbilical hernias, which occurs following disruption of the linea alba above, or much less commonly below, the umbilical cicatrix **(Michie and Berry, 1994).**

Stretching of the abdominal wall due to obesity, multiple pregnancy, and ascites favour the development of this hernia (**Knol and Eckhauser, 1993).**

Deposition of fat in the abdominal wall in the obese may also be an aetiological factor. The condition usually occurs after the age of 35 and is five times more common in females **(Michie and Berry, 1994).**

With vigorous contraction of the rectus muscle at parturition, significant stress is placed on the lowest tendinous intersection. This stress is transmitted to an overstreched linea alba at the superior aspect of the umbilicus, resulting in paraumbilical hernia. Chronic abdominal distention can weaken the linea alba. Finally, 80% of paraumbilical hernias occur in patients with a single midline aponeurotic decussation (Occuring in 30%of the population).as compared with 20% in those with a triple midline aponeurotic decussation (**Askar, 1984).**

Anatomy of para-umbilical hernia

The defect in the abdominal wall is usually 2 to 5 cm in diameter, but large openings (Up to 10cm in diameter) are also common **(Abrahamson, 1997).**

As the hernia enlarges it becomes rounded or oval in shape, with a tendency to sag downwards. Paraumbilical hernias can become very large. The neck of the sac is often remarkably narrow compared with the size of the sac and the volume of its contents , which usually consists of greater omentum often accompanied by small intestine and , alternatively or in addition , a portion of transverse colon. In long standing cases the sac sometimes becomes loculated owing to adherence of omentum to its fundus **(Kingnorth and Bennett, 2000).**

Epigastric hernia

An epigastric hernia is a defect in the abdominal wall in the midline junction of the aponeuroses of the abdominal wall musculature from the xiphoid process superiorly to the umbilicus inferiorly. The region of this midline raphe is termed the linea alba, and the rectus muscles are situated just lateral to the linea alba. In this area, there is no muscle layer to protect against herniation of intra-abdominal contents through defects in the midline fascia. A paraumbilical hernia is an epigastric hernia that borders on the umbilicus **(Zinner and Ashley, 2006).**

Incidence:

The frequency of epigastric hernia in the general population range from 3-5%. It is most commonly diagnosed in middle age, and congenital epigastric hernias are uncommon. The condition is more common in males by a ratio of 3:1. 20% of epigastric hernias may be multiple, although most are associated with one dominant defect **(Zinner and Ashley, 2006).**

Etiology:

The cause of epigastric hernias is a combination of stress on the linea alba and a congenital variation in the structure of the linea alba (**Knol and Eckhauser, 1993).**

Distention of the abdominal wall, moreover, results in the separation of the decussating aponeurotic fibres in a transversely oriented rhomboid pattern. Vertically oriented aponeurotic fibres extending from the anterior diaphragm to the linea alba midway between xiphoid and umbilicus have also been demonstrated. Vigorous diaphragmatic contraction can thereby exerts a disruptive force on the predisposed linea alba to produce an epigastric hernia at this midpoint, which is the most common location **(Bennett, 2002).**

It was hypothesized that epigastric hernia commences as a protrusion of extraperitoneal fat through the linea alba at the sit where small blood vessels pierced the linea alba (**Kingnorth and Bennett, 2000).**

The old ideas that epigastric hernias start as a protrusion of a lobule of fat through an abnormally wide orifice for a blood vessel or through a congenial defect in the linea alba do not have a solid anatomic basis. The existence of a blood vessel in an epigastric hernial orifice is denied by many authors **(Askar, 1984).**

The fact that it is common between 20 and 50 years of age probably reflects of a balance between a congenital defect and a rise of intra abdominal pressure, adiposity and weakening of the muscles in adults. It is more frequent in people with a wide linea alba (diastasis of recti muscles) **(Abrahamson, 1997).**

Anatomy of epigastric hernia:

The midline opening in the fascia is usually elliptic with the long axis lying transversely, or diamond shaped. The size is usually only a few millimeters, but openings several centimeters in diameter are not unusual (**Abrahamson, 1997).**

The small defects contain only preperitoneal fat with no sac. With increasing size, fat in the falciform ligament and eventually a peritoneal sac and abdominal viscera may be contained with in the hernia (True epigastric hernia). The preperitoneal fat in small defects is usually incarcerated. Multiple defects are usually present in up to 20% of patients **(Knol and Eckhauser, 1993)**.

SPIGELIAN HERNIA:

A spigelian hernia is an unusual abdominal wall defect, which occurs through the fascia along the lateral edge of the rectus muscle at the space between the semilunar line (the lateral border of the rectus sheath) and the lateral edge of the rectus muscle (**Eubanks, 2001).**

Incidence:

A total of 979 cases of spigelian hernia treated surgically have been reported in the literature. Most have been diagnosed in patients between 40 and 70 years. The female to male ratio is 4:3, with both sides being equally affected. Less than 5%occured in children younger than 16 years **(Bennett, 2002)**

Etiology:

The causes of spigelian hernia are unclear. In most cases, the hernia appears to be acquired and is associated with anterior abdominal wall hernias. Most spigelian hernias are small (1 to 2 cm in diameter).patients usually presents with localized pain without much prominence of a bulge because almost all spigelian hernias are interparietal in nature. Incarceration is common with this form of hernia because the fascial ring is small and inelastic. The pain is generally exacerbated with muscular tension in the abdominal wall (**Knol and Echauser, 1993).**

Anatomy:

The semilunar line was first described accurately by Adriaan van der Spieghel. He described the spigelian fascia as the aponeurotic structure between the transversus abdominis muscle laterally and the posterior rectus sheath medially. This fascia is what makes up the semilunar line, and it is through this fascial layer that a spigelian hernia forms. In practice, the semilunar line is taken as the lateral border of the rectus sheath. Spieghel originally intended this structure to represent the line of transition from the muscular fibers of the transversus abdominis muscle to the posterior aponeurosis of the rectus. The semilunar line runs from the ninth rib cartilage superiorly to the pubic tubercle inferiorly. The spigelian fascia varies in width along the semilunar line, and it gets wider as it approaches the umbilicus. The widest portion of the spigelian fascia is the area where the semilunar line intersects the arcuate line of Douglas (the linea semicircularis). It is in this region, between the umbilicus and the arcuate line, where more than 90% of spigelian hernias are found. It is thought that since the spigelian fascia is widest at this point, it is also weakest in this region. Below the arcuate line, all of the transversus abdominis aponeurotic fibers pass anterior to the rectus muscle to contribute to the anterior rectus sheath, and there is no posterior component of the rectus sheath. The rearrangement of muscle and fascial fibers at the intersection of the arcuate and semilunar lines is thought to cause an area of functional weakness that is predisposed to hernia formation. Hernias at the upper extremes of the semilunar line are rare and usually not true spigelian hernias since there is little spigelian fascia in these regions **(Zinner and Ashley, 2006).**

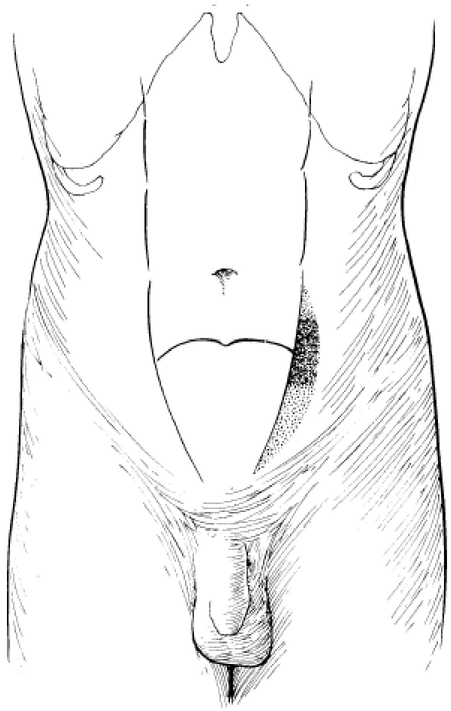


Fig.11: *Anatomy of the spigelian hernia and the sites of most common occurrence*
(Zinner and Ashley, 2006)

As the hernia develops, preperitoneal fat emerges through the defect in the spigelian fascia bringing an extension of the peritoneum with it. The hernia usually meets resistance from the external oblique aponeurosis, which is intact and does not undergo rearrangement of its aponeurotic fibers at the arcuate line. For this reason, almost all spigelian hernias are interparietal in nature, and only rarely will the hernia sac lie in the subcutaneous tissues anterior to the external oblique fascia. This fact makes the accurate diagnosis of spigelian hernias more difficult. The hernia also cannot develop medially due to resistance from the intact rectus muscle and sheath. Therefore, a large spigelian hernia is most often found lateral and inferior to its defect in the space directly posterior to the external oblique muscle **(Zinner and Ashley, 2006).**

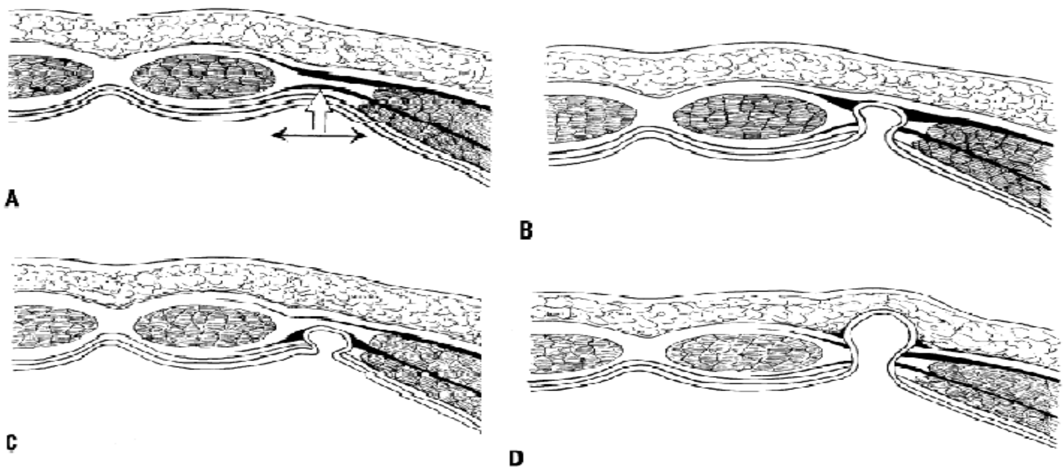


Fig.12: *The spigelian hernia.* ***A.*** *Breaching the spigelian fascia.* ***B.*** *The most common type has passed through the transversus abdominis and the internal oblique aponeuroses and is spreading out in the interstitial layer posterior to the external oblique aponeurosis.* ***C.*** *The less common type in the interstitial layer between the transversus abdominis aponeurosis and the internal oblique muscle.* ***D.*** *The least common subcutaneous type* ***(Zinner and Ashley, 2006)***

Clinical Manifestations:

The patient most often presents with a swelling in the middle to lower abdomen just lateral to the rectus muscle. The patient may complain of a sharp pain or tenderness at this site. The hernia is usually reducible in the supine position. However, up to 20% of spigelian hernias will present incarcerated, and for this reason operative repair is mandatory once the hernia is confirmed on diagnosis. The reducible mass may be palpable, even if it sits below the external oblique musculature.

When the diagnosis is unclear, radiologic imaging may be necessary. Ultrasound examination has been shown to be the most reliable and easiest method to assist in the diagnostic work-up. Testa and colleagues found that abdominal wall ultrasonography was accurate in 86% of cases of spigelian hernia. If the hernia is fully reduced during examination and no mass is palpable, ultrasound evaluation can show a break in the echogenic shadow of the semilunar line associated with the fascial defect **(Zinner and Ashley, 2006).**

B- Hernias of the Groin:

The groin is one of the natural weak areas in the abdominal wall and is the most common site for abdominal herniation. Hernias arising above the abdominocrural crease are inguinal and those arising below the crease are femoral or crural. Inguinal hernias may be direct or indirect **(Wantz GE, 1999).**

Incidence:

Both sexes of all ages are affected, but men are 25 time more likely to have a groin hernia than women. In men, **indirect** hernias outnumber **direct** hernias at a ratio of 2:1, whereas in women direct hernias are a rarity. **Femoral** hernias are uncommon, comprising about 2.5 % of all groin hernias. They occur occasionally in women, especially in multiparous elderly women, but not as frequently as inguinal hernias; in men they are rare. Both indirect inguinal and femoral hernias are ***twice*** as common on the right as on the left. In indirect inguinal hernias this is attributed to a delay in the atrophy of the processus vaginalis that follows the normally slower descent to the scrotum of the right testis. In femoral hernias the right side's predominance is credited to the sigmoid colon's tamponading the left femoral canal **(Wantz GE, 1999).**

Etiology:

Inguinal hernias can be congenital or acquired, and in both a family history of groin hernias is usually strongly positive. Most hernias of the groin therefore may be said to be transmitted genetically. Indirect inguinal hernias are thought to be congenital in etiology and result from a patent processus vaginalis, with which the patient is born. A patent processus vaginalis is found in 80% of newborns and in 50% of 1-year-olds. Closure continues until the age of 2 years. The incidence of a patent processus vaginalis in adults is 20%. Having the potential for a hernia does not mean that a hernia will develop. The erect stance of human beings, in contrast to that of four legged animals, promotes herniation by stretching and exposing the groin and, when a hernia is present, permitting the dependent intestines to drop into the hernial sac.

Muscle deficiency contributes to herniation. Congenital or acquired insufficiencies of the internal oblique abdominal muscles in the groin expose the deep ring and the floor of the inguinal canal to the destructive effects of intraabdominal pressure **(Wantz GE, 1999).**

It is commonly thought that repeated increases in intra-abdominal pressure contribute to hernia formation; hence, inguinal hernias are commonly associated with pregnancy, chronic obstructive pulmonary disease, abdominal ascites, patients who undergo peritoneal dialysis, laborers who repeatedly flex the abdominal wall musculature, and individuals who strain from constipation. It is also thought that collagen formation and structure deteriorates with age, and thus hernia formation is more common in the older individual. There is evidence that cigarette smoking is associated with connective tissue disruption, and hernia formation is more common in the chronic smoker **(Zinner and Ashley, 2006).**

Fracture deformities of the pelvis and denervation of the shutter mechanism following a low cosmetic appendectomy incision are well-known but uncommon causes of inguinal herniation. Inguinal hernias of all types occur equally in sedentary and in physically active men. Vigorous physical activity per se is not a cause of inguinal herniation, although strenuous effort may aggravate predisposing factors and precipitate herniation **(Wantz GE, 1999).**

In contrast to the inguinal hernia, the femoral hernia is unlikely to be of congenital etiology. The incidence of femoral hernia in infancy and childhood is exceedingly low, in the range of 0.5%. In addition, there is no embryologic mechanism for a preexisting sac of peritoneum in the femoral canal. The hernia defect most often presents in middle-aged to older women, suggesting that the natural loss of tissue strength and elasticity is a primary etiology **(Zinner and Ashley, 2006).**

Anatomy:

An indirect hernial sac is actually a dilated persistent processus vaginalis. It passes through the deep ring, lies within the spermatic cord, and follows the indirect course of the cord to the scrotum. At the deep ring the sac occupies the anterior lateral side of the cord. An indirect hernial sac is said to be complete if the sac has descended to the testis and filled the side of the scrotum and incomplete when it has not. When the processus vaginalis remains completely open, the testicle will be within the sac. This type of hernia is known as a congenital hernia or communicating hydrocele. They are common in infants but rare in adult men. **(Wantz, 1999).**

Retroperitoneal organs such as the sigmoid colon, cecum, and urinary bladder may slide into an indirect sac. They thereby become a part of the wall of the sac and are susceptible to injury during herniotomy. These sliding hernias often are large and partially irreducible. Direct inguinal hernial sacs originate through the floor of the inguinal canal, that is, Hesselbach's triangle; which is bounded by the inferior (deep) epigastric vessels as its superior or lateral border, the lateral edge of the rectus abdominis muscle as its medial border, and the inguinal ligament as its inferolateral border. They protrude directly; and they are contained by the aponeurosis of the external oblique muscle. Rarely, they so enlarge as to force their way through the superficial ring and descend into the scrotum. Direct hernias usually are diffuse and involve the entire floor of the inguinal canal. The less common discrete direct hernias have small orifices and diverticulum-shaped sacs. Direct inguinal hernias also originate lateral to the inferior epigastric vessels and present through the deep ring or interstitially through slips of fatty muscular atrophy in the shutter muscles of the deep ring. These types of direct inguinal hernia are rare and commonly referred to erroneously as extra-funicular indirect and interstitial indirect hernias, respectively. They do not follow the spermatic cord and enlarge interparietally. The inferior epigastric vessels are not a proper anatomic boundary distinguishing a direct hernia from an indirect hernia in all instances, as some surgeons believe. The bladder is a common sliding component of a direct hernial sac **(Wantz, 1999).**

The defect through which a femoral hernia occurs is in the medial femoral canal. The anterior boundary of this defect is the inguinal ligament, the lateral boundary the femoral vein, the posterior boundary the pubic ramus and Cooper's ligament, and the medial boundary the lacunar portion of the inguinal ligament. This space is obviously tight and does not have room to expand when hernia contents fill the sac since the boundaries are either ligamentous, bony, or the fibrous femoral sheath and its vessels. Therefore, femoral hernias have a high propensity for incarceration and strangulation. Gallegos and associates reported the cumulative probability of femoral hernia strangulation to be 22% in the first 3 months following diagnosis and 45% at nearly 2 years. Therefore, repair of a known femoral hernia is mandatory to avoid this highly morbid complication **(Zinner and Ashley, 2006).**

Femoral hernias also occur through the anterior femoral sheath. Prevascular femoral hernias are rare and are most often encountered as a recurrence after inguinal hernioplasty in which the femoral sheath or iliopubic tract has been used in the repair **(Wantz, 1999).**

Approaches to ventral hernia repair

Repair of a large ventral hernia is a major undertaking and requires careful preoperative assessment, sound operative technique and a careful postoperative care of the patient **(Abrahamson, 1997).**

Preoperative management:

When there is no indication for urgent surgical intervention, patients with ventral hernia need to have an adequate preoperative preparation in order to obtain a perfect repair **(Benett and Kingnorth, 2004).**

Weight control:

Obesity is one of the most important causes of ventral and incisional hernias. Thus obese patients must be urged to loose weight but few patients actually comply with this recommendation (**Eubanks, 2001; Abrahamson, 1997, Savage and lamont, 1994)**.

Body mass index is defined as the individual's body weight divided by the square of his or her height. The formulae universally used in medicine produce a unit of measure of kg/m^2. BMI provided a simple numeric measure of a person's "fatness" or "thinness", allowing health professionals to discuss over- and under-weight problems, a BMI lower than 18.5 suggests the person is underweight; while a number above 25 may indicate the person is overweight; a BMI of 18.5 to 25 may indicate the optimal weight for operation **(Eknoyan, et al.,2008).**

Associated medical conditions:

Associated cardiovascular, respiratory, and renal conditions, diabetes, hypertension and other general illness must be diagnosed, assessed, controlled and treated. Also, any septic foci and infection must be treated. The operation is usually elective and must be delayed until the patient is in an optimal state (**Abrahamson, 1997).**

Smokers should be urged to stop smoking and aggressive pulmonary toilet should be instituted preoperatively with attempts to alleviate chronic cough, which will place unnecessary strain on the hernia repair (**Holzman and Pappas, 2000).**

Respiratory exercises should begin few weeks before the operation so that the patient is in an optimal state for operation (**Abrahamson, 1997).**

A history of constipation and difficulties with urination can lead to straining and increased abdominal pressure, making the success of repair in danger. These conditions should be investigated and corrected, if possible, prior to elective herniorrhaphy **(Holzman and Pappas, 2000).**

Skin preparation:

Many patients with a large ventral hernia have poor cutaneous hygiene in skin folds below the hernial mass. Patients should shower preoperatively with germicidal soap and antifungal cream should be applied to affected skin areas. Talcum powder or corn starch may be applied to keep the skin dry (**Holzman and Pappas, 2000).**

Associated intra-abdominal pathology:

The patient should be investigated for co-existing intra abdominal pathology so that it can be dealt with at the same operation. This will avoid the embracing pit fall of further surgery for missed pathology soon after a major repair of a large abdominal hernia **(Abrahamson, 1997).**

Pre-operative pneumoperitoneum:

In patients with large incisional hernias, the contents of the hernia may have lost the right of domain in the abdomen, return of the contents of the hernia to the abdominal cavity may result in increased intraabdominal pressure, splinting of the diaphragm, and a significant reduction in pulmonary reserve especially in patients with chronic pulmonary disease thus pulmonary function studies are indicated preoperatively **(Savage and Lamont, 1994).**

This technique involves gradual expansion of the abdominal cavity over five to ten days. The percutaneous approach uses a 16-gauge angiocatheter inserted away from any previous abdominal incision. One to two liters of room air is introduced over a ten-minute period with a three-way stopcock and a 50 cc syringe. The procedure is terminated when discomfort or shortness of breath occurs. Each patient had spirometry measurements preoperatively, following pneumoperitoneum, and postoperatively. The procedure is prolonged if spirometry measurements reveal the patient will not tolerate acute abdominal expansion **(Raynor RW et al, 1995).**

With this technique, we can assess the patient's tolerance to reintegration of the hernial mass. The diaphragm can be readapted to work in physiological conditions and according to the author of the technique (Goni Moreno); dissection of the hernial sac is facilitated **(Flament and Palot, 2002).**

Deep vein thrombosis prophylaxis*:*

Prophylactic subcutaneous heparin is recommended **(Abrahamson, 1997).**

Types and dose of heparin:

- Enoxaparin or Clexan which is a low mol. Wt. heparin (approved in Canada and the United States) is administered at 20 mg subcutaneously 1-2 hours before surgery and once daily postoperatively for moderate-risk patients. A dose of 40 mg with the same schedule is administered to high-risk patients.
- Dalteparin (approved in Canada and the United States) is administered at 2500 U subcutaneously 1-2 hours before surgery and once daily postoperatively for moderate-risk patients. A dose of 5000 U with the same schedule is administered to high-risk patients.

- Nadroparin (approved in Canada) is administered at 2850 U subcutaneously 2-4 hours before surgery and once daily postoperatively for moderate-risk patients.
- Tinzaparin (approved in Canada and the United States) is administered at 3500 U subcutaneously 2 hours before surgery and once daily postoperatively for moderate-risk patients.
- Fondaparinux sodium (approved in Canada and the United States) is administered at 2.5 mg subcutaneously starting 6 hours postoperatively and once daily thereafter for moderate- and high-risk patients ***(Alikhan R, et al, 2004).***

Antibiotics:

Prophylactic antibiotics are indicated to reduce the incidence of wound sepsis and the chance of failure of the repair **(Savage and Lamont, 1994 and Abrahamson, 1997).**

However, in view of the reports of Davis and Houck, it appears that antibiotics should be used more liberally when repairing postoperative hernias, since a high proportion of them follow previous infected wounds and the procedure should in fact be considered a contaminated operation (**Houck et al., 1989).**

The arguments for antibiotics become even stronger when a foreign body such as a prosthetic mesh will be used for the repair (**Abrahamson, 1997).**

Operative treatment:

Surgery remains the only feasible treatment for epigastric, Paraumbilical and ventral aponeurotic hernial defects **(Askar, 1984).**

However, the natural history of umbilical and epigastric hernias in children differs from that observed in adults. Unless complicated by pain incarceration or strangulation, there is no indication for surgical intervention before the age of 2 years. If the fascial defect is less than **1.5**cm, there is a high likelihood of spontaneous resolution **(Bennett, 2002).**

There is no general agreement among surgeons regarding the optimal time to repair an umbilical hernial in a child. Some recommend elective repair of all hernias, others recommend elective repair of all hernias if the defect has not closed by four years of age, and at least one surgeon has advised against the repair until puberty. However, the British society of pediatric surgeons recommends repair prior to child commencing school (age 3 to 4 years) or if the fascial defect greater than **1.5**cm **(Larson and vandertoll, 1984) (Bennett, 2002).**

While the American role, is closure of the lesions 1.5 to 2.0 cm in diameter after 2 to 3 years of age, (1–1.5 cm) fascial defects that fail to decrease in size over 6 to 12 months of observation in children over 3 years of age, and fascial defects that persist at 5 to 6 years of age **(Cilley, et al, 2006).**

Based on observations made in Nigeria, fascial defects continue to close until at least 14 years of age; therefore, continued observation can be offered to families as well **(Meier, et al, 2001).**

The epigastric hernia in children, like the umbilical hernia is best managed expectantly (**Larson and Vandertoll, 1984).**

In adults small symptom-less epigastric hernias may safely be left untreated. The larger ones and those causing discomfort should be repaired **(Abrahamson, 1997).**

There is no place in the treatment of umbilical hernias for strapping and the definitive treatment of umbilical hernias is surgical repair **(Bennett, 2002).**

The application of a truss is usually unsuccessful because most of these hernias are loculated and often are partially irreducible. The hernial orifice in most cases lies deeper than could be efficiently reached by a truss pad. The use of a truss may even be hazardous, particularly in patients with recurrent Paraumbilical hernias in whom loops of small intestine and parts of the transverse colon often adhere to the hernial sac **(Askar, 1984)**.

Techniques:

Various methods and different techniques have been described as different options in the surgical management of ventral hernias.

1- Mayo's repair (vest over pants):

The traditional method is the so called "vest over pants" repair which was promoted by William j. Mayo as early as 1898. With this technique, the fascia is overlapped side to side or transversely, in order to secure a wide area of adhesions to strengthen the repair (**Larson and vandertoll, 1984).**

An elliptic transverse incision is made to excise the skin, umbilical scare, fat and the hernial sac. The hernial defect then was enlarged by incising the abdominal wall laterally on each side. The hernial contents were returned to the peritoneal cavity and the defect was closed by over lapping the upper flap of the abdominal wall over the lower by using two rows of staggered interrupted full thickness sutures (**Abrahamson, 1997).**

The classic mayo's operation has been discarded since Farris 1964 demonstrated that the bursting strength of the wound did not improve by imbrication and actually was impaired to a degree that was proportional to the amount of overlapping and tension **(Bennett, 2002).**

2- Simple direct apposition of the fascia:

The second method of repair is a simple direct apposition of the fascia, edge to edge, either horizontally or vertically depending on the orientation of the defect and the direction that produces least tension **(Bennett, 2002.)**

The umbilicus can be preserved by making a "curved smile" incision concave cranially around the inferior aspect of the hernia in the skin crease between the hernia and the abdominal wall. Skin flaps raised exposing fascial edge of hernial opening and neck of the sac with a wide area of anterior rectus sheath around the opening is cleared of fat. The sac is opened, the contents of the hernia are extracted and adhesions between them and the sac are freed. The bowel is returned to the peritoneal cavity while the omentum and the sac are excised **(Bennett, 2002).**

The fascial defect is closed transversely with the sutures are at a right angle to the line of the fascial fibers so that there is less tendency to cut out. Coughing and straining post-operatively tend to close the line of repair rather than to strain it outwards, since the fibers pull in a transverse direction rather than craniocaudal **(Abrahamson, 1997).**

The defect may be closed by a series of interrupted monofilament polypropylene or polymaide sutures. It is more convenient to place all the sutures inposition before tying them individually. Alternatively, a continous suture may be used **(Abrahamson, 1997).**

The sutures should be placed in solid healthy fascia about 1.5 cm from the wound edge and at intervals of **1.5**cm **(Larson and Vandertoll, 1984).**

In epigastric hernia the orientation of suture closure remains a matter of controversy; some surgeons claim that a transverse closure is more sound, while others prefer a vertical closure because of the frequency of multiple defects and of recurrence adjecent to the transverse hernioplasty (Although many of these recurrences are probably missed primary defects at the time of the original surgery) **(Bennett, 2002).**

A third group of surgeons prefer an oblique orientation of sutures claiming it to be more anatomic. The important principle is to do no harm, and for small defects, elaborate procedures that violate normal surrounding fascia are meddlesome and unnecessary and should be avoided **(Bennett, 2002).**

The previously mentioned primary closure of the hernia defect may be reinforced by an onlay darn of the anterior rectus sheath. After closure of the defect two lines of oblique sutures are used for the darn. The first line should go beyond, both above and below, the original transverse suture line. The second line of the darn should be placed even further beyond the first. Strong bites are to be taken of the rectus sheath **(Abrahamson, 1997).**

Post operative complications:

Haematoma and seroma:

The post operative complications of the above mentioned methods of repair include mainly local Haematoma formation and wound infection both of which increase the likelihood of recurrence of the hernia. However with proper care both complications should be rare **(Abrahamson, 1997).**

Hernia recurrence:

Unfortunately, after primary repair of incisional hernia, recurrent herniation was reported to occur in **30% 50%**of cases **(Leber et al., 1998 and Larson 2000).**

In a series of **68** primary midline incisional hernia cases in which a vertical mayo repair was performed, retrospective evaluation revealed that the **1,3,5** and **10** years cumulative recurrence rates were **35%, 46% 48% 54%**respectively. Considering these high recurrence rates, this study suggested that the “vest over pants” repair should no longer be used for closure of midline incisional hernias **(Luijendijk et al., 1997).**

Paul et al. report a recurrence rate of **54%**in **114** patients who underwent mayo repairs over **5.7** years (mean) follow up which was not acceptable and it was recommended that implantation of prosthetic mesh should be considered more frequently **(Paul et al., 1998)**

3- Reconstruction of the linea alba:

Several methods are advocated:

The keel operation:

In this procedure an extraperitoneal repair is done for the midline incisional hernias, this repair avoids opening the peritoneum thus minimizing postoperative ileus and allows early mobilization. The hernial sac and the neck of the hernia are cleared of the fibro fatty tissue and the hernia is inverted by the placement of interrupted mattress nylon sutures to close the defect in the musculoaponeurotic area. A longitudinal incision through the lateral aspect of the anterior rectus sheath is made to aid relaxation during approximation of the fibrous ring **(Ponka, 1980).**

Vertical mass closure:

Vertical mass closure is done through application of bites that include not only the linea alba but also part of the anterior and posterior rectus sheath **(Abrahamson, 1997).**

Vertical overlap technique:

This technique can be done by making a vertical incision along the anterior rectus sheath to create a medial flap which is double-breasted **(Abrahamson, 1997).**

The shoelace darn repair:

In this technique a new linea alba is constructed using a vertical strip **1** to **1.5**cm wide split off the medial edge of each anterior rectus sheath.

After defining the abdominal wall around the hernial opening an incision is made in each anterior rectus sheath about 1 cm or more from its medial edge to confirm the presence of rectus muscle, the incision is extended upwards and downwards keeping the ends of incision away from and parallel to the midline. The two medial strips are sewn together by a continuous suture starting at the top corners of the incision and incorporating the whole width of each strip. This not only creates the new linea alba but also returns the unopened sac and its contents to the abdominal cavity. The sac remains unopened throughout the operation. If it is opened inadvertently, it is closed with a synthetic absorbable suture. There is no need to open the sac and become involved in the tedious dissection for freeing the masses of adherent bowel from the sac walls and from each other unless dealing with an emergency case of strangulation, bowel obstruction or with a patient with a recent history of bowel obstruction. There appears to be no reported cases of mechanical obstruction following simple inversion of the sac. In this way the posterior rectus sheath and the rectus muscles have been approximated at midline. The flat muscles can be restored to their former lengths and the recti muscles to their normal thickness and position by a continuous monofilament suture passing to and fro in front of the rectus abdominis muscles, between the cut edges of the anterior rectus sheaths, and through the strong new mid-line anchor for the whole length, in the manner of a shoelace tightening a boot. Each bite on the rectus sheath passes vertically from above down, from out side in, and from in side out at least **2**cm from the edge, so that it crosses and pulls on the fibers of the rectus sheath at a right angle, there by preventing the sutures from cutting out. The sutures should be approximately **0.5**cm apart and fairly tense to narrow the gap considerably between the cut edges of the rectus sheath. Each suture is fixed at its midpoint by passing through the new midline, thus preventing bowstringing and reherniation between the sutures. Thus the cut edges of the rectus sheaths have been brought parallel to each other, the rectus muscles are narrowed and thicker and at the midline in their normal anatomic position with their fibers running parallel to each other. The edges of the anterior rectus sheaths may be approximated by the suture line, however in the usual cases of large hernia, a gap of at least a few centimeters remains, with the continuos pliable to - and -fro shoelace suture adjusting it self to the differing widths and tension across the fascial defect and thus functionally substituting for the missing anterior rectus sheath. In cases of incisional hernia even when only part of the original incision has herniated and the remainder is still intact, the complete incision should be included in the repair to spread the tension evenly along the greater length **(Abrahamson, 1997).**

In cases of epigastric hernia, it is believed that there is little reason for doing a major repair of all the linea alba when repairing a single small epigastric hernia, as most patients do not develop more than one epigastric hernia and do not need the major procedure and the repair of the hernia is usually a minor ambulatory operation and can be repeated easily **(Abrahamson, 1997).**

Complication of *shoelace* :

It was found that complications associated with this procedure to be few and usually minor. The most serious local complications are infection, which is a potent cause of recurrence of the hernia. Strict precautions must be taken regarding sterility. The dissection must be clean and atraumatic, meticulous hemostasis is important throughout the operation, since any collection may lead to infection **(Abrahamson, 1997).**

4- Mesh repair:

High recurrence rates associated with primary suture repair have led to an increased application of prosthetic mesh for the repair of incisional hernias. The use of synthetic mesh in incisional hernia repairs increased from 34.2% in 1987 to 65.5% in 1999**(Flum et al., 2003).**

The American Hernia Society has declared that the use of mesh currently represents the standard of care in incisional hernia repair **(Voeller et al., 1999).**

Placement of mesh allows for a tension-free restoration of the structural integrity of the abdominal wall. Advantages to the use of mesh include availability, absence of donor site morbidity, and strength of the repair **(Grevious et al., 2006).**

The ideal prosthetic material should be nontoxic, nonimmunogenic, and nonreactive. The ultimate goal when using mesh is for it to become incorporated into the surrounding tissues. Tensile strength is another important property of the synthetic material **(Grevious et al., 2006).**

Mesh materials:

Polypropylene mesh (prolene, marlex, atrium, vypro, surgipro):

This type of mesh closely meets the requirements of the ideal prosthesis and is to-day the most commonly used material for repair of all types of hernia. It consists of monofilaments thread of polypropylene, knitted in a fairly loose manner. It stimulates almost no biological response from the tissues or significant rejection and is rapidly incorporated by fibroblasts and granulation tissue that pass through and fill the interstices between the knit. There are no cervices and the thread is extremely smooth so that it is hardly colonizable by bacteria and thus withstands infection exceptionally well. Even when exposed in an infected wound, it will be covered rapidly and incorporated by the granulation tissue. Polypropylene mesh is well tolerated and does not appear to degrade or lose strength in patients **(Abrahamson, 1997) and (Schumpelick et al., 2002).**

Polyethylene terephthalate (Dacron, Mersilene, parietex):

The next most popular prosthesis is also a knitted mesh but has a multifilament polyester fiber thread (Dacron, mersilene). This is an excellent material, cheap and freely available and is very popular in french surgical centers, it is also recommended by some English and American surgeons. Its main advantage is that it is light and extremely supple, has a pleasant soft feel, and is strong and elastic. Because of its softness, it easily conforms to all shapes and surfaces without any tendency to recoil. Its surface is slightly granular and excites greater tissue inflammatory response than polypropylene. While some surgeons see this character as a negative quality, those who use this material consider these characteristics advantageous. They believe that the granular surface creats friction between the mesh and the tissues, especially the peritoneum, thus preventing slippage of the mesh (gripping the peritoneum) **(Wantz, 1991).**

The more extreme inflammatory response causes a rapid invasion of the mesh by fibroblasts and granulation tissue, quickly and strongly fixing the mesh in the tissues **(Schumpelick et al., 2002)**.

for these reasons the knitted polyester mesh is particularly suitable when mesh is placed in the plane behind the rectus muscles and laid on to the anterior aspect of the posterior rectus sheath, when no sutures are used to fix the mesh but friction and rapid incorportion is relied on while the intra-abdominal pressure holds the mesh in place. Thus using the intraabdominal pressure which is the cause of the hernia to prevent its recurrence **(Wantz, 1991)**

The two main disadvantages of this material is that, it tends to tear easily under tension, a recently recognized problem of polyethylene is the obilgate degradation with an entire loss of mechanical stability, which further more can be considerably accelerated in the presence of an insidious infection. Mean while, a few cases of recurrence due to rupture within the polyethylene have been reported **(Schumpelick and King, 1999) and (Schumpelick et al., 2002).**

The multifibered braided thread makes this mesh less resistant to infection. The crevices and spaces between the filaments making up the thread are **10** micron or less in size, and consequently, bacteria that are approximately **1** micron in size can safely colonize these spaces, since leukocytes are too large to squeeze into **10** microns. These clonies will continually reinfect the tissues and perpetuate the infection, leading to failure of the repair and recurrence **(Abrahamson, 1997).**

Expanded poly tetra fluoro ethylen (e PTFE, Teflon, Gore-Tex):

This material has been extensively and successfully used for vascular prostheses and is available in micro porous sheets of varying thicknesses. The e-PTFE patch is composed of pillar-shaped nodes of PTFE that are connected by fine fibrils of PTFE with a multidirectional arrangement of the fibrils in the surface view, which imports balanced strength to the patch in all directions. It is extremely strong, yet very pliable, soft, smooth and slippery to touch. It can be cut to any shape and do not unravel **(Debord et al., 1992).**

The e-PTFE patch is biologically inert and produces little or no inflammatory reaction, with no tendency to be rejected. Its porous micro structure provides a lattice for the incorporation of connective tissue **(Hamer and Scott, 1985) (Baur et al., 1987) (Law and Ellis, 1988).**

However this is not as efficient as the knitted meshes with wide spaces that are more easily invaded **(Schumpelick et al. 2002).** The Lichtenstein group claims that penetration of fibroblasts from the host tissue into the depth of ePTFE is only approximately **10%** after three years, and that this is further decreased in the presence of infection **(Amid et al., 1992).**

This poor penetration leads to defective fixation and slippage of the prosthesis and recurrence of the hernia. Thus the achievement of a sufficiently mechanical strength requires a tight and durable fixation of the mesh in the surrounding tissue **(Schumpelick et al., 2002).**

As a consequence; several modifications have been developed either with added perforations or as a combination with a second layer with large bores **(Bellon et al., 1995, Bellon et al., 1996a, Bellon et al., 1996b and Belon et al., 1996c)**

A further disadvantage is that ePTFE is made up of spaces between the synthestic material and that many of this spaces can be shown to be <**10** micron size, these small pore size hinders the destruction of the bacteria by macrophages, so that ePTFE mesh always have to be removed in cases of infection **(Amid, 1997).**

The biological inertness of e-PTFE, while being a disadvantage as far as incorporation is concerned, may be of some advantage in certain situation where the material is used to bridge large gaps of abdominal wall, where the unprotected bowel comes in contact with the prosthesis producing fewer adhesions, even in the presence of infection and perhaps may reduce the risk of bowel adhesion, obstructions and entero cutaneous fistula. Although there may be certain advantages of ePTFE, its high cost limits its availability since knitted polypropylene mesh is much cheaper and on the whole, probaply better **(Abrahamson, 1997).**

Polypropylene–expanded polyfluorotetraethylene Composix mesh (Bard/Davol):

A heavyweight polypropylene mesh with a layer of ePTFE. This composite graft allows for a macroporous mesh to be exposed to the anterior abdominal wall, while the undersurface resists ingrowth. This mesh has been popular for many years. Some problems can occur when there is a differential in contraction between the polypropylene and the ePTFE layers, which leads to rolling of the mesh edges and thus exposure of the polypropylene to bowel **(Bachman and Ramshaw , 2008).**

Fig.13: *An explanted mesh consisting of a heavyweight polypropylene–ePTFE composite, after cleaning. This specimen is notable for the contraction of the mesh, which led to exposure of the polypropylene to the viscera* ***(Bachman and Ramshaw , 2008).***

Absorbable synthetic meshes (polyglactin 910, vicryl, polyglycolic acid, Dexon):

These types of meshes are usually made of absorbable multifilaments with a mean time of **2** to **3** weeks to halve their mechanical strength and **6** to **8** weeks to be completely absorbed **(Schumpelick et al., 2002).**

In principle all absorbable materials, whether synthetic or natural can not provide a sufficient strength of the repair followed by high rates of recurrence or even implying rergularly large incisional hernias as seen after the application of a laparo stoma **(Lamb et al., 1983) and (Tyrell, Silberman, Chandrasoma., et al., 1989).**

The augmentation of a regular fascial closure by sutures with absorbable meshes can not decrease the rate for incisional hernias as it is demonstrated by **Pans et al., 1998.**

Absorbable meshes are preferred for temporary wound closure in case of abdominal wall defects or peritonitis for they show a considerably lowered risk of bowel fistulas. The temporary implantation as an onlay permits daily revision and reduces intra abdominal pressure promoting the blood supply to the bowels, kidney and the abdominal wall itself. Furthermore, they are used accordingly to cover the non absorbable meshes to prevent direct contact with the intestine until the peritonealization is finished **(Schumpelick et al., 2002).**

Choice of material:

A frequent question from surgeons is: ‘‘with the wide variety of mesh products to choose from, which mesh is best?’’ At this point, there is no‘‘best’’ mesh, so the decision of which mesh to use is based on several factors: the type of procedure being done, the clinical situation, the desired handling characteristics, and the products available to the surgeon based upon hospital materials contracts and costs **(Bachman and Ramshaw , 2008).**

Mesh placement techniques:

Many variations and combinations of mesh repair have been described. Apiece of mesh cut to the shape of the defect but larger than it **(Abrahamson, 1997) (Scott and Jones, 2001)**

The mesh may be sutured either as:

1- Onlay graft:

In this method, skin and subcutaneous tissue are elevated and underlying adhesions are lysed to expose the fascial edges laterally for approximately **4** cm on both the superficial and deep surfaces. Horizontal matterss sutures are placed from within the peritoneal cavity along one half of the defect through the full thickness of fascia and muscle, at least **2**cm from the fascial edge. These sutures are passed through the mesh and tied. A second row of sutures is placed on the other half of the defect; sutures are individually clamped and held in moderate tension. To avoid risk of intestinal injury all sutures are placed under direct visualization before the fascia are closed, as opposed to securing the mesh by blindly taking bites on the anterior fascial surface after the fascia has been closed. The latter practice is not-only unsafe but results in superficial bites that inadequately secure the mesh. After all the sutures have been placed, the fascia is closed in a running fashion, so long as this can be done in a tension free fashion. This step creates a barrier between the abdominal contents and the mesh to prevent adhesions and fistula formation. The clamped sutures are placed through the mesh and tied. If fascia can not be reapproximated, the hernia sac or peritoneum is closed at the midline, or omentum is interposed between the mesh and the intestinal contents to prevent bowel erosion **(Scott and Jones 2001) (Sanatora and Roslyn, 1993)**

Alternatively placing an absorbable mesh on the intraperitioneal side of the repair may create an adequate barrier against adhesions **(Porter 1995) (Naim, Pulley, Scanlan et al., 1993).**

The disadvantages of the onlay graft is that it may cover a repair that has too much tension and requires dissection of a subcutaneous flap, thus exposing the prosthetic mesh to poorly vascularized fat and increasing the likelihood of seroma and wound infection. In addition abdominal wall forces may break down the primary repair and push the graft off the outer fascial surface, predisposing to recurrence **(Mclanahan et al., 1997).**

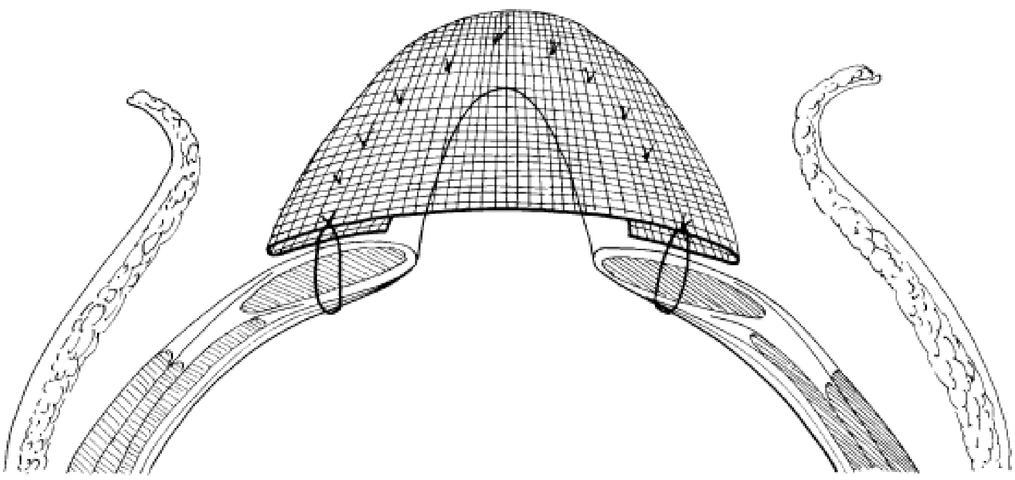


Fig.14: *Onlay graft* ***(Abrahamson, 1997).***

2- In lay graft or patch repair:

In which a piece of mesh the size and shape of the defect is sutured to the collar of the apponeuritic defect in an edge to edge manner **(Mclanhan et al., 1997) (Abrahamson, 1997) and (Scott and Jones, 2001).**

However this technique has certain disadvantage, the inlay graft attaches to the edges of the defect, where the tissue may already be weakened by previous surgery, scarring, and stretching. Also the intra-abdominal pressure and muscle contraction pulling laterally act to distract the suture line, leading to the commonly seen recurrence between the lateral edge of the graft and the edge of the original defect **(Mclanahan et al., 1997).**

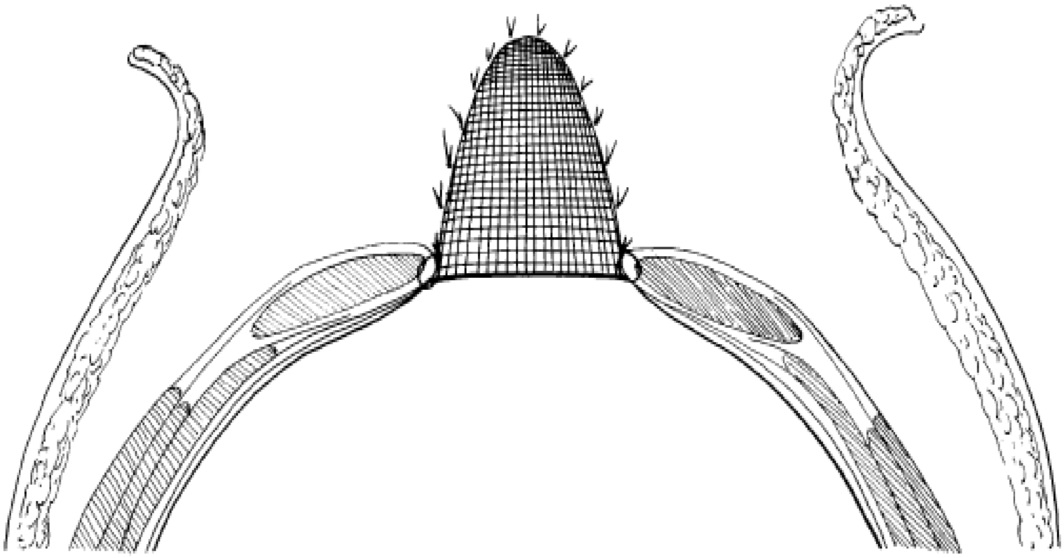


Fig.15: *Inlay graft (**Abrahamson, 1997).***

3- Underlay graft (intraperitoneal):

The mesh is placed deep to the peritoneal surface and fixed circumferentially with interrupted shaped stitches of monofilament polypropylene sutures to the full thickness of the abdominal wall so that the knots lie on the outer surface of the external oblique muscle **(Abrahamson 1997) (Larson and Vandertoll, 1984).** However this position of the mesh has several potent problems including adhesions, bowel obstruction and enteric fistula. These problems are more commonly encountered with polypropylene and mersilein and thus omentum should be inter-posed between the mesh & the intestine or with the use of slowly absorbable prothesis juxta posed to these types of meshes when used intraperitoneal or with the use of e-PTFE mesh **(Wantz, 1991).**

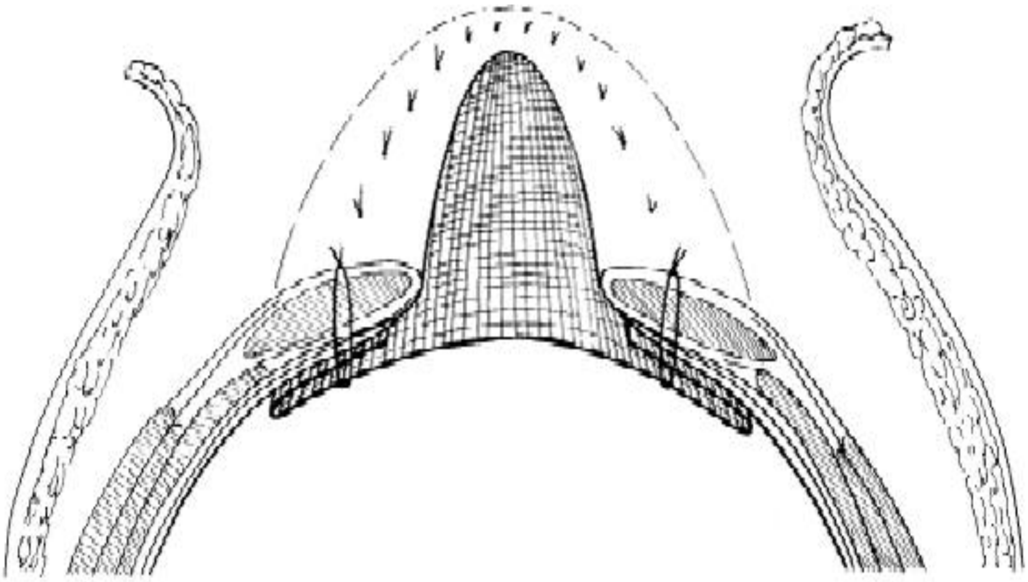


Fig.16: *Under lay graft (**Abrahamson, 1997).***

4- Sandwich and cuffed mesh repairs:

The sandwich or double-layer technique combines both the onlay and underlay techniques, theoretically provides reinforment of attenuated fascial edges to prevent suture dislodgement and recurrence. This technique has been described in several variations. Condon described placing a PTFE underlay followed by a polypropylene onlay, using mattress sutures to hold both layers in place **(Condon, 1995).**

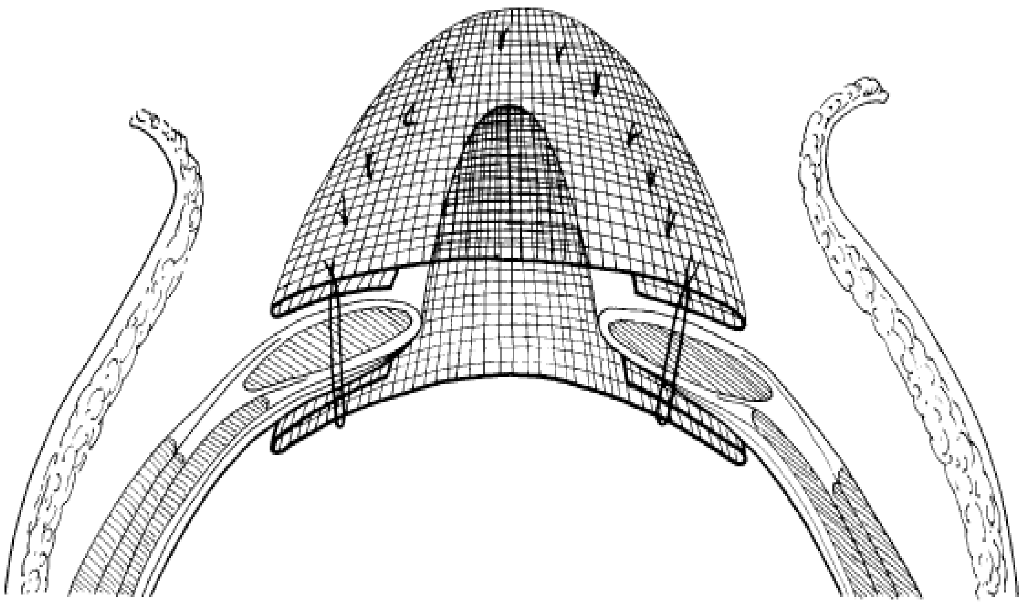


Fig.17: *Combined overlay and underlay grafts*
(Abrahamson, 1997)

Rubio described using two pieces of marlex mesh, suturing each piece in a cuffed manner to the anterior and posterior fascial surfaces, and then suturing the two pieces of mesh together in midline **(Rubio 1986).** After that, Rubio described using two pieces of PTFE for this repair **(Rubio, 1994).**

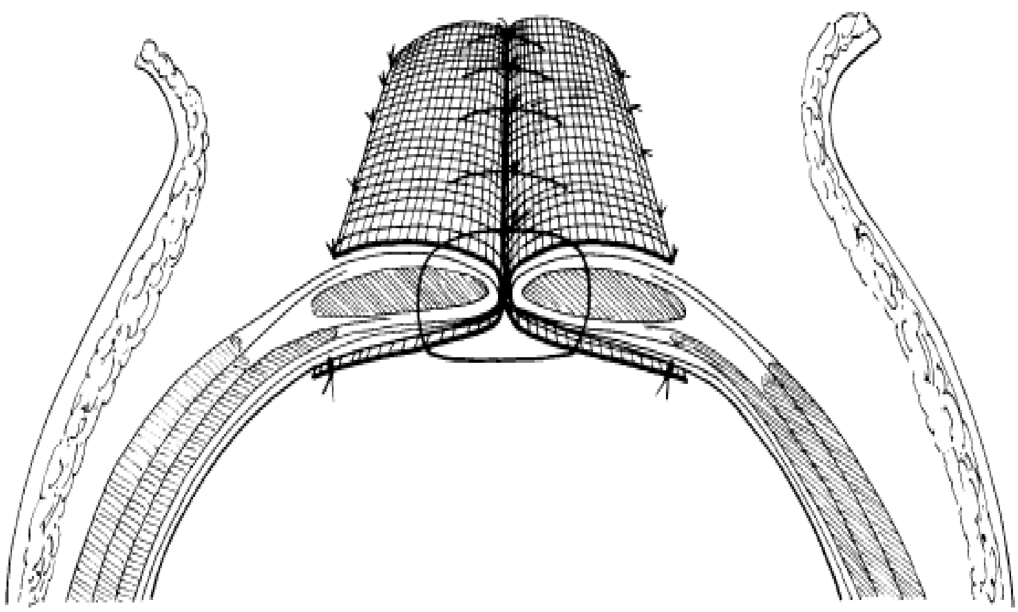


Fig. 18: *wrap around mesh reinforcement of wound edges*
(Abrahamson, 1997)

The disadvantage of two pieces of mesh may be entrapement of fluid between the layers and increase the potential for infection; also the use of two pieces of mesh is more cumbersome than using a single piece **(Scott and Jones, 2001).**

5-Retro muscular prefascial placement of mesh:

The placement of prosthetic material in a pocket beneath the rectus muscles and outside the peritoneum was devised in Europe by J. Rives and Rene stoppa in the 1970's. Excellent results with huge, previously repairable hernias were reported. Also George Wantz has described the technique in the recent American literature and in his beautifully illustrated book **(Mclanahan et al., 1997).**

After opening the incision and excising excess skin and subcutaneous tissue, the redundant hernia sac is usually excised. The posterior rectus fascia is incised close to linea alba and a pocket created bluntly behind the full width of the rectus muscles and infront of the peritoneum and posterior rectus fascia cephalad to the linea semicircularis, and above the peritoneum cauded to it. The peritoneum and posterior rectus fascia are closed with a running absorbable suture so as to interpose a barrier between the mesh and intra abdominal contents. In a few cases where there is insufficient tissue to close this layer, absorbable vicryle or dexon mesh, or incorporated omentum can be used to bridge the gap. The mesh is placed under-neath the full width of the rectus muscles and overlapped above and below the cephalad and cauded margins of the defect by **4** to **6**cm. It is anchored with interrupted absorbable sutures passed through the edge of the mesh, abdominal wall and out through the skin through stab incisions. Two suction drains are placed on the anterior surface of the mesh. The remnants of anterior rectus fascia, linea alba, and scar tissue are then reapproximated to cover the mesh, isolating it from the subcutaneous tissue **(Abrahamson, 1997) (Wantz, 1991) (Scott and Jones, 2001).**

The retrorectus mesh repair has several advantages. The mesh graft does not come into contact with the bowel minimizing the possibility of bowel obstruction or fistula from bowel adhering to the mesh. The mesh lies at a deep plane, covered by muscle and aponeurotic sheath, there by lessening the risk of infection as well as the risk of erosion through the skin. The graft has wide margins beyond the edges of the hernia defect so that there is a wide area for strong incorporation of the graft this avoids slippage and recurrent hernia between the graft, and the edge of the defect. The graft lies in a plane between the abdominal cavity and the abdominal wall so that it is compressed and held in place by the natural forces of the intra abdominal pressure against the abdominal wall, thus the mesh is rapidly incorporated **(Abrahamson, 1997) and (Mclanhan et al., 1997).**

Management of infected mesh:

The management of chronically exposed or infected mesh after prosthetic repair of incisional hernias has received little focused attention. The definition of the entity is a problem in itself. The patients all had chronic open or draining wounds in association with prosthetic mesh, and all had failed local wound management. When faced with a mesh extrusion, one must know how and why the mesh was placed. If the mesh was used as an overlay, then local management with mesh excision should not increase the chance for bowel injury, entry into the peritoneum, or a delayed hernia. However, when mesh was used to replace a full-thickness abdominal wall defect, subsequent attempts at local mesh removal expose the patient to all of the above possibilities **(Williams and Wilkins, 2003)**

So, the treatment of infected mesh is a difficult surgical challenge and removal of the infected mesh is the clearest manner of dealing with the problem. Avoidance of postoperative evisceration and maintenance of a competent abdominal wall are secondary and important goals of treatment of patients with infected mesh. Rectus abdominis myofascial flap closure of the large midline defect after mesh excision is one potential surgical solution. This procedure, also known as the "separation of parts" hernia repair, has been reported as having low hernia recurrence rates **(Saulis and Dumanian, 2002).**

Surgical Technique:

Patients receive a mechanical and antibiotic bowel preparation as an outpatient the day before surgery. A long midline skin incision is made, generously encompassing scar and open wounds. In selected cases of infraumbilical hernias and infected mesh, a panniculectomy incision is used **(Kohorn, 1995).**

The incision purposefully straddles the inflammation, and direct dissection of adherent bowel and mesh is avoided. The abdominal cavity is entered above or below any areas of exposed mesh. The medial borders of the rectus muscle are identified, and a dissecting finger along this medial edge is the guide for cautery dissection through subcutaneous tissue, mesh, and abdominal wall scar. This surgical maneuver along both rectus muscles serves to rapidly open the abdomen. All viscera are dissected off the posterior abdominal wall, while the infected mesh, inflamed tissue, and scar located between the rectus muscles will be removed en bloc. In cases with fistula, single bowel loops entering and leaving the inflamed tissue are often easy to isolate, and appropriate bowel work is performed at this time. Any mesh remnants are dissected free and removed to minimize the amount of residual prosthetic material. Mesh removal is easier in cases when it had been used as a “patch” closure to the edges of the rectus than when it had been used as a wide “overlay.” The resultant defect of the abdominal wall is reconstructed with bilateral rectus abdominis myofascial advancement flaps. The technique employed is a modification of previously described “separation of parts” repairs in its emphasis on the preservation of skin blood flow. The key to this procedure is to release the external oblique muscle and aponeurosis from its connection to the anterior rectus fascia from above the rib cage to the iliac crest at a level just lateral to the semilunar line.

The approach to the semilunar line is either through tunnels created via the midline incision, or else through two laterally placed transverse skin incisions. Skin is bluntly elevated off the semilunar lines bilaterally. **(Williams and Wilkins, 2003)**

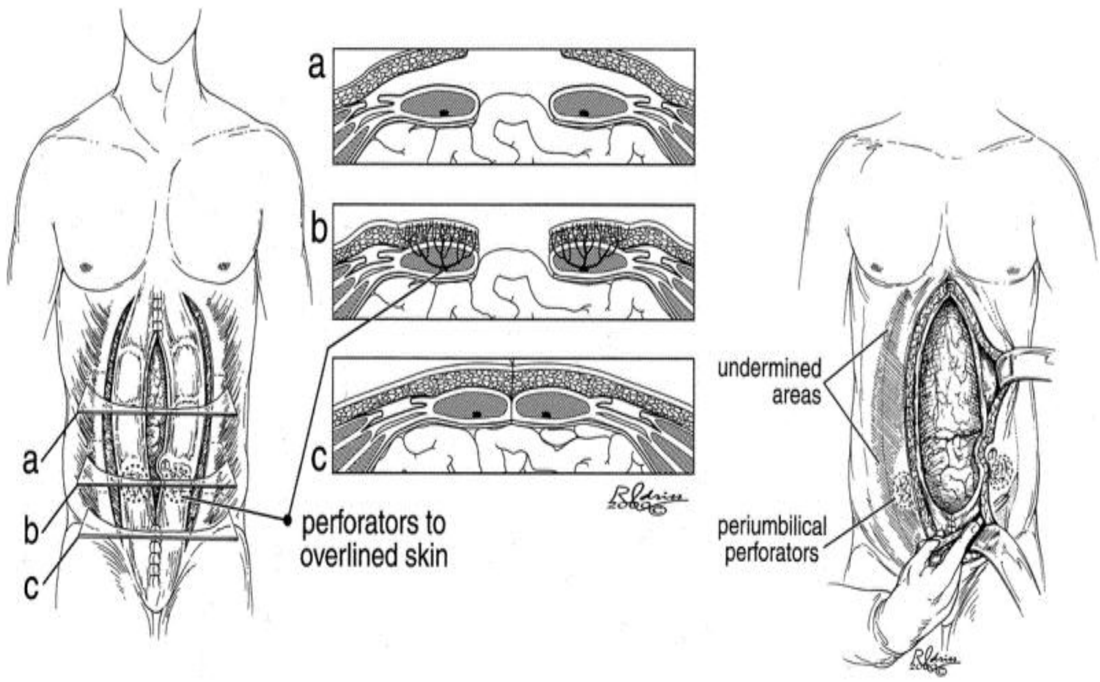


Figure 19: *“Separation of parts” procedure with perforator preservation* ***(Ann Surg. 2003)***

Using Deaver retractors for exposure, the external oblique can be released as in a fasciotomy incision. The external oblique is bluntly separated off the internal oblique to allow the muscles to slide relative to each other. The medial rectus muscle and fascia are now debrided of scar. Debridement is complete when the posterior sheath, the rectus muscle edge, and the anterior sheath are clearly visible. No other muscle or fascial release is performed. The fascia is sutured together with interrupted braided nylon figure-of-eight sutures. The medialization of the rectus muscles causes the skin to bunch in the midline. When the procedure is performed correctly, a large amount of medial skin on both wound edges can and should be excised. The skin is closed with dermal absorbable sutures and staples over three drains. One drain is placed along each semilunar line, while the third drain is in the midline. Drains are left in an average of 10 days. When an overhanging pannus was present and when patients had infraumbilical hernias, the procedure was performed through a panniculectomy incision. The principle of blunt dissection along the semilunar line with preservation of blood flow between the rectus muscle and skin can likewise be adhered to through this incision. Mobilization of the patient occurs on the first day. Binders are used for patient comfort only at their request. When bowel function resumes and adequate pain control is achieved, the patient is discharged to home with drains in place without antibiotics. **(Williams and Wilkins, 2003)**

Mathes et al. wrote briefly on the utility of the tensor fascia lata flap in cases of removal of infected mesh in a larger series of over 100 abdominal wall reconstructions **(Mathes et al., 2000).**

A more traditional surgical treatment for infected mesh is mesh removal, bowel work as needed, and placement of a new prosthetic mesh for abdominal wall reconstruction. Placement of permanent mesh in heavily contaminated fields has been found to have infection rates as high as 50% to 90%. Much depends on the quality of the overlying soft tissue **(Luijendijk, et al., 2000).**

Recurrent incisional hernia:

The major sequela from operative repair of the incisional hernia is hernia recurrence, and there are convincing data that placement of mesh to repair the hernia defect has decreased the high recurrence rate historically associated with primary suture repair to less than 25% **(Millikan , et al, 2003).** Many advocates of the operation believe that laparoscopic incisional hernia repair will have the lowest rate of hernia recurrence and definitive studies are underway to assess this question **(Zinner and Ashley, 2006).**

Complicated incisional hernia:

Elective ventral and incisional hernia repair are undertaken largely to alleviate symptoms and to prevent hernia incarceration with subsequent strangulation of the intestine. It is estimated that about 10% of all ventral hernias result in incarceration, although the actual percentage is not known **(Courtney, Lee, Wilson, et al., 2003).**

A common sequela of incarcerated ventral hernias is complete or partial bowel obstruction, with close to 50% of this population later developing strangulated hernias **(Kulah, Duzgun, Moran, et al., 2001).**

Almost 20% of those exhibiting strangulated hernias will need intestinal resection. Thus, their postoperative course will be more complicated, and the resection may preclude placement of prosthesis at that exploration **(Sowula and Groele, 2003).**

Small-Neck Incisional Hernias or Tender Incarceration:

Small-neck Incisional hernias or tender incarceration should undergo repair on an urgent basis. Patients who have trophic changes or ulceration in the skin overlying incisional hernias are also, candidates for urgent surgery. In some instances, cellulitis of the skin overlying the hernia sac develops and is difficult to distinguish from strangulation of the contents of the sac. Using mesh in the repair reduces the recurrence rate by nearly 50% even for small hernias **(Goroll and Mulley, 2009).**

Large Incisional hernias:

Large incisional hernias can pose a management problem because durable repair is difficult to achieve. Recurrence rates after initial repair range from 25% to 50% and remain at nearly 50% for repair of repeated herniation.The management of large incarcerated incisional hernias that occur in the abdomen in very obese patients is a particular problem. Major efforts should be directed toward weight reduction before repair if it is possible to delay .If, however the presence of intestinal obstruction is a possibility or the viability of the contents of the sac is doubtful, the advice of a surgeon should be sought promptly, both polypropylene mesh and suture repair are available; mesh reduces the recurrence rate by nearly 50% in persons with a midline incisional hernia, regardless of hernia size. With the use of mesh, care needs to be taken to avoid its contact with the underlying viscera **(Goroll and Mulley, 2009).**

Laparoscopic repair of ventral hernia

The successful application of laparoscopic techniques for the repair of ventral hernia has been well accepted. In fact, many authors have suggested laparoscopic ventral hernia repair with mesh as the new procedure of choice for the treatment of abdominal wall fascial defects. **(Park et al., 1996) (Saiz et al., 1996) (Franklin, Dorman, Glass et al., 1998) (Park et al., 1998) and (Heniford et al., 2000)**

In 1992, a successful series of laparoscopic incisional hernia repairs was reported in the medical literature by LeBlanc and Booth. Since then, the technique has been refined and has grown in acceptance within the surgical community ***(LeBlanc and Booth, 1993)***

The laparoscopic approach to ventral hernia repair seeks to apply the sound principles associated with the Rives- stoppa but with modifications in the technique for mesh placement. Using the laparoscopic approach a large prosthetic mesh can still be placed on the anterior abdominal wall (internal rather than external to the posterior fascia or peritoneum), overlapping the defect by several centimeters in all directions. However, with this technique, there is no need for the extensive soft tissue dissection seen in the open approach and its attendant complications. Further more, the patient can expect to receive all the other benefits of a minimally invasive procedure, such as decreased hospital stay, lower wound complication rates, and decreased pain **(Leblanc and Booth , 1993) (park et al., 1996) (Costanza et al., 1998)and(Toy et al., 1998).**

Indications:

Patients with ventral hernias were considered candidates for laparoscopic ventral hernia repair if they were morbidly obese or if the hernia defect was at least **4**cm in any dimension or recurrent **(Heniford et al., 2003).**

Contraindications:

Patients in whom a laparoscopic approach is contraindicated are those with “loss of domain”, strangulated intestine, children and those who cannot tolerate general anesthesia. If an enterotomy is made or ischaemic bowel needs to be resected, conversion to laparotomy is recommended **(Thoman and Phillips, 2002).**

Technique:

The technique demands general anesthesia as well as placement of a nasogastric tube and a Foley's catheter. The patient must be firmly attached to the table to allow for alterations in position to Trendelenburg's position, reverse Trendelenburg's, or extreme side to side to allow adhesions to be dissected. Laparoscopic ventral hernia repair is performed by using Veress needle, optical trocar, an angled (**30-**or **45-** degree), **5**mm or **10-**mm laparoscope, **5**mm bowel graspers, scissors, endo-shears and clip appliers. An antibiotic, usually first generation cephalosporin, is given prophilactically before the incision is made and often again if the operation continued for, more than **2** hours. Most patients are positioned supine with the arms at their sides; patients with hernias in the flank or lumbar area are placed in the lateral decubitus or semilateral position.

Pneumoperitoneum is established either by using a veress needle or by an open abdominal access technique. Most often, a window of access is present, even in the multiply operated abdomen, between the costal margin and iliac crest on one side or the other. There are three relatively safe areas for access, include the subxiphoid midline, where the left lateral lobe of the liver usually protects other intra- abdominal organs, and each subcostal space at the anterior axillary line, where the presence of preperitoneal fat or intraabdominal adhesions is rare **(Bruce Ramshaw,2005).**

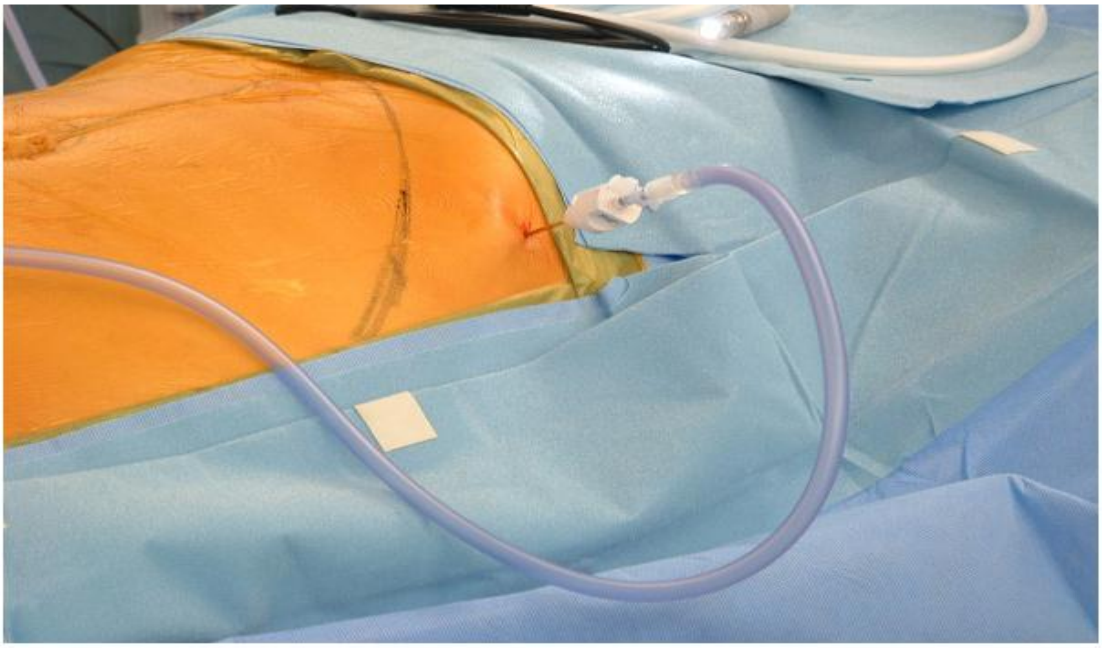


Fig.20: *Veress needle placed through the left 9th intercostal space to establish a preliminary pneumoperitoneum.* ***(Zinner and Ashley, 2006)***

The initial entry site is usually just inferior to the tip of the eleventh rib. After exploration of the abdomen, additional trocars are typically placed laterally in the abdomen, as needed, under direct visualization, each of the additional trocars should be considered as a port through which a stapler (or laparoscope) can be placed . Therefore **10-12**mm trocars are desirable at all ports, although **5** mm ports may be used with cork screw fixation devices **(Bruce Ramshaw, 2005).**

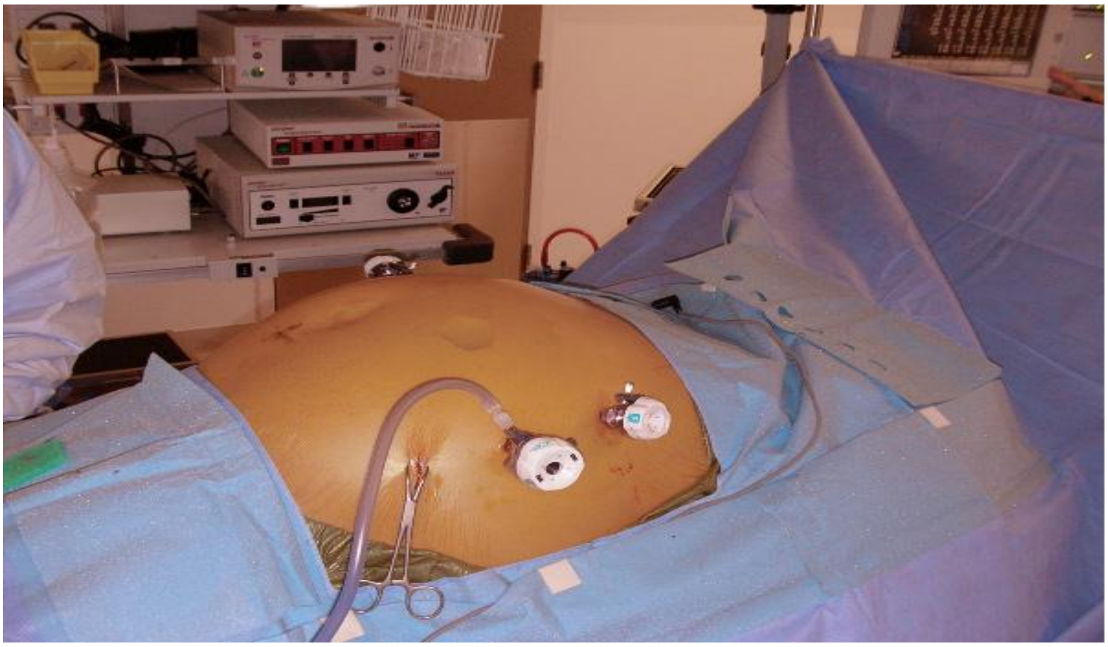


Fig.21: *Example of cannulae placement for repair of a mid line ventral hernia.*

(Zinner and Ashley, 2006)

Adhesiolysis is the first step and should be done very carefully. It must be remembered that depth perception is lost laparoscopically, and bowel and hernia sac can look very similar. After completion of adhesolysis, the hernia content is reduced and the peritoneal sac is left insitu in most patients, hernia contents can be reduced safely with gentle traction using atraumatic laparoscopic graspers. External, manual, compression will assist with safe reduction. If bowel is incarcerated or is even possibly included within a mass of incarcerated contents, care should be taken to avoid excessive tension with graspers to minimize the risk of bowel injury. In rare cases when incarcerated contents are not reducible, sharp division of the facial edge of the defect will facilitate reduction. As in open surgery, the viability of reduced contents should be assessed **(Bruce Ramshaw, 2005).**

After completion of the dissection, the borders of the fascial defect (s) are determined and measured and appropriately sized prosthetic mesh is tailored to overlap the margins of the defect by **3-4** cm. Various tips are provided that may help to accurately measure the size of the defect at the peritoneal level. First, the abdomen can be deflated to minimize the difference in external and internal circumference of the abdominal wall. Also the hernia defect can be measured directly, using a suture or laparoscope instrument or by cutting a plastic ruler lengthwise and placing it inside the abdominal cavity **(Bruce Ramshaw 2005).**

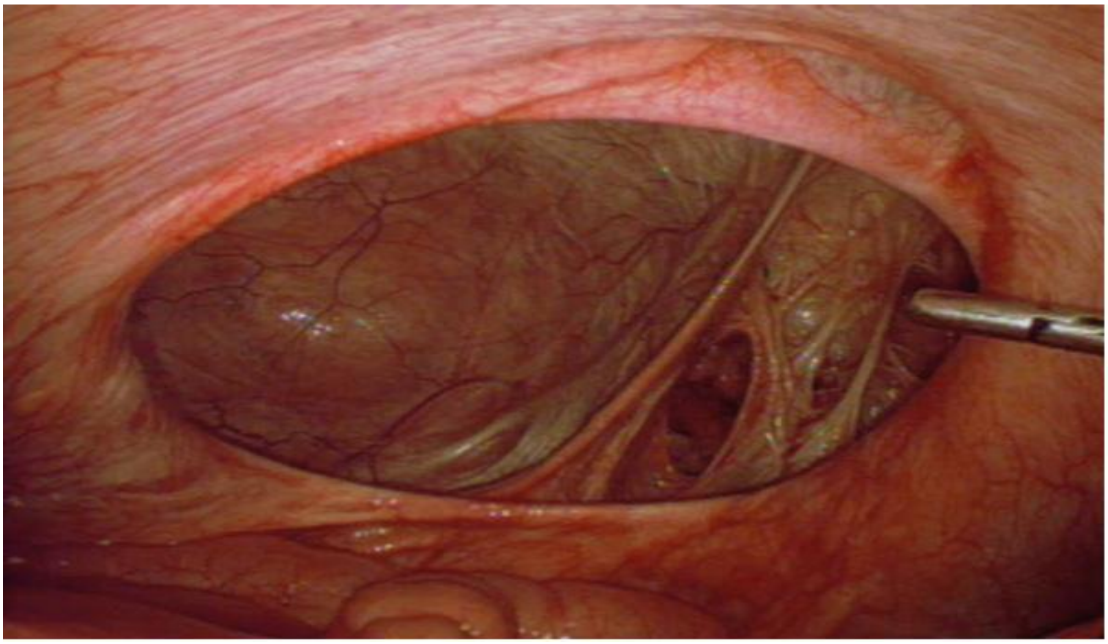
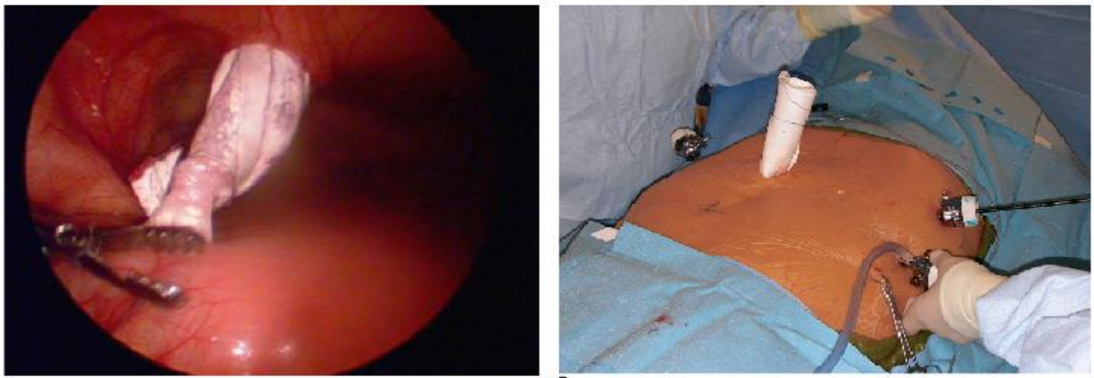


Fig.22: *Ventral hernia defect from a laparoscopic view.* ***(Zinner and Ashley, 2006)***

Toy and Smoot described a technique using a spinal needle passed through the abdominal wall and viewed with the laparoscope to aid in determining facial borders of the defect. Typically in the presence of multiple defects, the maximum distance between all defects is measured and one piece of e PTFE mesh is used to cover all defects. Occasionally defects are separated by long distances of healthy abdominal wall and use of two separate pieces of mesh may be more appropriate, based on the surgeon's judgment. For incisional hernia repair, it is recommended that the entire previous incision be covered with mesh unless there is no obvious hernia in a portion of the incision and adhesiolysis in this area would significantly increase the risks of the procedure **(Bruce Ramshaw 2005).**

The mesh is fixed in place by using at least **4** nonabsorbable monofilament or e PTFE sutures which are placed equidistantly along the mesh. Points of reference on the mesh and corresponding point on the abdominal wall were marked to aid in orienting the mesh after its introduction into the abdomen; the mesh was rolled up and pushed or pulled into the abdomen through a **5** or **10** mm trocar site.



A B

Fig.23: *Introduction of the prosthesis into the abdomen* ***A.*** *If the prosthesis is sufficiently small, it can be introduced through the largest cannulae site. This is facilitated by pulling with a grasper from the opposite side of the abdomen.* ***B.*** *A larger prosthesis is introduced through the center of the hernia defect by making an incision in the skin and hernia sac. The incision is then closed to prevent gas leak.*
(Zinner and Ashley, 2006)

A suture passer is then used to bring the sutures out through a small skin incision, angling the passer to achieve a fascial bridge of at least one cm between the two ends. The knots are tied in the subcutaneous space after the four corners are brought through and positioning is rechecked. A **5**mm spiral tacker or endostapler is then used to fix the mesh at **1**cm intervals circumferentially. After complete fixation of the mesh, the abdominal cavity should be explored for active bleeding or other injuries. The $C0_2$ is pushed out of the abdominal cavity, and the fascia of the **10**mm incision is closed.

Choice of mesh:

Alternatively, PTFE may be used safely since there are no reports of intestinal fistulization or obstruction with intra-abdominal placement. The disadvantage of PTFE is the limited incorporation into the abdominal wall. Several companies have marketed products to address this problem. Gore's Dual Mesh and Bard's composix has PTFE on the visceral side and polypropylene on the side to be incorporated into the abdominal wall. A Canadian series of **30** patients suggests the composite mesh-Bard composix mesh-may be the choice of prosthetic material for use intra peritoneally **(Bendivid, 1997).**

Additionally, there is marketed sepra mesh, which is a polypropylane mesh coated with sodium hyaluronate and carboxymethylcellulose to prevents adhesions **(Thoman and Philips, 2002).**

Complications:

Recurrence:

The long term efficacy of any hernia repair depends on the rate of recurrence and that rate of recurrence following any hernia repair depends on the technique used for repair **(Cobb et al., 2005)**

One of the most critical technical points of the laparoscopic repair that may significantly impact the rate of recurrence is adequate mesh fixation. The most widespread technique in laparoscopic ventral hernia repair involves fixation of mesh with tacks and transabdominal permenant sutures **(Heniford et al., 2003).**

Some surgeons have tried to reduce operating time and possibly postoperative discomfort by eliminating the use of transabdominal sutures completely, or by markedly reducing the number of sutures used and leaning primarily on the use of a laparoscopic tacker. **(Cobb et al., 2005)**

In an attempt to decrease postoperative suture site pain, Berger and colleagues used sutures to orient the mesh for tacking and did not tie them. With this technique, their recurrence rate is **2.7**%at a mean follow-up of **15** months **(Berger et al., 2002).**

Carbajo and associates have the largest series without suture fixation, over an **8**-year period, **270** repairs were performed using two layers of tacks to fix the mesh, or a “double crown” technique, with an average follow up of **12** months there were **12** recurrences ***(4.4%)*** **(Carbajo et al., 2003)**

In another multi-institutional series, **100** Consecutive patients underwent laparoscopic ventral hernia repair with suture fixation, there was a single recurrence **(1%)** over follow -up period ranging from (**1** to **60** months,) **(Gillian et al., 2002).**

Bageacu et al reported **19** recurrences that were detected on examination and confirmed with CT scan in **121** patients **(15.7%)** over a mean follow up of **49** months **(Bageacu et al., 2002).**

The study authors attributed their recurrence rate to inadequate mesh fixation with metallic tacks alone. Other series have attributed early failures to inadequate tack fixation alone, and the investigators have since added additional transabdominal sutures to their technique. **(Franklin et al., 2004) (Fid et al., 2003) and (Le Blanc et al., 2003)**

The physics of mesh fixation during laparoscopic ventral hernia repair do not support the sole placemnt of tacks. The majority of the meshes used for laparoscopic ventral hernia repair are roughly **1**mm thick, and the spiral tacks used are **4**mm long and take up a **1**-mm profile on the surface of the patch. A perfectly placed tack can be expected to penetrate only **2**mm beyond the mesh; hence, tacks will likely not give the same holding strength as a full - thickness abdominal wall suture. Because many candidates presenting for laparoscopic ventral hernia repair are obese (having a substantial amount of preperitoneal fat), the **2**-mm purchase of the tack will not reach the fascia in most cases. Further more, the mesh is placed against the peritoneum, so any ingrowth of the mesh is most likely into the peritoneum and not into the fascia **(Cobb et al., 2005).**

Experimental studies have confirmed the superior strength of sutures versus tacks alone in mesh fixation to the abdominal wall. Several studies were made to specifically examine the strength of full thickness transabdominal sutures versus two commercially available metallic fixation devices in an animal model. In these studies , the initial fixation strength for suture materials, both absorbable and permanent , was significantly greater than for either the metallic tack or anchor device; however absorbable sutures showed a significant loss of strength at 8 weeks when compared with permenant sutures. **(Joels et al., 2004)**

If the mesh remains where it is placed, assuming adequate overlap of the defect, the rate of recurrence should be zero. Therefore it is believed that suture fixation of the mesh in laparoscopic ventral hernia repair is imperative, especially during the early period of mesh incorporation **(Cobb et al., 2005).**

Another recognized cause of recurrence following ventral hernia repair is a missed hernia. The laparoscopic repair affords the surgeon the ability to clearly and definitively define the margins of the hernia defect and to identify additional defects that may not have been clinically apparent preoperatively. Complete visualization of the fascia underlying the previous incision allows for identification of smaller “Swiss-cheese” defects that could be missed in an open approach **(Park et al., 1998).**

In a review of the recent large series with mean follow up more than **12** months, the overall rate of recurrence for laparoscopic ventral hernia repair is **4.3%.** There are eight series in which only tacks were used for mesh fixation, and the recurrence is **5.6%** when the technique uses transabdominal sutures, the reported recurrence rate is **3.8% (Cobb et al., 2005).**

Seroma formation:

Seroma formation is not unique to the laparoscopic approach. Most seromas develop above the mesh and within the retained hernia sac, especially after repair of a large hernia defect. **(Cobb et al., 2005)**

In general, seromas are not considered a complication. Most seromas resolve without therapy and rarely produce symptoms. It is important to explain to the patient that the “bulge” is not a recurrent hernia. Seromas are usually significantly improved within six to eight weeks after surgery, although very large seromas can take several months to resolve **(Bruce Ramshaw2005).**

In the lasgest multi-institutional trail, seromas that were clinically apparent more than **8** weeks postoperatively were considered a complication and occurred **2.6%**of the time **(Heniford et al .,2003).** Rarely asymptomatic or persistent seroma is aspirated but sterile technique is essential to avoid secondary mesh infection **(Bruce Ramshaw, 2005).**

It is said that. Cauterization of the hernia sac may prevent seromas. **(Tsimoyiannis et al., 2001)**

Persistant pain:

After laparoscopic ventral hernia repair, patients will occasionally complain of persistent pain and point tenderness at a transabdominal suture site. This suture site pain is not uncommon and occurs in **1%**to **3%** of patients in the reported series of repairs using trans-abdominal sutures **(Heniford et al., 2003) (Le Blanc et al., 2003) (Franklin et al., 2004) and (Bower et al., 2004).**

The discomfort at the transabdominal fixation suture site typically resolves within **6-8** weeks **(Heniford et al., 2000).**

Over the short term, thin can be problematic, and little is understood as to reasons it occurs. A possible explanation may be that the transabdominal suture entraps an intercostal nerve as it courses through the abdominal muscles, local muscle ischaemia may be another possibility. The first line of treatment can be a course of oral nonsteroidal anti-inflammatory therapy or simply additional time. If the pain persists, injecting local anesthetic at these painful suture sites has good results. The majority **(92%)** of patients undergoing treatment with an anesthetic injection had complete relief of their symptoms and most of those responding to therapy **(91%)** required only a single injection **(Cobb et al., 2005).**

Missed or Delayed Bowel Injury:

The most serious complication, some what unique to laparoscopic ventral hernia repairs, remains the potentially devastating risk of a missed enterotomy. This complication seems to be more common early in the learning curve in patients requiring extensive adhesolysis **(Salameh et al., 2002).**

A missed or delayed bowel injury should be suspected in a patient who has worsening abdominal pain and tenderness and begins to show signs of sepsis, such as elevated temperature and white blood cell count, tachycardia, and decreasing urine output and blood pressure during the first few days after surgery. Close monitoring and radiographic evaluation, including CT scan, may be appropriate in stable patients, although the decision to reoperate should be made in a relatively short period of time, depending on the results of resuscitation, diagnostic testing, and close monitoring. A missed or delayed enterotomy and the resulting intraabdominal sepsis can be fatal even when diagnosed and repaired in a timely fashion **(Cobb et al., 2005).**

How to avoid these injuries?

In any case, prompt recognition of these injuries is critical to avoid late complications. These injuries can be obvious (e.g., traction or sharp dissection injuries) or can be subtle (e.g., a delayed thermal injury). Careful attention to tissue handling and thorough inspection of the intestine using meticulous completion laparoscopy to assess for intestinal injuries can minimize these risks **(Franklin et al., 2004).**

Advantage of laparoscoic repair over open repair:

Each has advantages and disadvantages. The collective results of all studies suggest that laparoscopic ventral hernia repairs have reduced perioperative morbidity, fewer wound complications, and lower rates of hernia recurrence. These benefits suggest that for many patients laparoscopy is an appropriate approach for the repair of incisional hernias in both straightforward and complex presentations. **(Turner and P ark,2008)**

Approaches to groin hernia repair

Treatment:

The treatment of all hernias, regardless of their location or type, is surgical repair. Elective repair is performed to alleviate symptoms and to prevent the significant complications of hernias, such as incarceration or strangulation. While the limited data available on the natural history of groin hernias show that these complications are rare, the complications are associated with a high rate of morbidity and mortality when they occur. At the same time, the risks of elective groin hernia repair, even in the patient with a complicated medical history, are exceedingly low. Outcomes of surgical repair are generally excellent with minimal morbidity and relatively rapid return to baseline health **(Zinner and Ashley, 2006).**

The major risk with delayed surgical repair is the risk of incarceration and/or strangulation. It is not possible to reliably identify those hernias that are at an increased risk for these complications. It is known that the risk of incarceration of a hernia is greatest soon after the hernia manifests itself. This is likely due to the fact that at the early stage of the hernia, the defect is small and fits tightly around the hernia sac; therefore any contents that fill the sac may quickly become trapped within the hernia. Over time, the hernia defect stretches due to the tissue that enters and leaves the sac with changes in intra-abdominal pressure. After **6** months, the risk of hernia incarceration decreases from **5%** per year to**1-2%** per year. In general, the larger the palpable defect on physical examination, the lower the risk of incarceration. Clearly, all risks of tissue loss aside, elective hernia repair is still preferred over emergent repair **(Zinner and Ashley, 2006).**

Anesthesia:

Groin hernia repair can be performed using a variety of anesthesia options, including general, regional (such as spinal or epidural), and local anesthesia (**Young DV, 1987).**

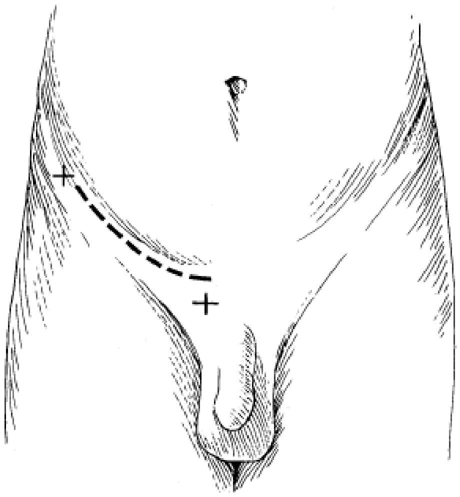
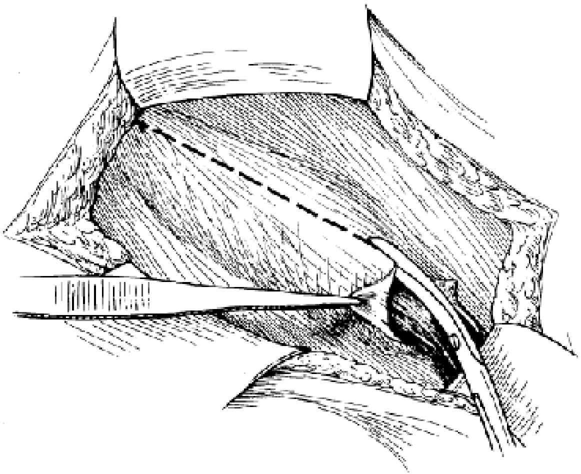
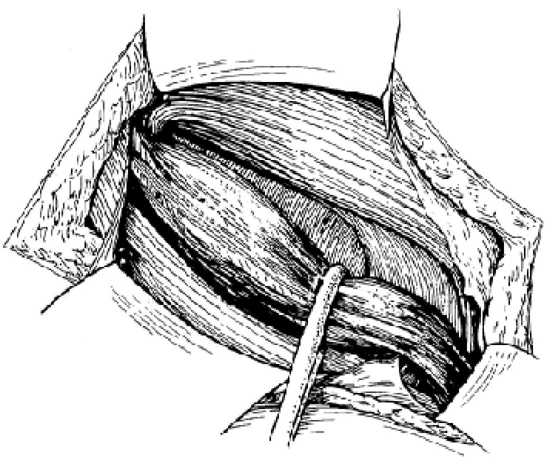
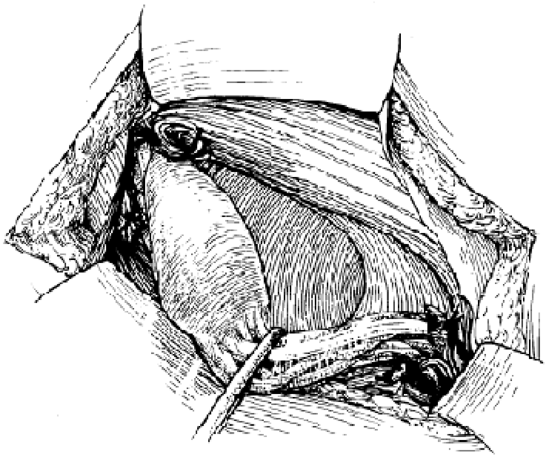
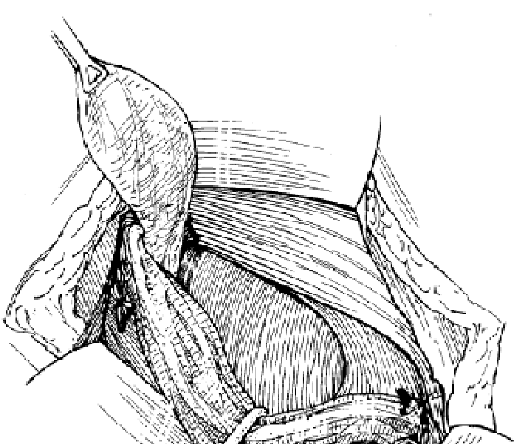
Laparoscopic repairs usually require general anesthesia in order to provide the complete muscle relaxation needed to achieve insufflation of the preperitoneal or peritoneal space. Open groin hernia repairs are most often performed using either regional or local anesthesia. Local anesthesia with controlled intravenous sedation, referred to as monitored anesthesia care, is often preferred in the repair of the reducible inguinal hernia. In groin hernia repair, local anesthesia can be administered as a direct infiltration of the tissues to be incised or as a local nerve block of the ilioinguinal and iliohypogastric nerves. The latter is associated with improved local pain control, but may be difficult to achieve. The local nerve block also spares the soft tissue of edema from diffuse infiltration of local anesthesia. Spinal or continuous epidural anesthesia allows the surgeon greater freedom to maneuver within the operative field since the anesthetized region is larger than in local anesthesia. However, these modes of anesthesia carry their own infrequent risks such as urinary retention, prolonged anesthetic effect, hypotension, and spinal headache. They may also be associated with longer in-hospital recovery times on the day of surgery **(Zinner and Ashley, 2006).**

Operative Techniques:

Successful surgical repair of a hernia depends on a tension-free closure of the hernia defect to attain the lowest possible recurrence rate. Previous efforts to simply identify the defect and suture it closed resulted in unacceptably high recurrence rates of up to **15%.** Modern techniques have improved upon this recurrence rate by placement of mesh over the hernia defect, or in the case of laparoscopic repair, behind the hernia defect. One exception to this rule is the classic Shouldice repair, which uses meticulous dissection and closure without mesh placement to obtain a consistently low recurrence rate. Another benefit of the tension-free closure is that it has been shown to cause the patient significantly less pain and discomfort in the short-term postoperative period **(Zinner and Ashley, 2006).**

The essential steps to the modern open inguinal hernia repair:

All of the open anterior herniorraphy techniques begin with a transversely-oriented slightly curvilinear skin incision of approximately **6-8** cm positioned one to two fingerbreadths above the inguinal ligament. Dissection is carried down through the subcutaneous and Scarpa's layers. The external oblique aponeurosis is identified and cleaned so that the external ring is identified inferomedially. Being careful to avoid injury to the iliohypogastric and ilioinguinal nerves, the aponeurosis is incised sharply and opened along its length through the external ring with fine scissors. The nerves underlying the external oblique fascia are then identified and isolated for protection. The soft tissue is cleared off the posterior surface of the external oblique aponeurosis on both sides and the spermatic cord is mobilized. Using a combination of blunt and sharp dissection, the cremaster muscle fibers enveloping the cord are separated from the cord structures and the cord itself is isolated. At this point, it is possible to accurately define the anatomy of the hernia. An indirect hernia will present with a sac attached to the cord in an anteromedial position extending superiorly through the internal ring. A direct inguinal hernia will present as a weakness in the floor of the canal posterior to the cord. A pantaloon defect will present as both a direct and indirect defect in the same inguinal canal **(Zinner and Ashley, 2006).**

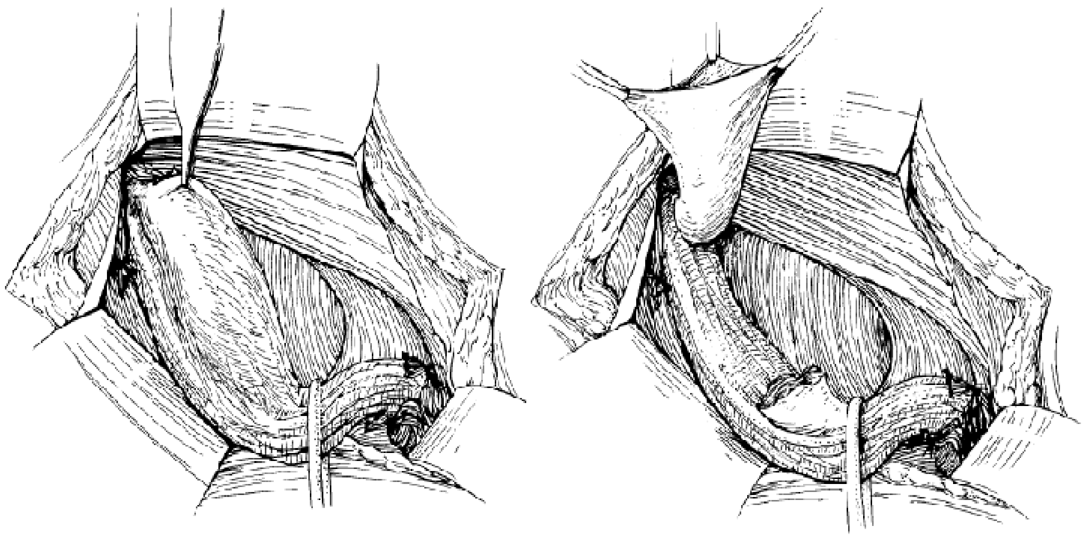



Fig.24: *The essential steps to the modern open inguinal hernia repair*

(Zinner and Ashley, 2006)

Bassini's repair:

The Bassini's repair was developed in the late nineteenth century and was revolutionary at the time for low recurrence rates when compared with the previous standard of care procedures; however, recent studies comparing the Bassini's repair and the closely related Shouldice repair show that the Shouldice repair is superior where recurrence rates are concerned. The Bassini repair involves exposing the transversalis fascia from the internal inguinal ring to the pubic tubercle, followed by reconstruction of the abdominal wall. This reconstruction is performed by suturing Bassini's triple layer (includes the internal oblique, the transversus abdominus muscle, and the transversalis fascia) to the iliopubic tract /inguinal ligament with interrupted permanent sutures **(Ravitch and Hitzrot, 1960).**

Shouldice repair:

The Shouldice repair originated when Shouldice sought more efficiency in preventing World War II recruits from being rejected from the Army due to inguinal hernias. Through this effort and that of his surgical hospital following the war, recurrence rates with this technique were reduced from 20% to below 2% between 1945 and 1953. Dissection involves exposing the crura of the external ring following exploration to the level of the external oblique, followed by incision of the external oblique in the direction of its fibers and with care not to damage the ilioinguinal nerve which is found just beneath the external oblique. The spermatic cord is then mobilized followed by ligation of the cremasteric muscle for necessary exposure and visualization of the incisional area on the transversalis fascia. The spermatic cord is reflected laterally, and the transversalis fascia is split from the internal inguinal ring as far down as necessary. The transversalis can be trimmed at this point, followed by freeing this fascia from preperitoneal fat to expose the edge of the posterior internal oblique and transversalis fascia **(Woods and Neumayer, 2008).**

Repair of the defect by the Shouldice method involves use of continuous nonabsorbable suture allowing for even distribution of tension and preventing interruption sites which could result in recurrence. The first suture line Begins at the pubic tubercle, tracking laterally and approximating the iliopubic tract and the medial flap (transversalis fascia, internal oblique muscle, transversus abdominus muscle). This line continues as far as and including the stump of the cremaster muscle and then is reversed without interruption to begin the second suture line which tracks medially and approximates the internal oblique and transversalis muscles to the inguinal ligament. The third suture line is begun with a new suture and starts close to the internal ring. This line approximates the external oblique aponeurosis to the lateral Flap and ends at the pubic crest. The last suture line is begun by reversing the third suture line and as a more superficial reinforcing line over the top of the third line **(Woods and Neumayer, 2008).**

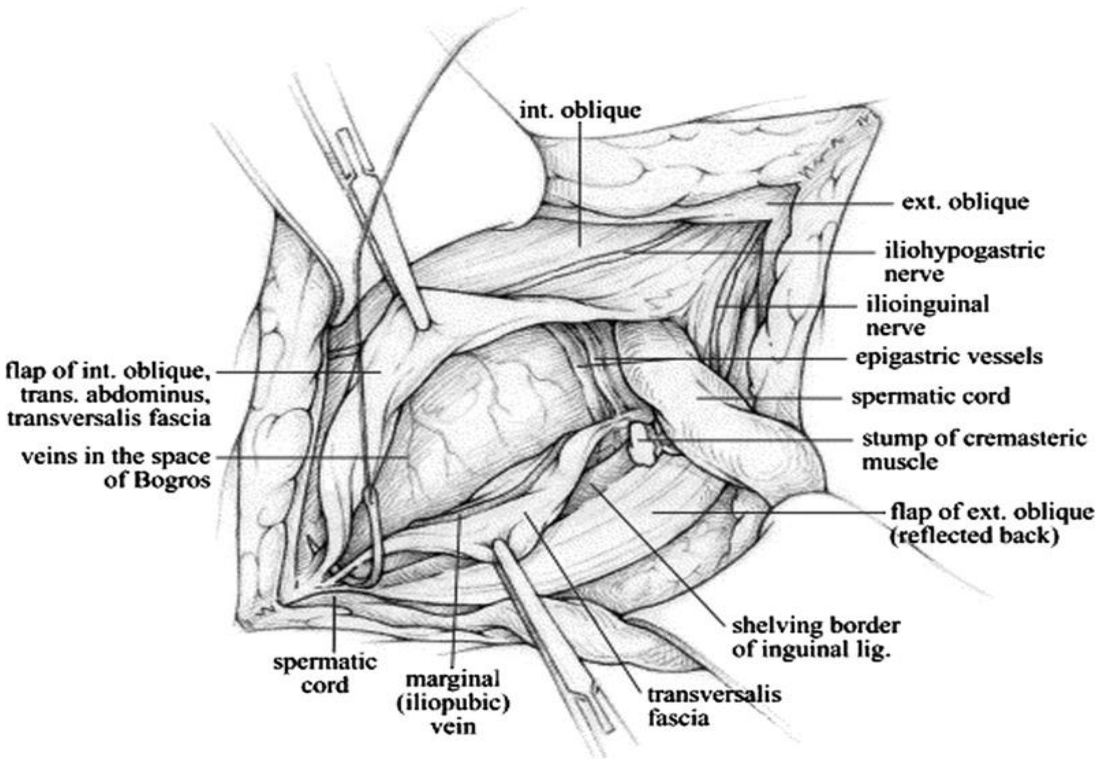


Fig.25: *The Shouldice repair for groin hernias* ***(Woods and Neumayer, 2008).***

The Cooper Ligament Repair:

The Cooper ligament repair is the only technique that definitively repairs both the inguinal and femoral hernia defects in the groin. The operation is often named after Chester McVay, who popularized the operation in the 1940s and introduced the concept of the relaxing incision to decrease the tension from the repair. The repair is also a primary tissue repair in that no mesh is utilized. The Cooper ligament repair begins similar to the Shouldice procedure, and exposure and isolation of the cord is performed. The transversalis fascia is then opened and cleaned posteriorly. At this time, Cooper's ligament is identified and dissected free of its fibrous and fatty attachments. The defects are repaired by using interrupted suture to affix the upper border of the transversalis fascia to Cooper's ligament beginning medially at the pubic tubercle and continuing until the femoral sheath is reached. At this point, the femoral canal is closed by carefully suturing Cooper's ligament to the femoral sheath. The repair is continued with interrupted sutures between the transversalis fascia and the iliopubic tract laterally until the entrance point of the cord is reached. In this way, the closure creates a new, and tighter, internal inguinal ring around the cord. The Cooper ligament repair requires a relaxing incision because this pure tissue repair is associated with significant tension in closing all three groin hernia defects. After the transversalis fascia has been mobilized, and prior to the closure of the fascia to Cooper's ligament, a 4 cm vertical incision is made at the lateral border of the anterior rectus sheath beginning at the pubic tubercle and extending superiorly. The relaxing incision can be left open since the rectus muscle should protect against any herniation; alternatively, some surgeons argue for placement of a mesh over the relaxing incision since hernia formation can occur at this site **(Zinner and Ashley, 2006).**

The Cooper's ligament repair is an outstanding technique for a femoral hernia and is associated with excellent long-term results in experienced hands. Disadvantages of the repair include a longer operating time, a more extensive dissection, the potential for vascular injury and thromboembolic complications from the femoral vessels, and a longer postoperative recovery phase **(Zinner and Ashley, 2006).**

Prosthetic Repairs:

Polypropylene mesh is the most common prosthetic used today in mesh repairs of the inguinal hernia. The two most common prosthetic repairs are the Lichtenstein and the "plug and patch" repair as described by Gilbert and popularized by Rutkow and Robbins **(Zinner and Ashley, 2006).**

The type of mesh to be used during prosthetic inguinal hernia repairs deserves a brief discussion. The most common and preferred mesh for groin hernia repair is a polypropylene woven mesh marketed under a variety of names. Polypropylene is preferred because it allows for a fibrotic reaction to occur between the inguinal floor and the posterior surface of the mesh, thereby forming scar and strengthening the closure of the hernia defect. This fibrotic reaction is not seen to the same extent with other varieties of prosthetic, namely expanded polytetrafluoroethylene (PTFE) mesh. PTFE is often used for repair of ventral or incision hernias in which the fibrotic reaction with the underlying serosal surface of the bowel is best avoided **(Zinner and Ashley, 2006).**

In the situation of a contaminated field (e.g., with strangulated bowel), if a primary tissue repair cannot be accomplished, a temporary mesh may be used (synthetic such as Vicryl or allogeneic such as Alloderm or Dermamatrix) with the assumption that there is a high likelihood of recurrence of the hernia as the temporary mesh is reab-sorbed; however, by this time, the wound should have healed, and the case should once again be clean **(Woods and Neumayer, 2008).**

The Lichtenstein Technique:

The true tension-free hernioplasty with mesh was introduced in 1984 and published by Irving Lichtenstein and colleagues in 1989.The perfected tension-free hernioplasty was then reported by Amid, Shulman, and Lichtenstein in 1993 **(Amid ,et al ,1993).**

Repair method; A 5-cm skin incision is made starting at the pubic tubercle and extending laterally along Langer's lines. The external oblique aponeurosis is opened including the external ring. If an indirect hernia is found, after dissecting it from the other cord structures to at least the level of the internal ring, the sac is either inverted without division when possible or divided leaving the distal portion insitu and closing the proximal sac. If a direct hernia is identified, the sac is simply inverted using an absorbable purse-string suture. A prosthesis measuring approximately 8-16 cm is used. The lower edge of the prosthesis is fixed using a continuous suture to Poupart's ligament beginning medially and overlapping 2cm into the pubic tubercle and proceeding laterally along the ligament beyond the internal ring using three to four bites of 2.0 Prolene, ending just lateral to the internal ring. If a femoral defect is suspected, the inferior edge of the prosthesis is sutured to Cooper's ligament, beginning near the area of the pubic tubercle and continuing laterally along Cooper's ligament. A transition stitch is then accomplished between the prosthesis, Cooper's ligament, the femoral sheath, and Poupart's ligament, and the repair is then continued laterally along Poupart's ligament to just lateral to the internal ring. The superior medial border of the prosthesis is secured to the rectus sheath with an interrupted 2.0 Prolene suture, creating a wrinkle in the mesh. The superior border of the mesh is tacked to the internal oblique with an interrupted 2.0 Prolene suture. A slit is made transversely in the mesh from the lateral aspect to the location of the internal ring. The slit should be made such that the lower portion is one-third the width of the mesh. The upper and lower portions of the mesh are brought around the cord. The lower border of the upper portion and the lower border of the lower portion are then tacked to the inguinal ligament just lateral to the internal ring with an interrupted 2.0 Prolene suture, recreating the shutter mechanism of the internal ring. The tails of the mesh are placed laterally under the external oblique. Management of the cremasteric muscles (split versus divided) is at the discretion of the surgeon and frequently depends on the characteristics of the hernia and the condition of the muscle. Additional analgesia (30 mL of dilute Marcaine [10 mL of 0.5% Marcaine mixed with 20 mL of saline]) may be instilled into the operative site. The external oblique fascia is then closed, and the skin is closed with a running subcuticular suture **(Woods and Neumayer, 2008).**

The "plug and patch" repair; represents a tension-free hernioplasty and can even be performed without sutures. In this technique, the patch is placed in a similar fashion to the modern Lichtenstein repair as it lies along the inguinal canal from the pubic tubercle medially to beyond the cord laterally. In addition, a mesh plug in the form of an umbrella or cone is snugly fit up and into the internal ring. In this way, the repair goes beyond just a tightening of the internal ring, but serves to close the ring around the spermatic cord. Modifications of this operation exist and are practiced commonly by general surgeons. The patch and plug can be sutured to the surrounding inguinal canal tissue in an interrupted or continuous fashion. Alternatively, both prostheses can be placed in appropriate position with no suture affixment. In this way, the body's natural scarring mechanism will hold both pieces of mesh in place over time. Wide internal ring defects, often caused by large or chronic indirect sacs, may require one or two sutures to tack the plug in place to avoid slippage into the canal anteriorly or the retroperitoneal space posteriorly. **(Zinner and Ashley, 2006)**

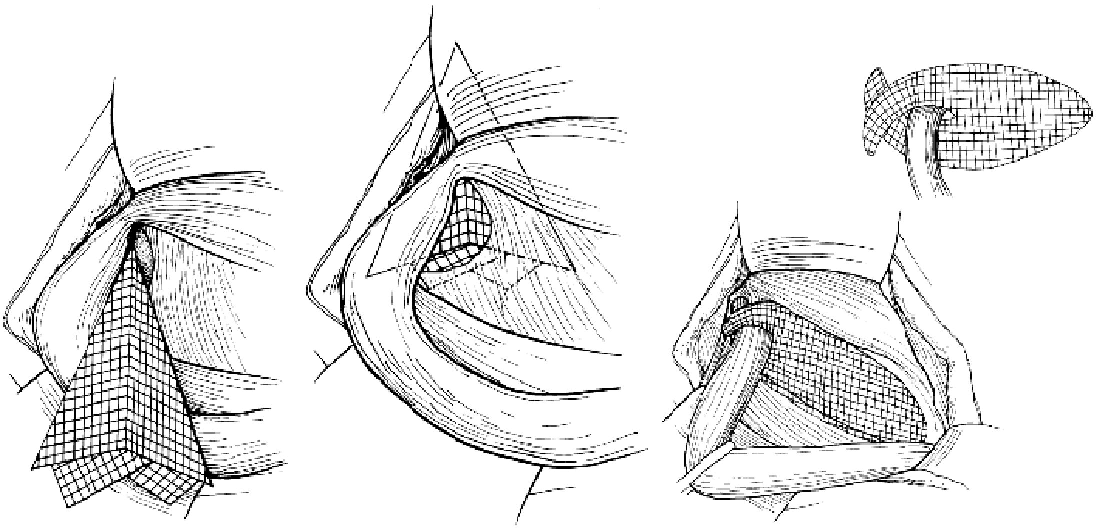


Fig. 26*"patch and plug" tension-free inguinal hernia repair* ***(Zinner and Ashley, 2006).***

The Preperitoneal Approach:

The preperitoneal space is found between the transversalis fascia and the peritoneum itself. The actual groin hernia defect is located anterior to this space, whether the defect exists in the internal ring (indirect inguinal hernia) or through the transversalis floor of the inguinal canal (direct inguinal hernia). Several authors, including *Rives, Nyhus, Stoppa, and Kugel***,** advocate the use of a preperitoneal or posterior approach to repair of the inguinal hernia. They argue that this approach is more effective than the traditional anterior herniorraphy because a repair in the preperitoneal plane fixes the hernia defect in the space between the hernia contents and the hernia defect. In contrast, the anterior approach does not keep the hernia contents from contact with the defect, but rather fixes the hernia defect anterior to the defective anatomy. The operation is also advocated for difficult inguinal hernia recurrences, since the posterior approach will usually remain open and without scar following a previous anterior hernia repair. The original operation as described by Nyhus repairs the hernia primarily with suture, although more recent modifications incorporate a mesh patch posterior to the floor of the inguinal canal. The standard laparoscopic technique for inguinal hernia repair is based entirely on the preperitoneal hernia repair. The preperitoneal repair as described by Rives, the incision is usually made transversely in the lower quadrant 2 -3 cm cephalad to the inguinal ligament. The incision is made slightly more medial than the anterior approach so that the lateral border of the rectus muscle can be exposed after incising the anterior rectus sheath. Once the muscle is exposed, retraction of the rectus muscle medially allows for careful opening of the posterior rectus sheath and entry into the preperitoneal space. The inferior epigastric vessels and the cord can be visualized in this space. The cord usually does not require extensive manipulation or dissection since the usual cord attachments (lipoma and cremaster fibers) are found in the anterior layers of the inguinal canal. In this way, the approach also avoids exposure to the sensory nerves of the inguinal canal **(Zinner and Ashley, 2006).**

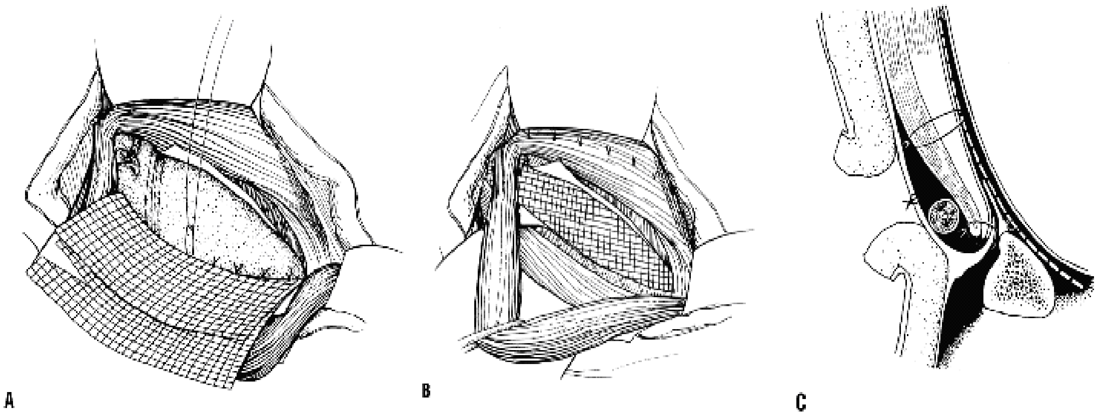


Fig.27: *Rives prosthetic mesh repair.* ***A.*** *Lower line of fixation of the mesh.* ***B.*** *Lateral and upper points of fixation of the mesh.* ***C.*** *Preperitoneal placement of the mesh* ***(Zinner and Ashley, 2006).***

Once the preperitoneal space has been entered and exposed, the specific repair to be performed depends on hernia anatomy. For direct defects, the sac is inverted back into the peritoneal cavity but does not need to be excised. The fascia transversalis is then reapproximated over the inverted sac using interrupted sutures; in this way the upper border of the transversalis fascia is affixed to the lower border composed of the iliopubic tract. For indirect defects, the sac is reduced off of the cord and a high ligation of the sac is performed at the sac neck; ironically, with this approach, the "high ligation" is actually a "posterior" ligation, since the surgeon ideally should transect the sac just above the preperitoneal fat, which is situated along the inferior border of the exposed field. Once the sac has been ligated, the defect in the internal ring is repaired from the posterior plane using interrupted suture to affix the ring leaflets of the transversalis fascia to the iliopubic tract thereby tightening the ring itself. Modifications of this approach using the prosthetic mesh patch are relatively straightforward. The mesh patch is placed underneath the transversalis fascia and directly on the preperitoneal fat. This patch, if placed completely over the inguinal region, covers any peritoneum that could potentially form a hernia sac through a direct or indirect fascial defect **(Zinner and Ashley, 2006).**

Disadvantages:

Insuffetiont Anesthesia:

The lower abdominal wall must be relaxed to facilitate visualization of the posterior inguinal wall. The operation can be performed successfully with only one assistant, provided good abdominal wall relaxation is achieved by general or regional anesthesia (epidural).

Obesity:

Extreme obesity complicates any hernial repair. Because of the necessity of dealing with an anterior abdominal wall flap during exposure of the posterior inguinal wall, the natural difficulties encountered in obesity are multiplied considerably by this approach **(Nyhus, 2001).**

Kugel repair:

The Kugel repair is considered a simple and minimally invasive repair, but its success is dependant on the experience and training of the surgeon. The Kugel repair combines the ease of an anterior approach with mesh placed in the preperitoneal position. The mesh is designed to expand into its full dimensions after being rolled or folded and placed in the preperitoneal space through a relatively small opening. A 2-to3-cm incision is located halfway between the anterior superior iliac spine and the pubic tubercle delving through the external oblique, internal oblique, and transversalis fascia. Any indirect sac is ligated or inverted. The inferior epigastric vessels are identified and should remain attached to the transversalis fascia while the peritoneum is freed from the posterior aspect of the transversalis fascia, creating a preperitoneal pocket in which to place the Kugel patch. The Kugel patch, typically a standard size of 8-12 cm, is inserted into the preperitoneal space and allowed to expand. The patch is secured with a single stitch and allowed to cover the defect. The suture holds it in place along with the pressure from the peritoneum as the patient stands and proceeds with normal activities **(Kugel, 2003).**

Prolene Hernia System:

The Prolene Hernia System (PHS) was developed as an option inguinal Hernia repair that combined the benefits of anterior and posterior mesh components. It was introduced in 1998 and since then has been studied in retrospective chart reviews **(Awad, et al., 2007).** And randomized trials **(Chauhan et al., 2007) (Vironen et al., 2006)** however, none of these studies provide long-term data (beyond 1.5 years) for recurrence. In the procedure for using this system **(Awad et al., 2007)** the inguinal canal is approached anteriorly as described for the Lichtenstein repair. If present, the indirect sac is dissected and inverted, and a preperitoneal pocket is created through the internal ring using a Raytec sponge. The posterior portion of the PHS is then deployed in the preperitoneal space. The anterior portion is positioned and sutured much like the onlay patch in the Lichtenstein repair. A lateral slit is made in the PHS mesh to accommodate the cord and relocate the internal ring, usually a bit laterally. The lateral anterior portion of the PHS is then deployed under the external oblique aponeurosis laterally. The advertised advantages of the PHS in comparison with an onlay mesh or mesh plug include reduced pain and reduced recurrence rates. Only one study found a reduction in immediate postoperative pain **(Kingsnorth et al., 2002).** PHS was associated with a shortened operative time by 4 to 5 minutes in two of the randomized trials **(Nienhuijs et al., 2005).** The studies have not shown a difference in long-term pain. The lack of evidence supporting the advertised claims may be responsible for the low use of this system **(Kingsnorth, 2002)**

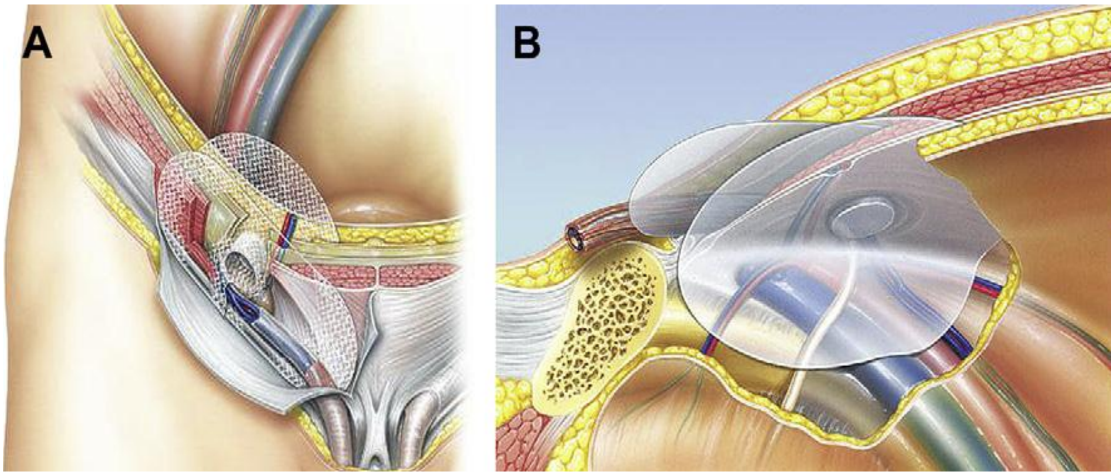


Fig.28: *(A) Prolene hernia system anterior view. (B) Prolene hernia system posterior view* ***(Woods and Neumayer, 2008).***

Stoppa operation (Repair):

The Stoppa repair involves reinforcement of the visceral sac by preperitoneal bilateral mesh prosthesis. The technique, recommended for large, complex, or bilateral hernias, is performed using one of two standard incisions a vertical midline subumbilical or a low horizontal skin incision. The midline fascial layers are divided, providing access to the preperitoneal space. This space is further opened with blunt dissection, much like that used for a laparoscopic approach. The hernia sacs are reduced using gentle traction. Indirect sacs should be opened and explored with the finger to simplify their dissection from the other cord structures and to ensure evacuation of their contents .Large sacs can be transected and closed proximally .A large piece of mesh (Stoppa recommended Dacron) is then prepared in a chevron shape with a dimension of 24-18cm.Using clamps ,the mesh is then placed into the preperitoneal space being sure to pull the cephalad lateral clamp as far as possible laterally and posteriorly, and the lower lateral clamp as far as Possible behind the corresponding obturator wall. No attempt is made to secure the mesh with clips or sutures. Several variations on this repair have been reported and are outlined in available textbooks. This repair is similar in many ways to the laparoscopic repair, and familiarity with the anatomy from the ‘‘inside’’ is helpful when approaching hernias laparoscopically **(Stoppa et al., 2001).**

Results:

A reviewed study of a series of 1,628 patients with 2,224 groin hernias operated on from 1970 to 1984 to compare the results of four techniques: the Bassini-Shouldice operation (BSO), the Mc Vay-Cooper's ligament repair (MVR), the inguinal patch (IP), and the Stoppa repair

(SR).The patients were 16 to 103 years of age. The mean age was 55.8 years for men and 61.5 years for women. The sex ratio was 5.3 men to 1 woman. The clinical and anatomic types of the hernias were as follows: 38.9% were indirect inguinal hernias, 29.8% direct inguinal hernias, 7.6% groin eventration, 5.5% femoral hernias, and 18.2% diverse miscellaneous hernias. Of the hernias, 814 (36.6%) were bilateral (407 patients) and 349 (15.6%) were recurrent. Operation was performed on 153 patients (9.3%) for acute complications. The BSO technique was used to treat 109 hernias (5.0%), the MVR to treat 564 (25.3%), the IP to treat 215(9.6%), the SR to treat 1,223 (55%), and other techniques to treat 113 (5.1%) **(Stoppa, 2001)**

Disadvantages:

Hematoma formations are 5.15%. The sepsis rates are 2.15%. Other complications observed are chest infections, instances of phlebitis and pulmonary embolisms.

In a personal series of 529 Stoppa repairs he reports 2.1% of hematomas; 1.35% of sepsis, and no death; these data can be considered the results of improved indications of Stoppa repairs **(Stoppa, 2001)**

Prosthetic Repair of femoral hernia:

A simple and possibly safer way to repair the femoral defect is a mesh plug placed from cephalad to caudad to obstruct the defect and promote scar tissue formation. This technique has been reported by Lichtenstein with excellent results and low rates of recurrence 1% to 7% (**Lichtenstein and Shore, 1974).**

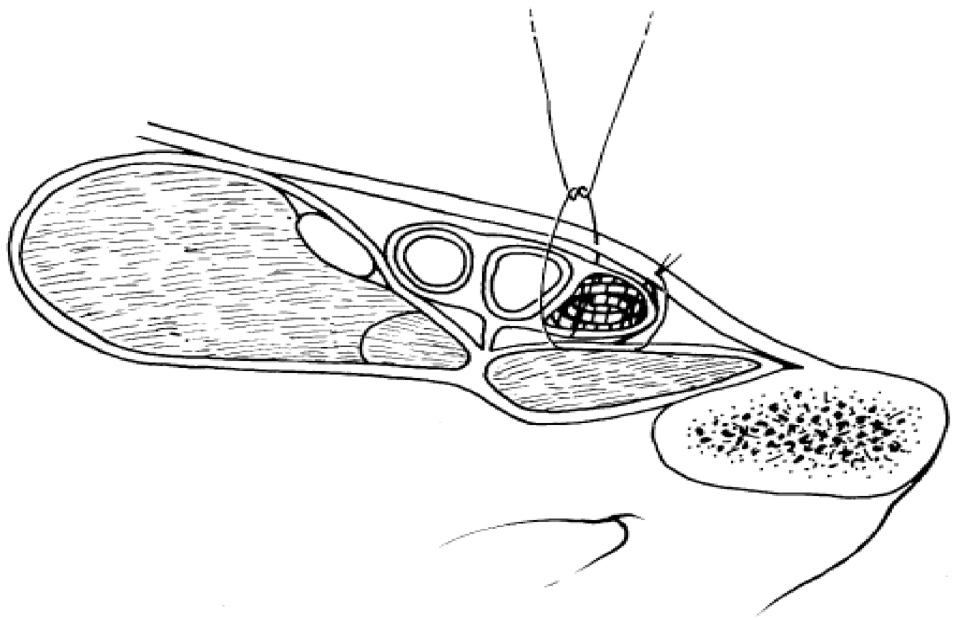


Fig. 29: *The Lichtenstein polypropylene plug for repair of a femoral hernia* ***(Zinner and Ashley, 2006).***

Surgical Complications of Groin Hernia:

Although groin hernia repair is associated with excellent short- and long-term outcomes, complications of the procedure exist and must be recognized **(Zinner and Ashley, 2006).**

Recurrence:

Recurrence of the hernia in the early postoperative setting is rare. When this does occur, it is often secondary to deep infection, undue tension on the repair, or tissue ischemia. Clearly, all of these etiologies raise the concern for a technical complication on the part of the surgeon, either in the handling of the groin tissues or the placement of mesh or suture. The patient who is overactive in the immediate postoperative setting may also be at risk for early hernia recurrence. In this way, it is thought that early exercise is performed before the suture or mesh in the repair has had an opportunity to hold tissue in place and promote scar tissue formation. In the initial postoperative setting, patients may also develop seromas along the planes of dissection as well as fluid in the obliterated hernia sac. These benign consequences of surgery must be differentiated from the more worrisome early recurrence. The size of the hernia defect is proportional to the risk of hernia recurrence. Larger hernias have an increased rate of recurrence postoperatively. This is most likely due to the nature of the surrounding fascial tissues that are critical to the strength and reliability of the repair. As large hernias stretch and attenuate the surrounding fascial planes, these tissues are correspondingly weaker when repaired with suture or mesh. The weakened tissue may also be relatively ischemic at the time of hernia repair, although this has not been adequately studied **(Zinner and Ashley, 2006).**

An emergency operation for strangulated or incarcerated hernia may increase the risk of postoperative recurrence. It is likely that the strangulated hernia, with its inherent inflammation, tissue ischemia, and fascial edema, provides an environment in which the hernia repair is placed either at increased tension or through unhealthy tissue. A hernia that is overlooked in the operating room represents a potential etiology of hernia recurrence, although this should not be a major concern for the modern hernia surgeon. Most of the repairs in the current era emphasize the repair of both an indirect and direct defect through strengthening of the internal ring and inguinal canal floor, respectively **(Zinner and Ashley, 2006).**

A final etiology of hernia recurrence pertains to tobacco use and smoking. The relationship between smoking and hernia formation as well as recurrence was first reported in 1981 and further research has identified proteolytic enzymes that may degrade the connective tissue components **(Read, 1992).**

Seromas and hematomas:

Seromas and hematomas are frequent complications in the postoperative setting. Seromas form in the dead space remaining from a wide dissection during the hernia repair or when fluid fills the distal remnant of the hernia sac. Hematoma formation must be assiduously avoided during groin hernia repair. This is especially true in the anticoagulated patient, and therefore it is recommended that patients temporarily stop taking aspirin and clopidogrel at least 1 week prior to their operation. Hematoma formation may be minor and lead only to ecchymosis and wound drainage. The ecchymosis often spreads inferiorly into the scrotal plane in a dependent fashion. The hematoma usually resolves in days to weeks following repair and supportive management for pain control including scrotal elevation and warm packs is all that is required. A large volume of hematoma is concerning, as it may serve as a nidus for infection deep in the hernia wound and may risk secondary infection of the prosthetic mesh. Therefore hemostasis at the end of a groin hernia repair is paramount to achieve effective wound healing **(Zinner and Ashley, 2006).**

Infection:

Infection of the hernia wound or mesh is an uncommon postoperative complication but represents another etiology of hernia recurrence. In specialized hernia practices, the incidence of wound infection following inguinal hernia operation is 1% or less. It increased to reach 3% to 9% in other hospitals. When an infection does occur, skin flora is the most likely etiology, and appropriate gram-positive antibiotics should be initiated. Patients who undergo mesh placement during groin hernioplasty are at a slightly higher risk of postoperative wound infection. It is often difficult to determine whether the mesh itself is infected or if just the skin or soft tissue anterior to the layer of mesh is infected. However, even if mesh is present, most postoperative groin hernia infections can be treated with aggressive use of antibiotics after the incision is opened and drained expeditiously. Mesh removal in this setting is rarely indicated; when this is mandated, primary closure or redo hernioplasty with a synthetic tissue substitute may be warranted and a preperitoneal approach may be necessary **(Gilbert, Felton, 1993).**

Neuralgia:

Postoperative groin pain, or neuralgia, is common to varying degrees following groin herniorrhaphy. Often, the neuralgia will follow the known distribution of the regional nerves, including the ilioinguinal, iliohypogastric, genital branch of the genitofemoral nerve. During open hernia repair, the ilioinguinal, iliohypogastric, and the genitofemoral nerves are most commonly injured, Nerve injury is usually due to entrapment of a portion of the nerve in the mesh or suture line placed in one of the soft tissue layers **(Tverskoy, Cozacov, Ayache, et al,1990).**

Neuralgias can be prevented by meticulously avoiding overt manipulation of the nerves during operative dissection. The ilioinguinal and iliohypogastric nerves are generally injured during elevation of the external oblique fascial flaps, while the genitofemoral nerve is most likely to be injured during the isolation of the cord and stripping of the cremaster muscle fibers. Often, once the nerve branches are identified, they are encircled with a vessel loop and retracted out of the operative field to avoid injury. The nerves can also be intentionally sacrificed at time of surgery. The result of this maneuver is a region of sensory deprivation in the distributions of these nerve structures, namely on the inner upper thigh and the hemiscrotum. However, the sensory deprivation is thought to be better tolerated by the patient than the chronic and persistent pain attributed to nerve entrapment in scar or mesh. Neuralgia should first be managed conservatively, with attempts at local anesthetic injection in the affected groin. When local anesthesia is injected along the known course of a nerve, this modality may serve as both a diagnostic and therapeutic maneuver. In some cases, temporary control of the chronic pain with local anesthesia may reduce or altogether eliminate the sequelae of chronic groin pain. When this conservative approach does not succeed, groin re-exploration can be performed to ligate or excise affected nerve branches. This is clearly not the preferred first option, since the groin wound has abundant scar and previously undamaged nerve structures may be placed at additional risk. Occasionally, patients will present with postoperative neuralgia that does not match the distribution of any known inguinal nerve. Groin re-exploration should be avoided in this case since it is unlikely to ameliorate the pain and may damage additional structures (**Zinner and Ashley, 2006).**

Bladder Injury:

The urinary bladder may be inadvertently injured during dissection of a direct inguinal hernia sac, but only rarely during repair of an indirect defect. The bladder can also participate in a sliding hernia, so that a portion of the bladder wall is adherent to the sac in a direct defect. Because of the potential for this complication, direct sacs should be inverted into the peritoneal cavity so that excessive dissection can be avoided. If bladder injury takes place, the sac should be opened, and the bladder injury repaired in two layers of an absorbable suture. In general, a urethral catheter is placed for a minimum of 7 -14 days (**Zinner and Ashley, 2006).**

Testicular Injury:

Testicular swelling and atrophy is seen after inguinal hernia repair. Edema of the scrotum or testis may be secondary to edema or hematoma of the inguinal canal that tracks inferomedially to the scrotum in a dependent fashion. Alternatively, a tender testicle or an atrophic testicle may be secondary to injury to the blood supply to the genitals during dissection and isolation of the cord. In most cases, this is not an emergency in the adult patient, and the testes will atrophy without significant infectious complications so that orchiectomy is rarely necessary. A testicle that is tender on examination may require ultrasonographic imaging to rule out testicular torsion or a corresponding abscess. Necrosis of the testes, a very rare complication of groin hernia repair, usually requires orchiectomy to avoid infectious complications (**Zinner and Ashley, 2006).**

Vas Deferens Injury:

Injury to the vas is a rare complication of groin hernia surgery in the male patient. Minor injuries to the vas can be avoided by using gentle, atraumatic traction only and by avoiding complete grasping or squeezing of the vas **(Zinner and Ashley, 2006).**

Direct injury to the vas deferens itself can result in infertility if the contralateral side is abnormal. Injury usually manifests as a painful spermatic granuloma, formed by highly antigenic spermatozoa once they have escaped the vas. Excision of the granuloma and microsurgical repair of the vas is the treatment of choice **(Scott and Jones, 2003).**

Laparoscopic repair of groin hernia

Laparoscopic groin hernia repair was first performed by Ger in 1982, although it was only within the past decade and a half that laparoscopic hernia repair became more accepted. The laparoscopic approach to hernia repair has since evolved into a common and effective procedure. Today, the laparoscopic approach comprises approximately 20-25% of groin hernia operations and 80,000 to 100,000 laparoscopic hernia repairs are performed annually in the United States. The most important difference between the laparoscopic and open approaches for inguinal hernia repair is anatomical: the laparoscopic approach uses mesh to repair the hernia defect in a plane posterior to the defect (either in the preperitoneal space or from within the peritoneal cavity), whereas the open approaches repair the hernia anterior to the defect **(Zinner and Ashley, 2006).**

In 1990, Ger and colleagues **(Ger, Monroe, et al, 1990)** performed the first laparoscopic inguinal hernia repair in dogs by stapling the abdominal opening of the patent processus vaginalis. Other minimally invasive techniques were later developed, including a plug and patch repair **(SchultzL, etal, 1994)** and an intraperitoneal onlay mesh repair **(Fitzgibbons, et al, 1994)**.

The plug and patch repair was not widely accepted because of high recurrence rates coupled with small bowel obstructions related to adhesions. The intraperitoneal onlay mesh repair involved placing mesh over the inguinal hernia defect intra-abdominally without performing a preperitoneal dissection. Although this operation was relatively simple, it was abandoned because of the risk of mesh erosion into bowel **(Tetik, etal, 1994).**

Today, most laparoscopic inguinal hernia repairs are performed with placement of a synthetic mesh into the preperitoneal space, which can be accomplished in one of two ways: the transabdominal preperitoneal (TAPP) approach **(Arregui, Davis, Yuce, 1992)** or the totally extraperitoneal (TEP) approach **(McKernan, Laws, 1993).**

Operative procedure:

Positioning for transabdominal preperitoneal repair (TAPP) and totally extraperitoneal repair (TEP)

The patient is supine with both arms tucked and general anesthesia is used. The monitor is placed at the foot of the operating bed, with the surgeon standing by the patient's shoulder on the opposite side of the hernia. If bilateral inguinal hernias are present, the surgeon starts opposite the side of the larger, more symptomatic hernia. The patient needs to be paralyzed to allow for insufflation of the peritoneal (TAPP) or preperitoneal (TEP) space. After pneumoperitoneum is established and the trocars are inserted, the patient is placed in the Trendelenburg's position **(Takata and Duh, 2008).**

Operative steps for transabdominal preperitoneal repair (TAPP):

The transabdominal preperitoneal (TAPP) repair involves standard laparoscopy with access into the peritoneal cavity and placement of a large mesh along the anterior abdominal wall, thereby repairing the hernia posterior to the defect. This technique was the first laparoscopic hernia repair to be performed. Ports are generally placed through the umbilicus and then laterally on either side of the rectus muscle. The hernia defect is usually well visualized from within the peritoneal cavity.

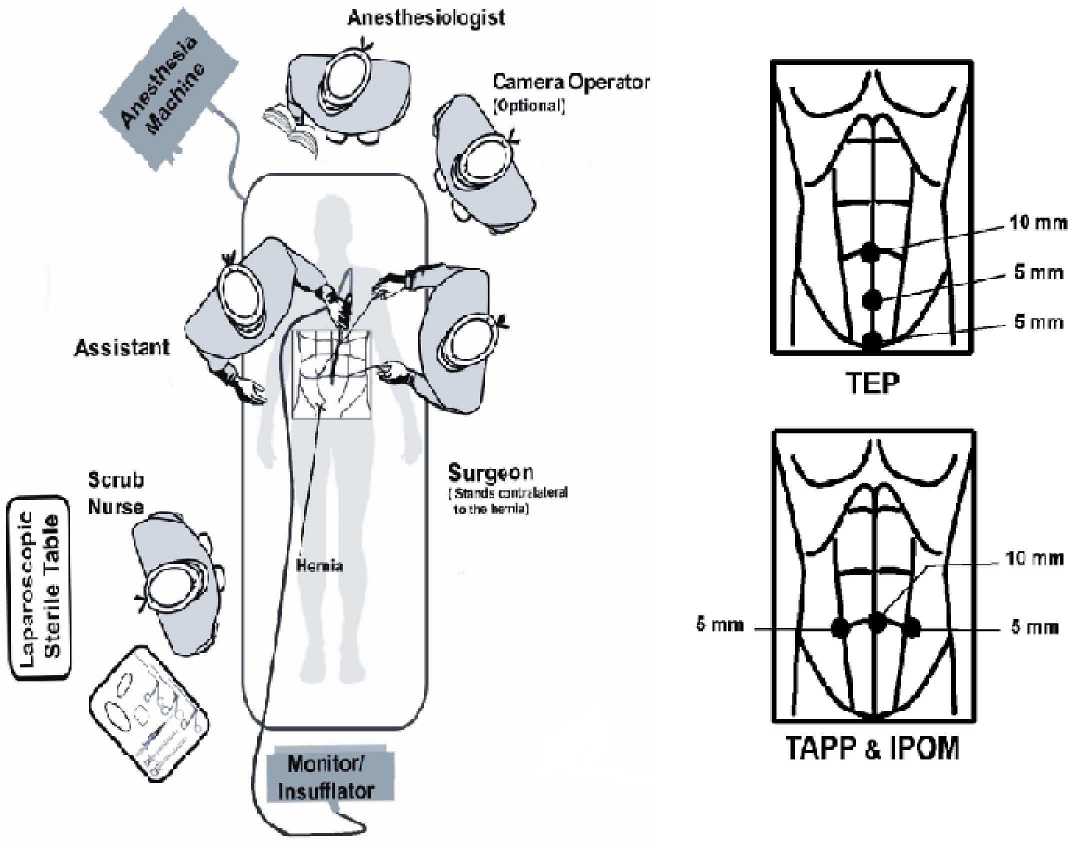


Fig.30: *Typical operating room set up for a right sided laparoscopic inguinal hernia repair and Port sites for the various laparoscopic inguinal hernia repairs* ***(Zinner and Ashley, 2006).***

After both inguinal regions have been inspected and laparoscopic adhesiolysis performed if necessary, the median umbilical ligament (the urachal remnant), the medial umbilical ligament (the remnant of the umbilical artery), and the lateral umbilical fold (the reflection of peritoneum over the inferior epigastric vessels) are identified. The parietal layer of peritoneum is then incised superior to the hernia defect and reflected inferiorly, thereby exposing the hernia defect, the epigastric vessels, Cooper's ligament, the pubic tubercle, and the iliopubic tract. The cord structures are then dissected free of their peritoneal attachments. In a direct hernia, the peritoneal sac is pulled back within the peritoneal cavity with gentle traction to separate the thin peritoneal layer from the equally thin layer of transversalis fascia anterior to it. In an indirect hernia, the peritoneal sac is retracted off of the cord structures and pulled back within the peritoneal cavity. Alternatively, in the setting of a large chronic indirect hernia, the sac can be divided distal to the internal ring so that only the proximal portion of the sac needs to be mobilized for the repair. A large polypropylene mesh patch is then placed between the peritoneum and the transversalis fascia that covers the inguinal floor, internal ring, and the femoral canal. The mesh is stapled or tacked to the pubic tubercle medially, Cooper's ligament inferiorly, and the anterior superior iliac spine laterally. The incised peritoneal flap is then closed over the mesh **(Zinner and Ashley, 2006).**

While the TAPP repair has been shown to be effective, there is a risk that the prosthetic mesh will be in direct content with the bowel, and significant concern has been raised about the potential for intra-abdominal adhesions postoperatively. Enthusiasm for this technique has waned in recent years with the advent of extraperitoneal laparoscopic approaches to inguinal hernia repair **(Vader, Vogt, Zucker, et al, 1997).**

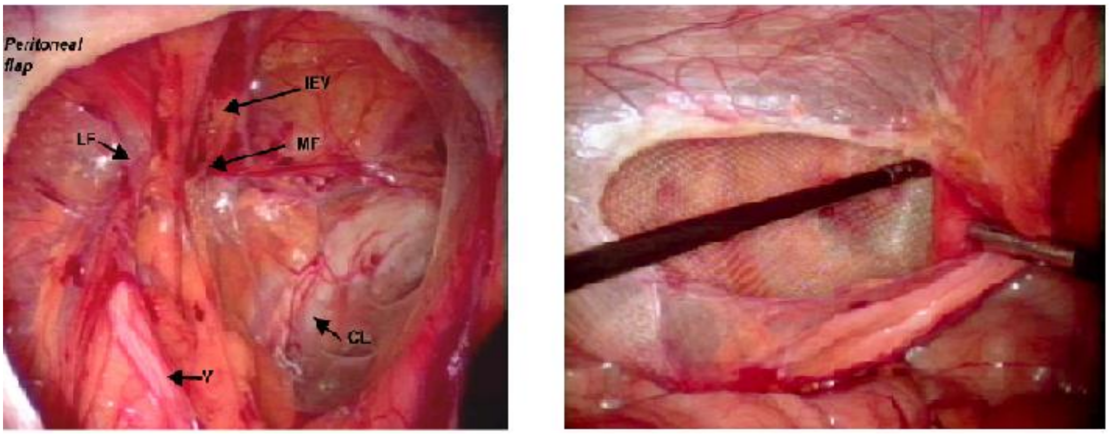


Fig.31: *Critical anatomical landmarks are exposed during a left TAPP inguinal hernia repair. IEV, inferior epigastric vessels; MF, medial fossa containing the direct hernia; LF, lateral fossa; CL, Cooper's ligament; V, vas deferens . /   A large formed mesh is placed in the preperitoneal space during a TAPP repair of a left inguinal hernia* ***(Zinner and Ashley, 2006).***

Operative steps for totally extraperitoneal repair (TEP):

The total extraperitoneal (TEP) approach to laparoscopic inguinal hernia repair is currently the most popular laparoscopic technique. This repair is performed entirely within the preperitoneal space and does not involve the peritoneal cavity when performed correctly.

In this technique, the surgeon carefully develops a plane between the peritoneum posteriorly and the abdominal wall tissues anteriorly and thus insufflate the preperitoneal space.

An incision is made inferior to the umbilicus, and the anterior rectus sheath on the ipsilateral side is incised.

The rectus muscle is retracted laterally, and the preperitoneal space is bluntly dissected to allow placement of a balloon port to facilitate insufflation.

Once the space has been insufflated, two additional ports are placed in the midline between the umbilicus and the pubic symphysis.

In experienced hands, this approach provides for excellent visualization of the groin anatomy, and the dissection proceeds in a similar fashion to the TAP.

The TEP repair allows a large prosthetic mesh to be placed through a laparoscopic port into the preperitoneal space, and it is then positioned deep to the hernia defect to repair the hernia from a posterior approach **(Ferzli, Sayad, et al, 1998).**

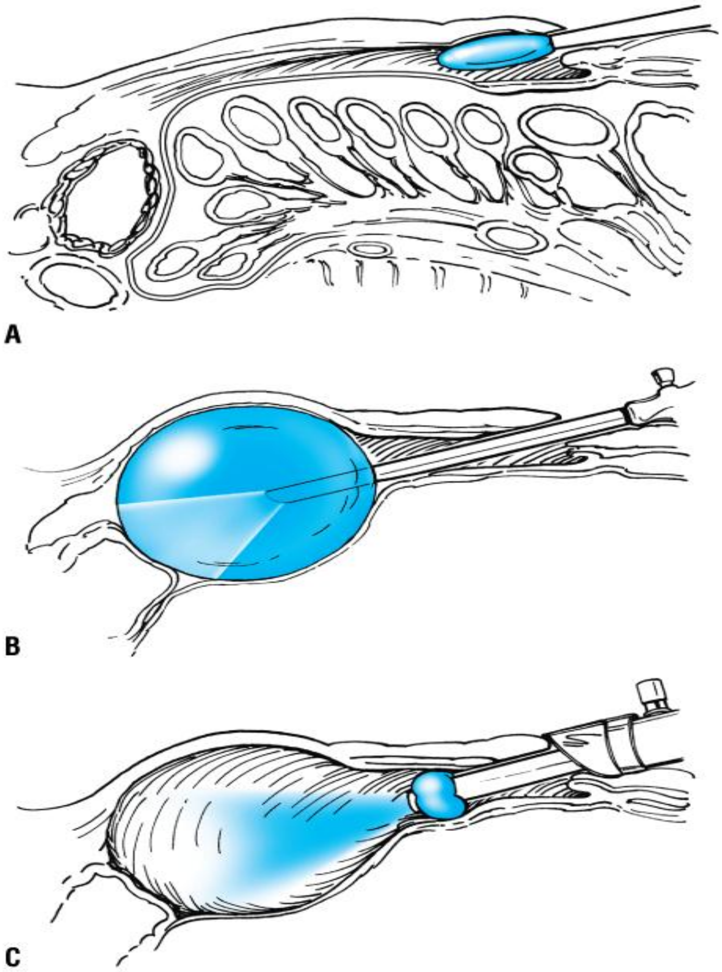


Fig. 32: *Use of a dissecting balloon during a laparoscopic TEP repair to create an extraperitoneal space.* ***A.*** *The noninflated balloon is introduced in the space between the rectus muscle and the posterior rectus sheath.* ***B.*** *The balloon is inflated in the preperitoneal space creating a working space. A laparoscope placed in the balloon allows this step to be performed under direct vision.* ***C.*** *The balloon is removed and replaced with a Hassan type cannula and CO_2 insufflation used to maintain the space* ***(Zinner and Ashley, 2006).***

Complications:

Laparoscopic hernia repair has a history of unique and potentially serious intraoperative complications not seen with open hernia repair. Most of these complications were encountered when the techniques of laparoscopy were still relatively new and experience was minimal. The

Medical Research Council (MRC) Laparoscopic Groin Hernia Group reported three major complications during TAPP repairs: one bladder injury, one common iliac artery injury, and one injury to the lateral femoral cutaneous nerve (**Lancet, 1999).**

The SCUR Hernia Repair Study Group (SCUR) reported two bladder injuries that occurred during TAPP repairs **(Johansson, Hallerback, Glise, et al, 1999)**.

The laparoscopic groups of the European Union Hernia Trialists Collaboration reported 15 visceral or vascular injuries mainly in TAPP repairs **(Grant, 2002)**.

Finally, small bowel obstruction after TAPP repair from herniation of the intestine through the peritoneal opening was a complication that occurred before the importance of complete peritoneal closure was understood **(Kapiris, Brough, Royston, et al, 2001)**

The incidence of these injuries has substantially decreased as experience has grown and as many centers changed to the TEP repair **(Felix, Michas, Gonzalez, 1995).**

Other complications unique to laparoscopic hernia repair are trocar site hemorrhage, trocar site herniation, and injury to the epigastric or gonadal vessels. Other, less serious, complications associated more with the use of laparoscopy and less to surgeon technique are hypotension secondary to elevated intra-abdominal pressure, hypercapnia, subcutaneous emphysema, pneumothorax, and increased peak airway pressures .Most of the time, these are minor problems correctable by lowering the intra-abdominal pressure or completely evacuating the intra-abdominal carbon dioxide. However, if improvement is not achieved, it may be necessary to delay repair.

The same postoperative complications may occur after laparoscopic and open repair. These include urinary retention, groin hematoma, neuralgia, groin pain, testicular problems, wound infection, and mesh complications **(Fitzgibbons, 1995).**

Fitzgibbons and colleagues found a significant decrease (7.0%–1.8%) in postoperative neuralgia manifested by leg pain after surgeons performed 30 laparoscopic cases. This finding reflects a better understanding of the nerve Anatomy from the intra-abdominal or preperitoneal perspective as experience increases. In addition, if mesh fixation is desired, it is important to secure the mesh cephalad to the inguinal ligament to avoid nerve entrapment **(Fitzgibbons, Camps, Cornet, etal, 1995).**

There are emerging data comparing laparoscopic techniques to open inguinal hernia repair, although the evidence is far from definitive. While there are multiple meta-analyses in the literature, only two truly compare the laparoscopic hernia technique with a tension-free open repair. A meta-analysis of 29 randomized trials in 2003 found that laparoscopic hernia repair was associated with earlier discharge from the hospital, quicker return to normal activity and work, and fewer postoperative complications than open repair. **(Memon, Cooper, Memon, et al, 2003).**

However, in these data there was a trend towards an increase in the risk of recurrence after laparoscopic repair. A separate meta-analysis reviewing 41 published randomized trials found no significant difference in risk of recurrence between the two approaches **(Collaboration, 2000).**

Laparoscopic repair was associated with a quicker return to function and less postoperative pain, but also was found to have a higher risk of visceral and vascular injuries. A more recent multicenter, randomized trial that analyzed long-term hernia results in over 2000 patients in 14 Veterans Affairs hospitals found that laparoscopic hernia repair was associated with a higher recurrence rate among primary hernias, but was equivalent to open repair in recurrent hernias **(Neumayer, Giobbie-Hurder, Jonasson, et al, 2004).**

In all of these studies, the laparoscopic repair was noted to take more time in the operating room. Finally, a recent study has reported a significant learning curve inherent in the laparoscopic approach **(Neumayer, Gawande, Wang, et al, 2005).**

Clearly; more definitive multicenter data from surgeons experienced in both procedures are needed to reach formal conclusions about the utility of both hernia approaches **(Neumayer, 2005).**

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Summary

Ventral hernias are a common surgical condition, well known to be associated with occurrence of serious complications and usually appear during adulthood and are frequently associated with multiple pregnancies and obesity.

Since surgery remain the only modality of treatment, an effective repair with low preoperative morbidity and recurrence rates should be performed.

Since the overall morbidity and recurrence rate following the initial musclofascial repair of ventral hernia were unacceptably high, the prosthetic reinforcement of the abdominal wall defects has been widely advocated.

The best method of hernia repair has not been developed yet, as evidenced by multitude of procedures described in various textbooks and significant failure rates associated with these methods. Currently the Rives-stoppa approach to be the most promising open technique with comparatively low recurrence rates.

There are, however, several drawbacks to this method, including extensive soft tissue dissection, raising flaps, and drain placement. The open technique, performed in tissues that are already of poor quality, has led to an overall complication rate up to 20% involving wound infection and infection of the mesh, fistula formation and other problems.

The advent of laparoscopy contributed many advantages in ventral hernia treatment. The approach seeks to apply the sound principles associated with Rives-Stoppa but with modifications in the technique for mesh placement. Using the laparoscopic approach, a large prosthetic mesh can still be placed on the anterior abdominal wall (internal rather than external to the posterior fascia peritoneum), Overlapping the defect by several centimeters in all directions. However, with this technique, there is no need for extensive soft tissue

dissection seen in the open approach and its attendant complications. The patient can expect to receive all the other benefits of a minimally invasive procedure, such as decreased hospital stay, lower wound complications rate and decreased pain.

For primary inguinal hernia in adults the method of repair will account for the surgeon's training, the type of hernia, and the patient's age. Shouldice repair, the Lichtenstein operation, and laparoscopic techniques conform to the principles of good repair surgery-namely careful and accurate identification of the anatomy and use of appositional suture material or implanted mesh to repair the defect. When combined with good management policies, all techniques are effective.

The Lichtenstein operation has gained popularity because of its simplicity and equally good results in the hands of experts and trainee surgeons; it is the recommended operation of first choice for uncomplicated unilateral inguinal hernia in men. In countries where mesh is not affordable, Shouldice repair gives excellent results in the hands of well-trained surgeons.

The rate of recurrence and complications between open and laparoscopic procedures do not differ significantly. Laparoscopic repair requires a general anaesthetic in most cases, takes more operative time to complete, and the hospital costs are greater. However, earlier return to normal activities and work seems to make the overall costs of the laparoscopic operation less than those of the open procedure.

The trend in most centers is for laparoscopic repair to be restricted to bilateral and recurrent inguinal hernias, for which the results are excellent. The choice between the TAPP and the TEP is a personal preference of the surgeon. There is no clinical difference between the conversions to open, the complications seen, or the recurrence rates between these two operations in skilled hands.

Conclusion

Management of incisional hernia:

The prosthetic reinforcement of the abdominal wall defects has been widely advocated.

The best method of hernia repair has not been developed yet, as evidenced by significant failure rates associated with these methods.

The Rives-stoppa approach is the most promising open technique with comparatively low recurrence rates.

The advent of laparoscopy contributed many advantages in ventral hernia treatment.

The approach seeks to apply the sound principles associated with Rives-Stoppa but with modifications in the technique for mesh placement.

Using the laparoscopic approach, a large prosthetic mesh can still be placed on the anterior abdominal wall (internal rather than external to the posterior fascia peritoneum).

The patient can expect to receive all the other benefits of a minimally invasive procedure, such as decreased hospital stay, lower wound complications rate and decreased pain.

Management of grion hernia:

Shouldice repair, the Lichtenstein operation, and laparoscopic techniques conform to the principles of good repair surgery.

Shouldice repair gives excellent results in the hands of well-trained surgeons.

The Lichtenstein operation is the recommended operation of first choice for uncomplicated unilateral inguinal hernia in men.

The trend in most centers is for laparoscopic repair to be restricted to bilateral and recurrent inguinal hernias, for which the results are excellent.

The choice between the TAPP and the TEP is a personal preference of the surgeon.

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