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«UZHHOROD NATIONAL UNIVERSITY»  
FACULTY OF MEDICINE  
DEPARTMENT OF SURGERY DISEASES

## **External Abdominal Hernias**

Methodological materials for independent study for students

UZHHOROD

2024

UZHHOROD NATIONAL UNIVERSITY  
FACULTY OF MEDICINE  
DEPARTMENT OF SURGERY DISEASES

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The methodological materials are devoted to the etiology, pathogenesis, clinical presentation and treatment of external abdominal hernias. The authors also focus on the anatomical features of the abdominal wall, modern methods of treatment, and surgical tactics for various complications. The methodical materials are intended for senior year students of higher medical educational institutions.

Uzhhorod

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## **DEFINITION**

An external abdominal hernia is the protrusion of an abdominal viscera, covered by peritoneum through the congenital or acquired fascial defect outside under the skin.

## **Epidemiology**

The high prevalence of hernia, for which the lifetime risk is 27% for men and 3% for women, has resulted in this condition inheriting one of the longest traditions of surgical management.

Hernia repair is one of the most frequently performed surgical procedures in the developed world with over 700 000 being performed each year in both the USA and Europe. Few surgical procedures have been as intensively evaluated as surgical methods for hernia repair.

Annually about 90 000 surgeries about hernia are carried out in Ukraine. Up to 13 000 operations are performed by emergent indications. The interrelation elective and emergent herniotomies in Ukraine makes it as a ratio of 6:1. The ratio is not less than 15:1 in developed countries, that specifies an unsatisfactory state of the surgical help to the patients with hernias in our country. Emergent indications and complications are seen in every 8<sup>th</sup>-10<sup>th</sup> patient.

The mortality after elective herniotomies in Ukraine about 0,06% and at the same time mortality in the operations of strangulated hernias is about 3%. The highest mortality is seen in cases with a huge incisional hernia (with pre- or postoperative complications) which is up to 21%.

## ETIOLOGY AND PATHOGENESIS

There are various reasons that contribute to the formation of abdominal wall hernias. They are divided into local and general.

Local include weak areas of the abdominal wall, where vessels, nerves, spermatic cord, round ligament of the uterus pass through it. Next important thing is decrease in muscle tone of the anterior abdominal wall during pregnancy, in old age, after traumatic injuries, as well as changes in the layers of the abdominal wall that occur after surgical interventions (atrophy, atony, cicatrices).

General reasons are usually divided into favorable and causative:

- ***Favorable reasons include:*** age, gender, congenital genetic weakness of tissues, weight loss, unfavorable working conditions. In adulthood, hernias occur more often than in the elderly. Inguinal hernias are more common in men, and femoral and umbilical hernias in women. Anamnestic data indicate the heredity of the disease, in some families a number of generations are affected, both in male and female lines. Losing weight leads to a decrease in the elasticity and strength of tissues, which can also contribute to the occurrence of hernias.
- ***The causative factors include:*** significant and often sudden increase of intra-abdominal pressure, which can be caused by:
  - physical activities
  - lifting heavy weights
  - difficult childbirth
  - persistent cough caused by some lung disease (whooping cough, bronchial asthma, chronic bronchitis)
  - chronic constipation
  - difficult urination (phimosis, prostate adenoma etc.)

There are four stages can be distinguished in development of external abdominal hernias (especially inguinal).

Most hernias appear gradually and then gradually increasing in size. Sudden onset is less common, when acute elevation of intra-abdominal pressure in the

presence of anatomical weakness of the abdominal wall rupture occurs inguinal canal with subsequent formation of hernia.

I stage. Initially formed hernia orifice. Initial hernia (during coughing pushing wave of parietal peritoneum can be determined).

II stage. Incomplete hernia. Hernia has all the constituent parts, but the hernia sac does not pass through all layers of abdominal wall. It can appear only during significant increase of intraabdominal pressure and disappears after its over.

III stage. Formed hernia. Hernia pass through abdominal wall and causes notable bulging that well observed in standing position and at the slightest physical exertion.

IV stage. Huge hernia. Hernia size increase and may contain much of the abdominal viscera.

## ANATOMY

The components of the hernia are (Fig. 1 A): hernia orifice (gate, hiatus), hernia sac and hernia content. In case of strangulation a hernia fluid may appear along with content. Hernia orifice are openings, slits in the muscle-aponeurotic layer of the abdominal wall, through which, under the influence of various reasons that increase abdominal pressure, the parietal peritoneum protrudes and the viscera follows it outside the abdominal cavity. The shape of the hernia orifice can be round, oval, slit-like, triangular. Their size depends on the size of the hernia and can reach tens of centimeters. The hernia sac is a part of the parietal peritoneum that has come out through the hernia orifice, where the viscera are located. Hernia sac consist of: the mouth, neck, body and fundus (Fig. 1 B).

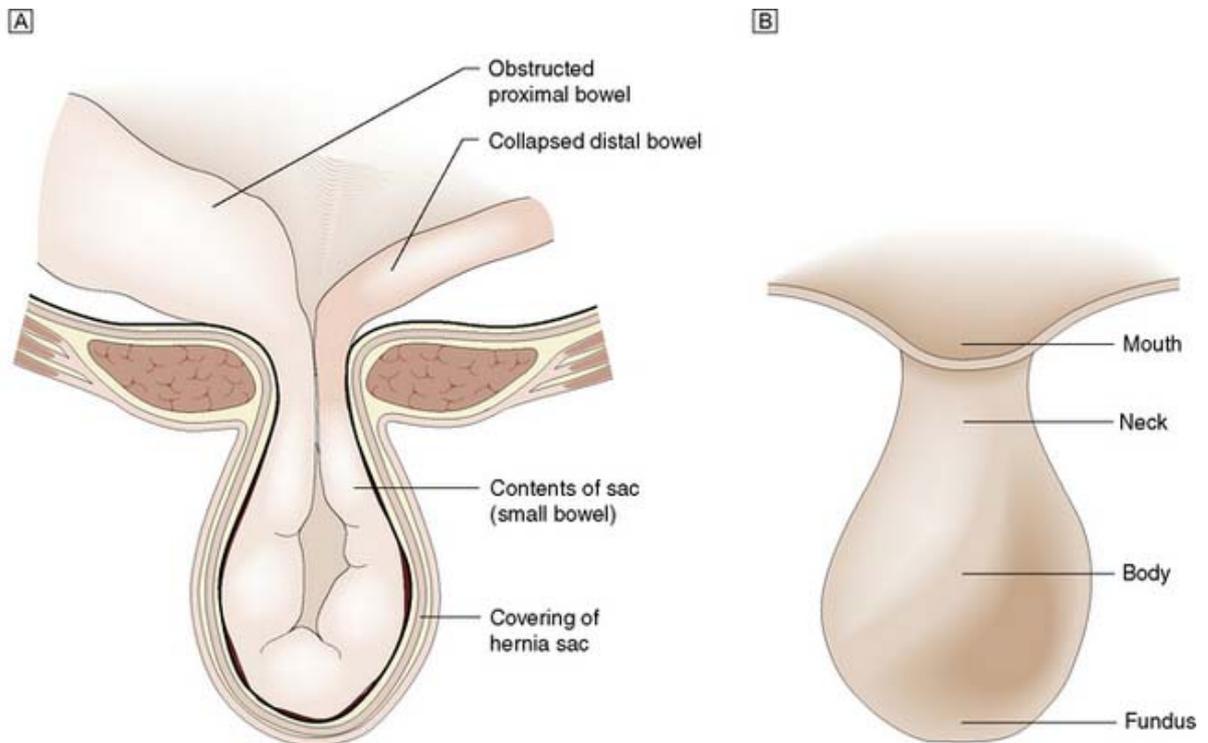


Fig. 1. Components of hernia (A) and hernia sac (B)

The mouth is a narrowed part of the parietal peritoneum in front of the hernia orifice. The neck of the hernia sac located at the level of the hernia orifice. The body is widest part, which is located directly under the covering of hernia sac. The fundus of the sac is its distal part. The hernia sac can be one-chambered, two-chambered and multi-chambered.

A *sliding hernia* is a protrusion through an abdominal wall of a retroperitoneal organ. (ex. bladder, cecum, sigmoid colon). In such case, one part of a hernia sac represented with retroperitoneas viscera and can be damaged during cutting the hernia sac (Fig. 2).

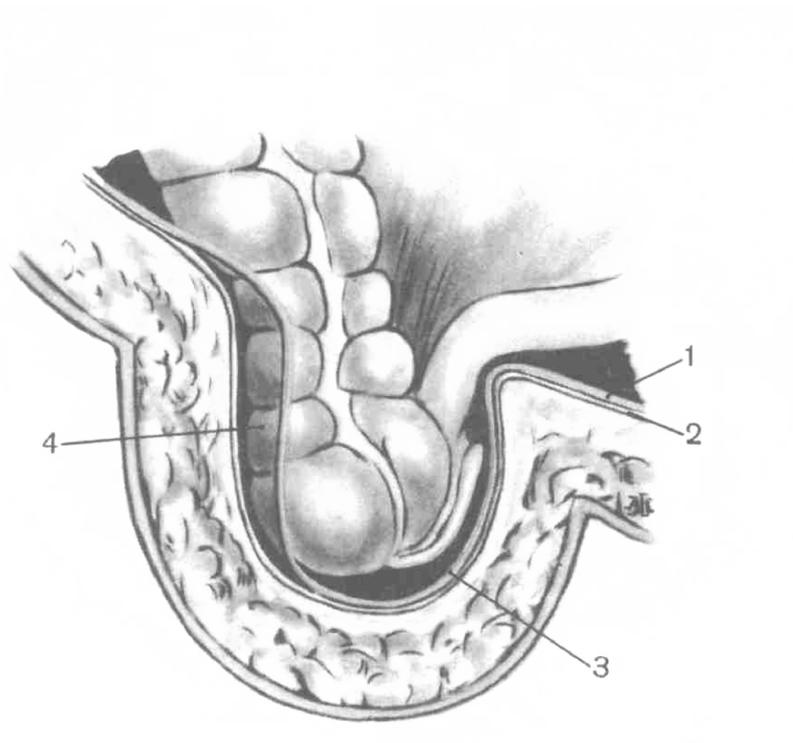


Fig. 2. Sliding hernia with ceacum

Hernia content can be almost all organs of the abdominal cavity, depending on the location of the hernia orifice. The frequency of finding one or another organ in a hernia occurs in the following order:

- 1) Small intestine.
- 2) Omentum.
- 3) Large intestine.
- 4) Appendix (Amiand's hernia).
- 5) Organs partially covered by peritoneum (bladder, cecum, sigmoid colon).
- 6) Stomach, gallbladder, Meckel's diverticulum (Litre's hernia).

## CLASIFICACION OF HERNIA

The classification of hernias is based on consideration of the following aspects: clinical and anatomical. The clinical classification is only a presumption; it is difficult, during clinical evaluation, to make a definitive diagnosis as to whether the hernia is direct, indirect, or femoral; primary or recurrent; or complicated or uncomplicated. The anatomic classification and the definitive diagnosis are made during the operative event. There are different classifications that take into account the pathophysiology of the hernia, the anatomical conditions of the ring, as well as the possible repair technique

Hernias are divided into **congenital** and **acquired** by origin. The reason that leads to the formation of a congenital hernia is a violation of the anatomical structure of the abdominal wall that occurs in the embryonic period of the fetus (failure of closure of the vaginal process for inguinal hernia; abnormal development of the abdominal wall of the navel area). Acquired hernias occur due to different factors (favorable and causative).

**According to localization:** inguinal (direct and indirect), femoral, umbilical, midline, incisional, Spigelian hernia (Fig. 3) and less common – lumbar (triangle of Petit and triangle of Grynfelt), oburator, gluteal, sciatic and perineal (Fig. 4).

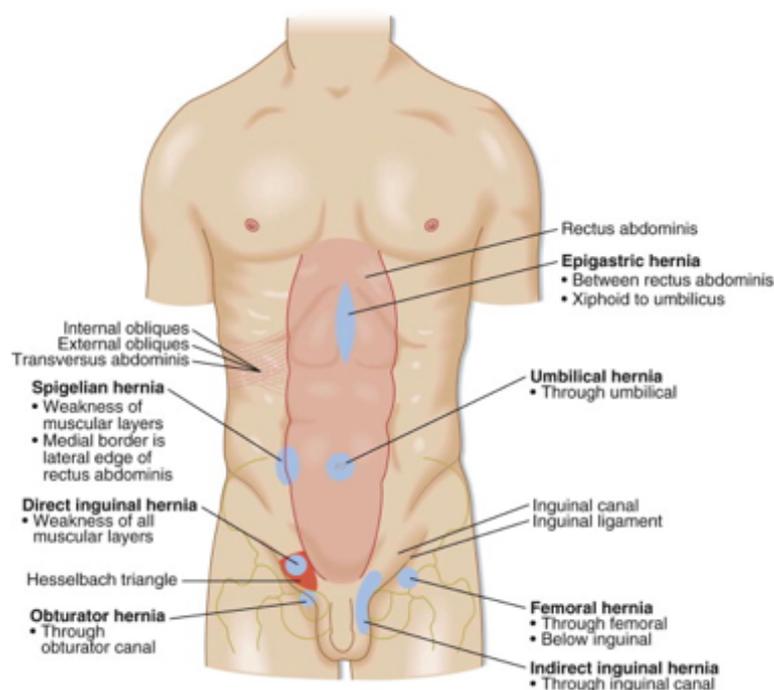


Fig. 3. Abdominal wall hernias

*Lumbar hernia* (Fig. 4) are quite uncommon as compared to other ventral abdominal wall hernias, accounting for less than 1.5% of all abdominal hernias, with fewer than 300 cases reported over the past 300 years. About 25% of all lumbar hernias have a traumatic etiology. This may be post-surgical or following blunt injuries associated with intra-abdominal injuries. The management of such patients constitutes a surgical challenge. Clinical diagnosis of this entity is difficult due to non-specific symptoms. The diagnosis is particularly elusive in obese individuals or in post-surgical patients. Though rare defects, lumbar hernias are prone to incarceration and strangulation

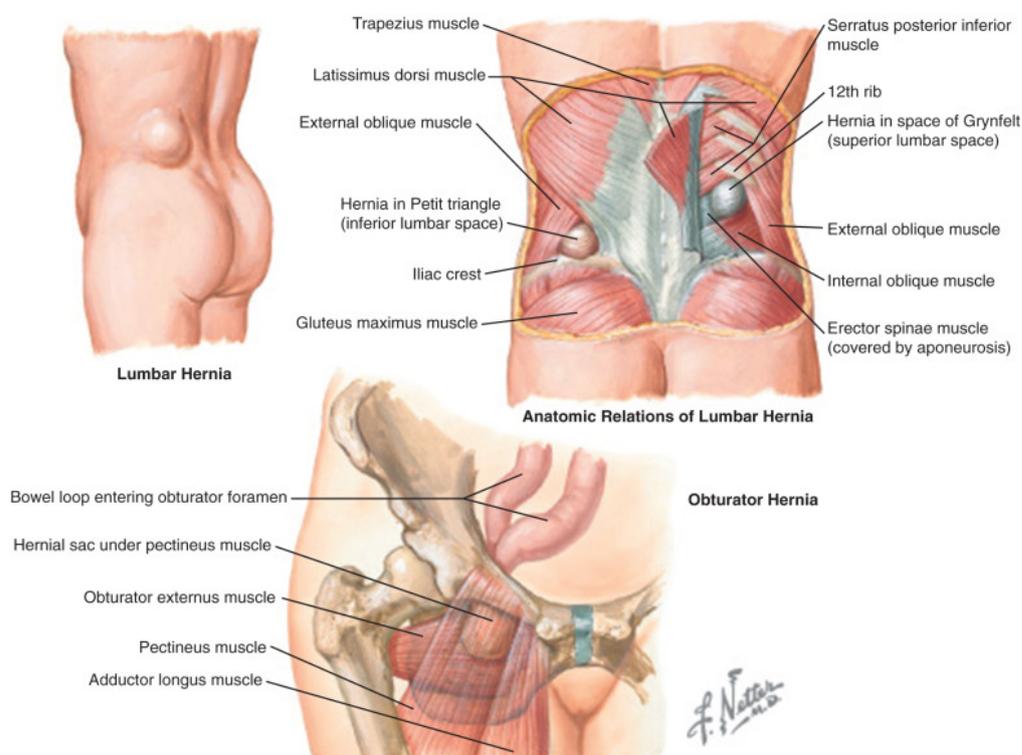


Fig. 4. Lumbar and obturator hernias

*Sciatic hernia* are rare (Fig. 5). The hernia can pass through the greater sciatic foramen above (1) or below (2) the piriformis muscle or through the lesser sciatic foramen medial to the sciatic nerve (3).

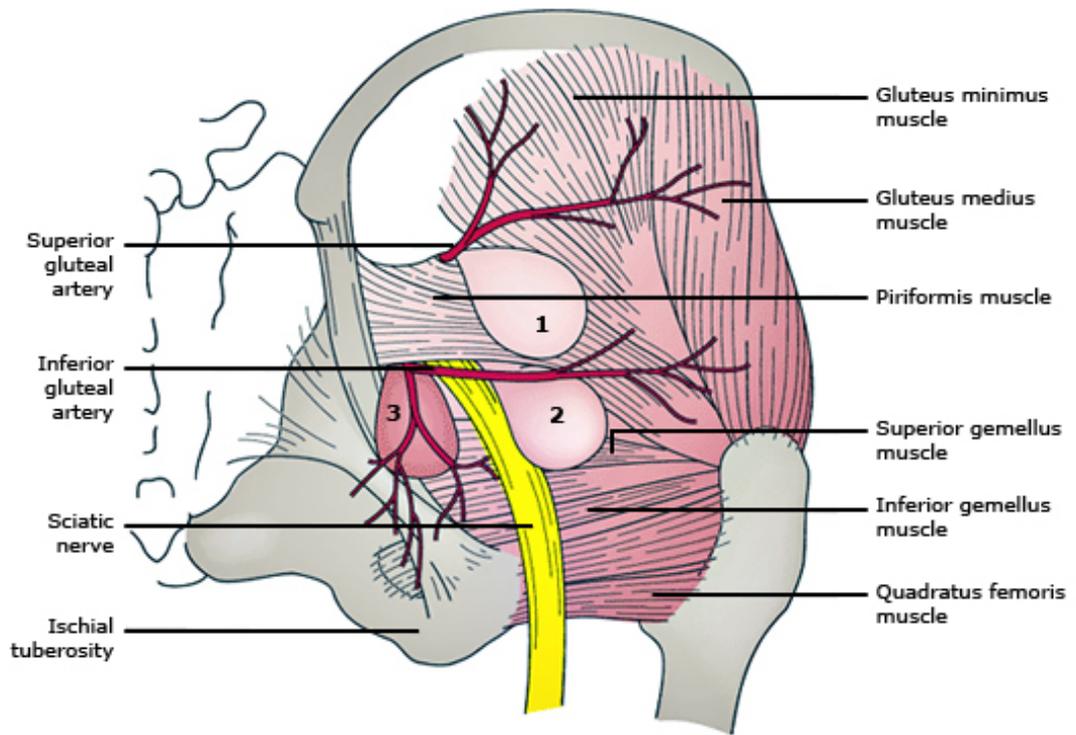


Fig. 5. Sciatic hernias

*Perineal hernia* (Fig. 6) may occur anteriorly or posteriorly to the superficial transverse perineal muscles.

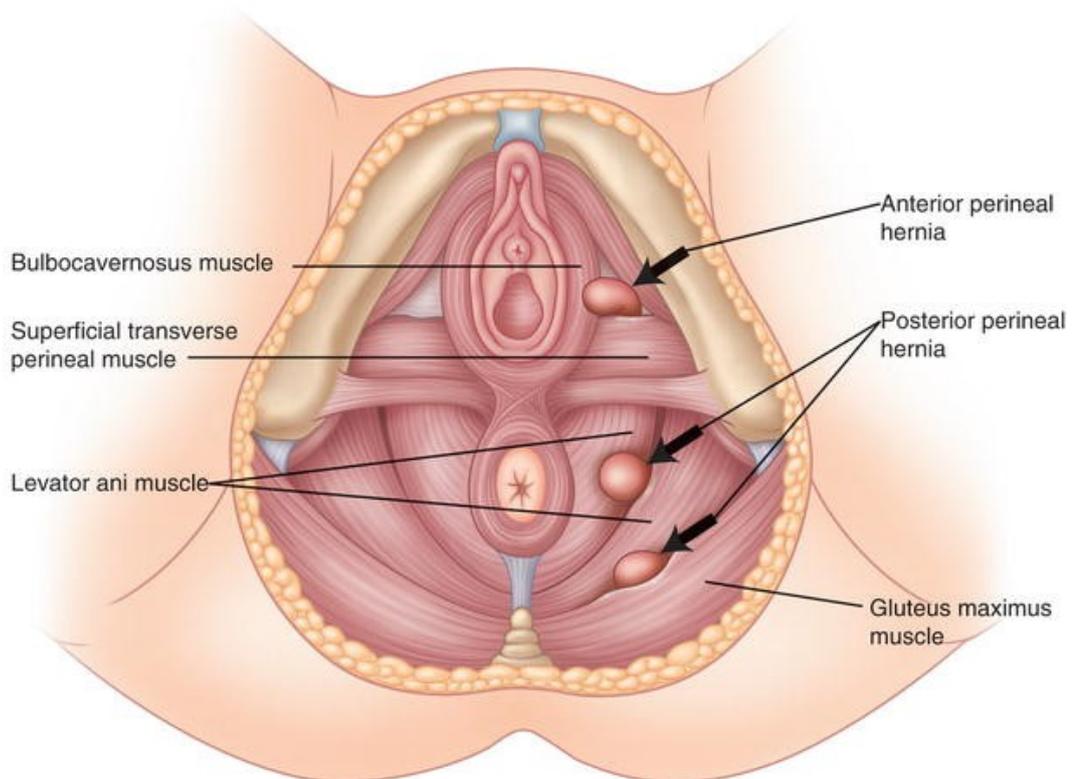
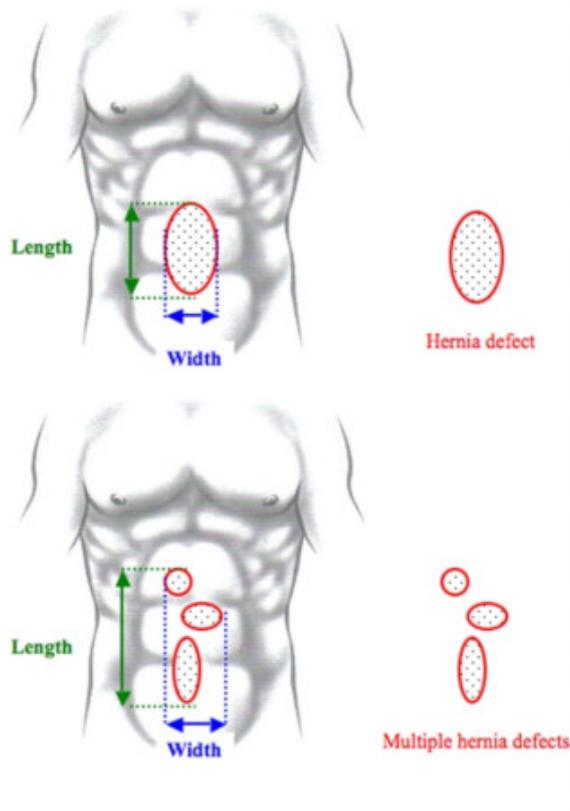
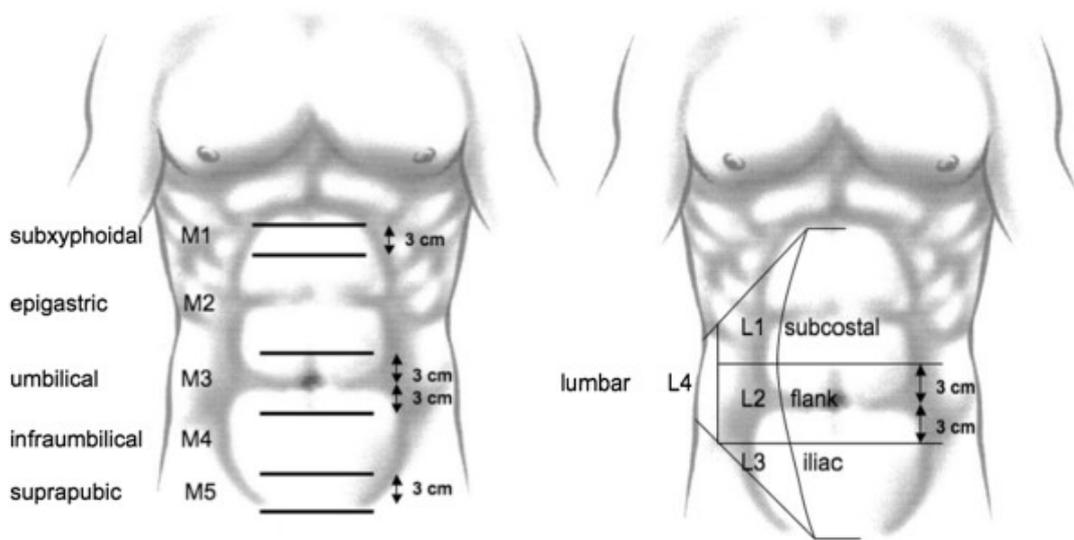


Fig 6. Perineal hernias

Congenital perineal hernia is a rare entity. Failure of regression of the peritoneal cul de sac of the embryo is considered a predisposing factor for hernia formation. Acquired perineal hernias are primary or secondary. Primarily acquired perineal hernias are caused by factors associated with increased intra-abdominal pressure. They are more common in females as a result of the broader female pelvis and the attenuation of the pelvic floor during pregnancy and childbirth. Secondarily acquired perineal hernias are incisional hernias associated with extensive pelvic operations such as abdominoperineal resection of the anorectum and pelvic exenteration. Pain in the perineal area, intestinal obstruction, topical skin erosion, and difficulty with urination necessitate the surgical repair of a perineal hernia. This can be accomplished through transabdominal, perineal, or combined abdominoperineal approaches.

*Incisional hernia* refers to abdominal wall hernia at the site of a previous surgical incision. It is a type of ventral hernia. Midline incisional hernias are more common than other sites. It can be a definite hernia with all the hernia components of the defect, sac, and content. Or, it can be a weakness of the wall with shallow sac and occasional bulge of content.

To facilitate perception and unification of incisional ventral hernias classification has been proposed by European Hernia Society (Fig. 7). This classification takes into account location, size, and previous recurrences.



EHS			
Incisional Hernia Classification			
Midline	subxyphoidal	M1	
	epigastric	M2	
	umbilical	M3	
	infraumbilical	M4	
	suprapubic	M5	
Lateral	subcostal	L1	
	flank	L2	
	iliac	L3	
	lumbar	L4	
Recurrent incisional hernia?			Yes <input type="radio"/> No <input type="radio"/>
length: cm		width: cm	
Width cm	W1	W2	W3
	<4cm <input type="radio"/>	≥4-10cm <input type="radio"/>	≥10cm <input type="radio"/>

Fig. 7. EHS Incisional hernia classification

**According to clinical course:**

**Reducible hernia.** A hernia either reduces itself when the patient lies down or can be reduced manually by the patient or surgeon hand. Note that intestine gurgles on reduction and the first portion is more difficult to reduce than the last. Omentum is doughy and the last portion is more difficult to reduce than the first. A reducible hernia imparts an impulse on coughing (Fig. 8 A).

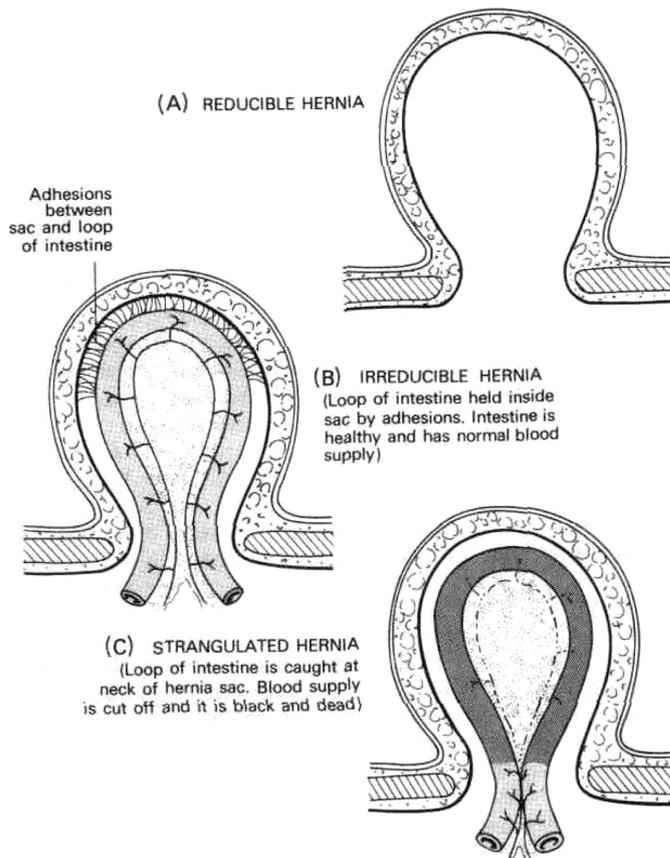


Fig. 8. Clinical course of hernia

**Irreducible hernia.** Hernia content can't be reduced to the abdomen and there is no evidence of other complications. Permanent injury by recurrent strangulations of hernia content accompanied by chronic aseptic inflammation process of organs and peritoneum of hernia sac. It results in adhesions formation between the wall of hernia sac and content. That may lead to partial or total impossibility to reduce content back to the abdominal cavity. Any degree of irreducibility predisposes to strangulation. Irreducibility without other symptoms is almost diagnostic of an omentocele especially in femoral and umbilical hernia (Fig. 8 B).

**Strangulated hernia.** A hernia becomes strangulated when the blood supply of its contents is seriously impaired, rendering gangrene imminent. Gangrene may occur as early as 5 or 6 hours after the onset of the first symptoms of strangulation.

The intestine is obstructed and in addition its blood supply is cutted off. At first only the venous return is impeded. The wall of the intestine becomes congested and bright red and serous fluid is poured out into the sac. As the

congestion increases, the intestine becomes purple in color. As a result of increased intestinal pressure the strangulated loop becomes distended, often to twice its normal diameter. As venous stasis increases, the arterial supply becomes more and more impaired. Blood is extravasated under the serosa (an ecchymosis) and is effused into the lumen. The fluid in the sac becomes bloodstained. The shining serosa becomes dull and covered by a fibrinous, sticky exudate. By this time the walls of the intestine have lost their tone; they are flabby, and are very friable. The lowered vitality of the intestine favors migration of bacteria through the intestinal wall, and the fluid in the sac becomes infected. Gangrene appears first at the constricted spots which become deeply furrowed and grey in color, and then it appears in the antimesenteric border and spreads upwards, the color varying from black to green according to the decomposition of blood in the subserosa. The mesentery involved by strangulation also becomes gangrenous. If the strangulation is unrelieved, perforation of the wall of the intestine occurs, either on the loop which is inside sac or at the neck of the hernia (Fig. 8 C). Peritonitis spreads from the sac to the peritoneal cavity.

## CLINICAL SYMTOMS AND SIGNS

The clinical picture of uncomplicated hernias is quite typical. The first sign of a hernia is slight pain in the abdomen or in the area of the abdominal wall where the hernia is formed. Pain can radiate to the epigastric area, spermatic cord, labia, thigh or perineum. With the development of the hernia, the pain intensifies and shifts to the area of localization of the hernia. The pain increases significantly with physical exertion, straining the abdomen, coughing and changing position from a horizontal to a vertical.

An important sign of a hernia is the appearance of a protrusion in one or another part of the abdominal wall, which the patient himself draws attention to. With hernias, various dyspeptic disorders appear early: heartburn, nausea, sometimes vomiting. They are associated with stretching of the omentum and mesentery, which is located in hernia sac and has a reflexive origin. With large and sliding hernias dysuric disorders and intestinal dysfunction may occur.

The main objective signs of an external hernia are:

- protrusion in the abdominal area where the hernia is located. The dimensions of the protrusion depend on the type of hernia, the age of the disease and the degree of its development.
- bulging during bloating and coughing increases, becomes tense. When the patient moves from a vertical position to a horizontal position, the protrusion decreases, and when pressure is applied to it, it is easily inserted into the abdominal cavity. Depending on the contents of the hernia sac, palpation, percussion and auscultation results will be different. If there is an intestine in the hernia sac, the protruding surface is smooth, and the consistency is soft, intestinal peristalsis can be seen, intestinal noises can be heard. With percussion in such cases there will be tympanitis. The presence of omentum in the hernia sac represents as unclear seal.
- the presence of a defect in the abdominal wall, that is, a hernia orifice, in the area where the hernia is located after its insertion into the abdominal

cavity. Hernia orifice can be of different sizes and shapes. In some patients, only the tip of the finger may pass it, and in others a few fingers pass through them. Hernia orifice can be round, oval or slit-like.

- the presence of the "cough impulse" symptom, which is manifested by the transmission of cough impulses to the inserted fingertip in the hernia orifice or the hand placed on the hernia protrusion. A positive symptom of "cough impulse" indicates a free connection of the abdominal cavity with the cavity of the hernia sac. It becomes negative when the hernia becomes strangulated.

An anatomical feature of sliding hernias is that the hernia sac, when the hernia protrusion increases, pulls organs closely related to the peritoneum into the hernia orifice.

At the same time, the visceral peritoneum covering the organ becomes part of the hernia sac. Without knowledge of these anatomical features of sliding hernias, there is a real threat of intraoperative damage to the wall of the intestine or bladder, which should always be remembered. According to literary sources, with a sliding hernia, damage to organs reaches 26.4%, and mortality - from 1% to 8.3%. The most common cause of death is postoperative peritonitis.

The most frequent and severe complication of a hernia is hernia strangulation, which is a sudden compression of the contents of the hernia sac in the hernia gate or in the neck of the hernia sac. According to statistics, hernia strangulation is detected in 8-10% of patients. Postoperative mortality in this complication is 5-7 %, in elderly patients - up to 10-16 %.

Strangulation can occur in patients of any age, but most often in middle-aged patients engaged in heavy physical labour. The cause of strangulation is usually a sudden increase in intra-abdominal pressure. It is caused by a narrow, incompetent hernia gate, as well as by inflammatory processes and scarring changes in the neck of the hernia sac. There are true and false strangulations (false - Brock's hernia). In case of true strangulation, the contents of the hernia sac are compressed in the hernia gate or in the neck of the hernia sac with impaired blood circulation in the

strangulated organ and the appearance of intense pain of ischaemic origin. In case of false strangulation, the pain occurs due to the ingress of abdominal organs into the hernia sac in acute surgical diseases or infected effusion in case of gastric or duodenal ulcer, acute appendicitis, acute cholecystitis, acute pancreatitis and other diseases, without compression of the hernia sac contents. True strangulation occurs more often and is the most dangerous.

According to the mechanism of strangulation, there are elastic and faecal strangulations. Elastic strangulation occurs in patients with narrow hernia gates with a significant sudden increase in intra-abdominal pressure (Fig. 9. A). The elasticity of the hernia gate and adjacent tissues allows them to expand and allow other anatomical formations of the abdominal cavity to enter the hernia sac, and after its contraction, to compress its contents. Faecal impaction occurs when the intestinal contents rapidly enter the intestinal adductor loop located in the hernia sac, followed by compression of the abdominal outlet loop (Fig. 9. B). The basis of faecal impaction is a violation of intestinal function.

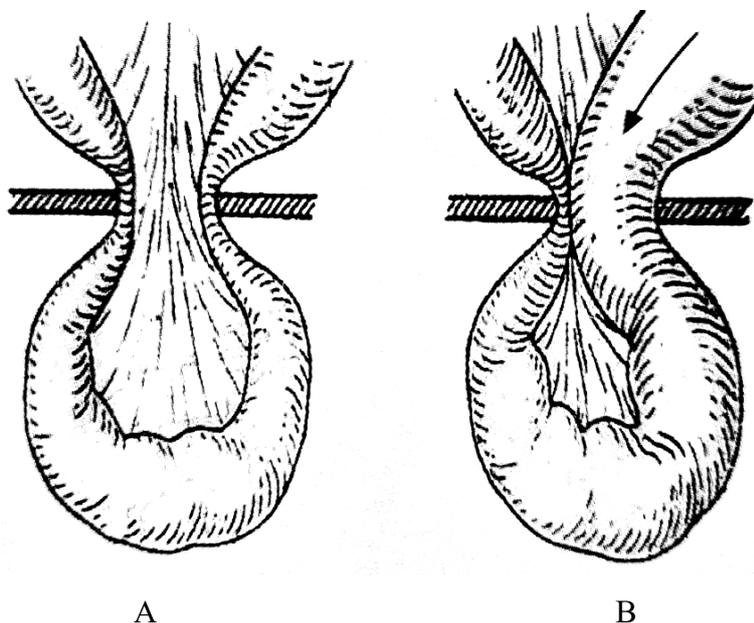


Fig. 9. A – Elastic strangulation; B – Faecal strangulation

Mixed strangulation occurs when faecal strangulation turns into elastic strangulation, i.e. when, along with strangulation of the contents of the hernia sac, there is a disturbance of blood circulation.

There are the following rare types of elastic strangulation: retrograde or reversible (Maydl hernia; Fig. 10 D); one wall (Richter hernia; Fig. 10 A); Meckel's diverticulum strangulation (Amyand hernia, Fig. 10 B); appendix strangulation (Littre hernia, Fig. C)

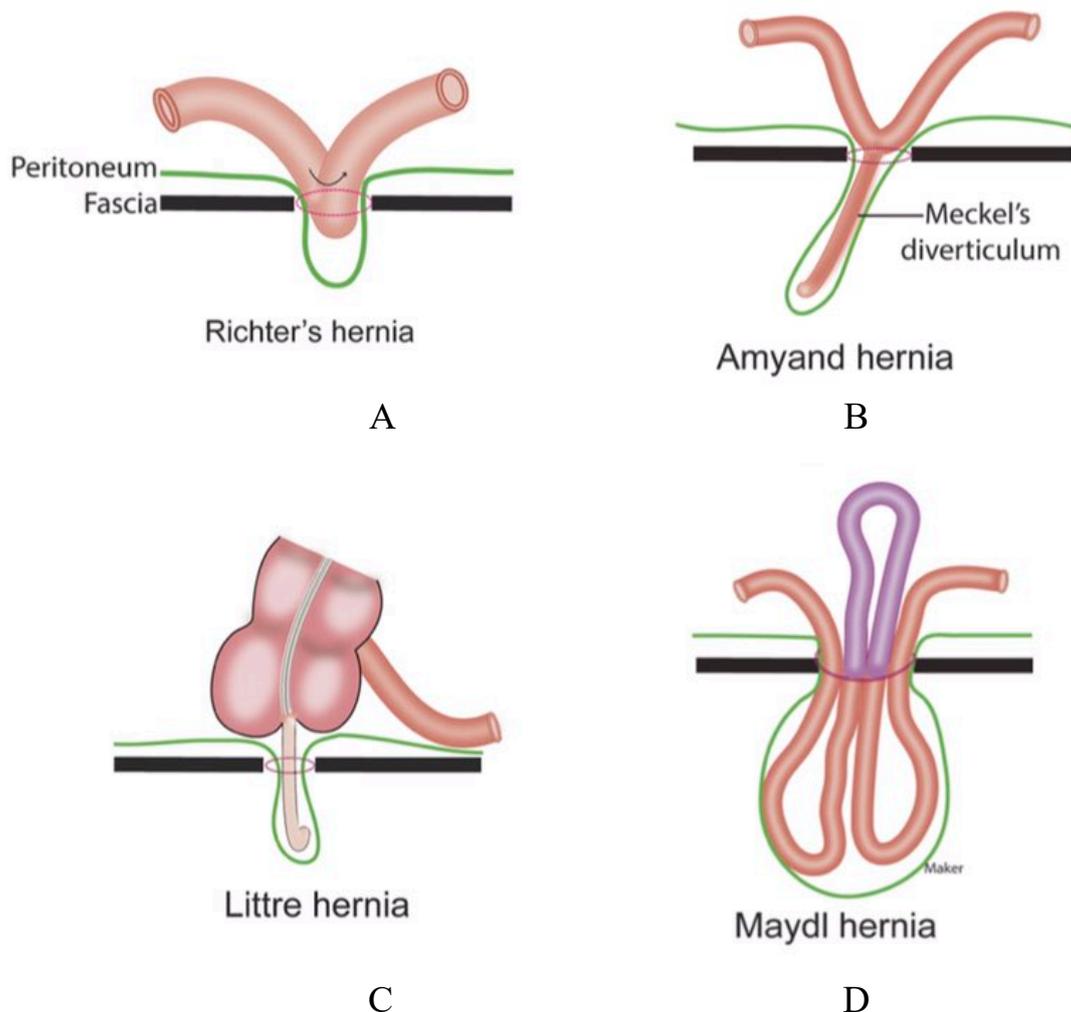


Fig. 10. Rare types of hernia strangulation

Retrograde strangulation occurs when two or more intestinal loops enter the hernia sac. In this case, the intestinal loop located in the abdominal cavity and connecting the loops located in the hernia sac is more affected, so it is necessary to assess its condition during surgery. The diagnosis of retrograde strangulation can be made only during surgery.

One wall (Richter's) strangulation occurs in the initial stage of hernia. In this case, not the entire intestine is compressed, but only its wall opposite the edge of the mesentery. Surgeons call this type of strangulation insidious, because due to

the preservation of the intestinal lumen, there are no clear signs of intestinal insufficiency, which often leads to diagnostic errors.

Blood circulation is impaired in the impinged organ, tissue edema and morphological changes occur, which cause necrosis. The degree of their severity depends on the pressure and the duration of the period from the moment of compression.

Most often, the organ that is strangulated is the loop of the small intestine. Three segments are distinguished in the pinched area of the loop of the intestine: the adductor loop, the central knee, and the abductor loop. The most pronounced morphological changes are noted in the central loop, slightly less in the adductor loop, and almost absent in the abductor loop.

During strangulation, venous outflow is primarily impaired, resulting in venous stasis, increased venous wall permeability, which causes swelling of the intestinal wall and fluid to enter the hernia sac with accumulation of hernial water. In case of red blood cell diapedema, the contents of the hernia sac become haemorrhagic. Increased edema is an additional factor that causes compression of the intestinal loop and its mesentery, in which case arterial circulation disorders, arterial stasis in the pinched intestinal loop with its necrosis occur. Morphological changes in the intestinal wall begin with the mucosa and submucosa. Later, perforation of the intestinal loop is possible with the formation of hernia phlegmon. In the initial stages of strangulation, the infection is limited to the contents of the hernia sac, as the hernia gate is closed. However, in the case of necrosis of the adductor loop, the abdominal cavity is infected with the development of peritonitis.

In the adducting loop of the intestine, due to increased peristalsis and spasm of non-striated muscle fibres, accumulation of large amounts of intestinal contents and gases, there are circulatory disorders and morphological changes in the intestinal wall. The segment of the adductor loop located next to the hernia gate is most affected. Macroscopic changes appear later, which should be borne in mind during the intraoperative assessment of the viability of the strangulated bowel

segment and determination of the margins of its resection. It is necessary to remove at least 50 cm of the adductor loop of the intestine (Kocher's rule).

In the outgoing loop of the intestine, pathological changes are limited to minor edema and venous stasis without thrombosis and significant circulatory disturbances. These changes occur in a small section of the outlet loop of the intestine near the hernia gate. Therefore, when resecting a necrotised section of the intestine, it is sufficient to remove 15-20 cm of the outlet loop.

The classic clinical signs of hernia strangulation are:

- sudden, intense pain in the area of hernial protrusion or in the abdominal cavity or in the peritoneal cavity;
- inability to reduce a hernia that was previously reducible;
- rapid increase and tension of the hernial protrusion;
- inability to determine the hernial gate;
- negative symptom of a cough impulse;
- appearance and progression of dyspeptic symptoms (nausea, vomiting, heartburn) and, if the intestinal loop is strangulated, clinical signs of acute intestinal obstruction (gas and stool retention, abdominal distension, etc.).

The severity of the clinical signs of hernia strangulation depends on the duration of the period since the strangulation. The patient's condition is severe from the first minutes of strangulation. The patient's restless behaviour, pallor of the skin, tachycardia, etc. are noted. The patient's condition progressively deteriorates. If surgical intervention is delayed, intestinal necrosis, perforation, faecal phlegmon of the hernia, and acute peritonitis may occur.

Diagnosis of a strangulated hernia is usually not difficult. In case of doubtful diagnosis, additional examination methods are used: ultrasound and X-ray examination of the abdominal cavity. Ultrasound examination usually reveals a fixed, altered loop of intestine or a large cap area in the hernia sac against the background of hernial water. The intestinal wall and its lumen, which contains fluid and gas, are visible. The area of the strangulated cecum looks like an

additional echogenic mass with irregular contours, without a cavity. The blood supply to the impinged organ is assessed by Doppler examination.

The main radiological sign of small bowel strangulation in an external hernia is the accumulation of gas and fluid in the bowel loop contained in the hernia sac. Horizontal levels and Kloiber's cups in the bowel cavity appear later.

The differential diagnosis of a strangulated hernia should be made with diseases in which the lesion is localised in areas typical of hernia and characterised by an acute onset.

In case of inguinal hernia, it is orchitis, epididymitis, inflammation of the inguinal lymph nodes; in case of femoral hernia, inflammatory changes in the femoral lymph nodes, thrombophlebitis of the great saphenous vein of the lower extremity at its junction with the deep vein of the thigh; in case of umbilical hernia, omphalitis, tumour metastases to the umbilical region. In all these diseases, there is no information about the presence of a hernia in the anamnesis. Classical signs of strangulation are not determined.

Hernia strangulation must also be differentiated from hernia inflammation and coprostasis. In these complications, the pain is moderate, the hernia can be partially reduced and the hernial gate can be palpated, and the coughing impulse symptom is positive.

In situations where it is impossible to verify the diagnosis on the basis of subjective and objective data and special examination methods, the diagnosis of hernia strangulation should be preferred and the patient should be operated on urgently, as waiting can cause intestinal necrosis and perforation with the development of peritonitis.

The differential diagnosis of a strangulated irreducible hernia is also often difficult. The pain in a hernia that is not repaired is constant, less intense than in a strangulated hernia; the hernia is not tense, it decreases when trying to insert it into the abdominal cavity. In an incompressible hernia, the hernia gate or its edges can be identified, the cough test is positive, and there are no clinical signs of acute intestinal obstruction.

## GENERAL PRINCIPLES OF TREATMENT

If a diagnosis of a strangulated hernia is confirmed, immediate surgical intervention is required. Even after self-reduction of the hernia, the patient should be hospitalised in a surgical department and operated on urgently. Forced hernia reduction is unacceptable, as there may be such serious complications as intestinal rupture, insertion of a necrotic intestinal loop into the abdominal cavity, thrombosis and embolism of mesenteric vessels, and false insertion of a strangulated hernia under the skin or into the preperitoneal tissue.

Preparation for surgery is short-term and is aimed primarily at improving the patient's general condition and correcting disorders of the cardiovascular system, respiratory system, and metabolic processes. In case of subcompensated and decompensated state of the organism, the correction of homeostasis disorders and functional state of vital organs is carried out with the participation of an anaesthetist and related specialists. The short duration of preoperative preparation is due to the direct threat of necrotic changes in the injured organ. Based on this situation, it is advisable to perform surgery simultaneously with intensive corrective therapy.

Anaesthesia - endotracheal anaesthesia. sometimes local anaesthesia.

Features of the surgical intervention: after the hernial sac is isolated, it is opened and the hernial contents and wound are sanitised to prevent infected hernial water from entering the abdominal cavity. In order to prevent self-reduction of the strangulated organ, which must be inspected to assess its viability, the strangulation ring should be cut only after the strangulated organ wound has been rehabilitated. As a rule, the segment of the strangulated intestinal loop is limited by two strangulation furrows at the site of its compression by the hernia gate. The strangulation furrow may be barely visible or necrotic. The viable intestine is cyanotic-red in colour, gradually turns pink after the compression is removed, its serosa becomes smooth, shiny, without damage, intestinal peristalsis and mesenteric vessel pulsation are preserved. Non-viable intestine is dark cyanotic in colour with dirty green inclusions, the serosa is dull, sometimes desquamated,

intestinal peristalsis and mesenteric vascular pulsation are absent. The viable intestine is inserted into the abdominal cavity, and the non-viable segment of the intestine is removed following Kocher's rule. Further stages of surgical intervention are performed in the same way as for an uncomplicated hernia.

In the case of phlegmon hernial sac, surgical intervention begins with a laparotomy followed by resection of the strangulated necrotically altered intestinal segment, restoration of intestinal patency by forming an interintestinal anastomosis, drainage of the abdominal cavity and suturing of the laparotomy wound. Only after these stages of surgery are completed, an incision is made in the projection of the hernia and pathologically altered tissues, hernia sac, and previously resected segment of the intestinal loop are removed. Reconstruction of the hernia gate and the weak point of the abdominal wall is not performed. The surgical intervention is completed with wound drainage. Repeated surgical intervention aimed at hernia repair is performed in 6-12 months.

Complications that occur during surgery for a strangulated hernia: damage to the strangulated organs (bladder, intestines); damage to blood vessels during hernia incision (femoral artery and vein, inferior epigastric artery - the "crown of death").

The key to reliable prevention of these complications is tissue cutting, hernia repair, and other manipulations performed only under visual control.

The most common postoperative complications are: wound infection and haematoma of the postoperative wound; pulmonary embolism.

General principles of operation for uncomplicated hernias:

- 1) Incision of skin and subcutaneous fat;
- 2) Dissection of hernial sac;
- 3) Opening hernial sac;
- 4) Assessing hernial content and reducing it in abdominal cavity;
- 5) Ligation hernial sac at the neck and cutting it off;
- 7) Fixing the abdominal wall defect (herniorrhaphy, hernioplasty).

## INGUINAL HERNIA

### *Risk factors*

Well-documented risk factors for primary inguinal hernia include:

- Male sex (increases risk by 8 to 10-fold)
- Age (peak incidence between 0 to 5 and 75 to 80 years of age)
- Family history of inguinal hernia in first-degree relatives
- Impaired collagen metabolism
- History of prostatectomy, especially open (increases risk fourfold)

In some studies, fewer inguinal hernias are detected in patients who are overweight or obese. Mechanistically, obesity can both exacerbate hernia development by increasing abdominal pressure and alleviate it by blocking herniation/incarceration of the viscera with extra fat. Thus, whether obesity is truly protective of inguinal hernia development is unclear and deserves further investigation.

Well-documented risk factors for recurrent inguinal hernia include:

- Female sex
- Direct, as opposed to indirect, hernia at the primary repair
- Surgeon low volume/inexperience

Other risk factors, including White race, chronic cough, chronic constipation, smoking, and contralateral groin hernia, are commonly cited but supported by less evidence.

**Females.** Overall, groin hernia repairs are 8 to 10 times more common in males than in females. However, while males are 9 to 12 times more likely to develop an inguinal hernia, females are four times more likely to develop a femoral hernia. This discrepancy can be explained anatomically by a greater distance between the pubic tubercle and the internal ring, a wider rectus muscle in females, and a wider internal ring in males.

Females manifest groin hernias at a later age. In one review, the median age at presentation was 60 to 79 for females compared with 50 to 69 for males.

Females have more emergency presentations due to a higher incidence of femoral hernias, which are more likely to incarcerate or strangulate. Another explanation may be that females presenting with hernias are older and exhibit smaller hernia defects due to relatively smaller internal inguinal and femoral rings.

In females, a retrospective review of data from the National Health and Nutrition Examination Survey (NHANES) also found that rural residence and greater height were independently associated with a higher incidence of acquired inguinal hernia in females. In patients with low body mass index (BMI; <20 kg/m<sup>2</sup>), there was a relative abundance of females, femoral hernias, and emergency presentations. Although females accounted for only 8 percent of all groin hernias, they represented 30 percent of repairs in the low BMI group.

### **PATHOGENESIS**

Groin hernias can be classified by etiology (congenital versus acquired). Congenital hernia is a result of abnormal development, whereas acquired hernia is due to alterations of otherwise normally developed tissues that lead to weakening or disruption. Males and females exhibit differences in the anatomic development of structures in the groin, which impacts the nature of the hernia each develops.

Congenital hernia – is due to failure of the processus vaginalis to close. The processus vaginalis is an invagination of parietal peritoneum that precedes the migration and descent of the testicles in males. The same invagination occurs in females, and the portion of the processus vaginalis within the inguinal canal is called the "canal of Nuck," which usually obliterates around the eighth month of fetal life.

- In males, the gubernaculum (caudal genital ligament) normally migrates through the internal inguinal ring into the inguinal canal and through the external ring into the scrotum to allow descent of the testicle. Later in development, the upper portion of the gubernaculum degenerates and the lower portion remains as the scrotal ligament, securing the testicle to the lower part of the scrotum and limiting its mobility. Once the testicle has descended, the internal ring normally

closes. Failure of the internal ring to close combined with failure of obliteration of the processus vaginalis provides the necessary defect through which abdominal tissues can pass (eg, small bowel, cecum), which can occur during childhood or adulthood.

- In females, migration of the gubernaculum does not take place. The upper portion of the gubernaculum in females forms the suspensory ligament of the ovary; the lower portion of the gubernaculum is bent into an angular form. Cephalic to the bend, it becomes the round ligament of the ovary (ie, ligamentum ovarii proprium) and, caudal to it, the round ligament of the uterus (ie, ligamentum teres uteri). Thus, the inguinal component of the gubernaculum remains in females as the round ligament, whereas it degenerates in males. The round ligament runs through the internal ring, through the inguinal canal, and ends in the fat of the labium majora or terminates just outside the external ring without attachment or extension to the labium. The internal ring is narrower in females and may explain the lower incidence of indirect inguinal hernia in females. The ligamentous structure found within the inguinal hernia sac in female patients is often erroneously identified as the round ligament. However, detailed anatomic examination identifies this structure as the suspensory ligament of the ovary, which helps explain the occasional presence of the fallopian tube or ovary in the hernia sac in female patients.

Acquired hernia – are due to a weakening or disruption of the fibromuscular tissues of the body wall allowing intra-abdominal contents to protrude through the acquired defect. Acquired groin hernias can develop as a result of inherent connective tissue abnormalities, chronic abdominal wall injury.

Tissues of the groin may disrupt as a result of inborn or acquired biochemical or metabolic processes that weaken connective tissue due to disturbed collagen metabolism. A tendency toward hernia formation may be evident in the patient or family history. Aortic aneurysmal disease, which is linked to connective tissue abnormalities, is also associated with groin hernia. Although rare, a number

of inborn errors of metabolism, such as abnormalities in collagen type I and III synthesis, can be the underlying cause for the development of hernias.

Chronic overstretching of the musculoaponeurotic structures due to increased intra-abdominal pressure or abdominal wall injury is another factor contributing to acquired hernia. Elevations in intra-abdominal pressure can also result from chronic cough, constipation, strenuous exercise/activity, and pregnancy. Direct hernias occur with unusual frequency in athletic individuals. The relationship between inguinal hernias and intermittent straining or heavy lifting is not clear; some studies suggest that the incidence of hernia is no higher in professions performing heavy manual labor than in sedentary professions, while others have come to the opposite conclusion. Pectineus muscle atrophy with age may contribute to femoral hernia formation. The higher incidence of femoral hernia in females may relate to comparatively less baseline muscle bulk compared with males or a weakening of the musculature from childbirth.

## **CLASSIFICATION**

Groin hernias can also be classified according to the anatomic location of the abdominal wall defect. Several such classification schemes for groin hernias exist, but the simplest and most useful system separates groin hernias into indirect and direct inguinal hernias and femoral hernias. Approximately 96 percent of groin hernias are inguinal and 4 percent are femoral.

Indirect inguinal hernia — Indirect inguinal hernias are the most common type of hernia in both males and females. In the Swedish registry, indirect inguinal hernia accounted for 49 percent of repairs in females and 54 percent in males. Indirect inguinal hernias are classified as lateral hernias in the European Hernia Society groin hernia classification system.

Indirect hernias protrude at the internal inguinal ring, which is the site where the spermatic cord in males and the round ligament in females exit the abdomen. The origin of the hernia sac is located lateral to the inferior epigastric artery. Indirect hernias develop more frequently on the right in both male and females,

which is thought to be due, in males, to a later descent of the right testicle and, in females, to the asymmetry of the female pelvis.

Most indirect inguinal hernias in adults are congenital, even though they may not be clinically apparent in the neonatal period or childhood. A shutter mechanism, which is postulated to close the internal inguinal ring to a slit, may be dysfunctional in patients with a patent processus vaginalis. Increases in intra-abdominal pressure in association with reduced muscle tone or other connective tissue abnormalities can then force abdominal contents through the widened internal ring into the inguinal canal, resulting in a clinically detectable hernia.

Direct inguinal hernia accounts for 30 to 40 percent of groin hernias in males but approximately 14 to 21 percent of groin hernias in females.

Direct inguinal hernias protrude medial to the inferior epigastric vessels within Hesselbach's triangle, which is formed by the inguinal ligament (Poupart's ligament) inferiorly, the inferior epigastric vessels laterally, and the rectus abdominis muscle medially. Direct hernias are classified as medial hernias in the European Hernia Society groin hernia classification system.

Direct inguinal hernias occur as a result of a weakness in the floor of the inguinal canal. This weakness appears to be due to connective tissue abnormalities in many cases, although some may occur due to deficiencies in the abdominal musculature resulting from chronic overstretching or injury.

Femoral hernias account for <10 percent of all groin hernias and only 2 to 4 percent of all groin hernia repairs. Femoral hernias represent 20 to 31 percent of repairs in females compared with only 1 percent in males. Femoral hernias occur later in life than inguinal hernias. Over the age of 70, femoral hernias represent 52 percent of repairs in females and 7 percent of repairs in males.

Femoral hernias are located inferior to the inguinal ligament and protrude through the femoral ring, which is medial to the femoral vein and lateral to the lacunar ligament (figure 1). The femoral ring can widen and become patulous with aging and following injury.

Although femoral hernias are the least common type of hernia, 40 percent present as emergencies with incarceration or strangulation.

## **CLINICAL FEATURES**

Groin hernias have a variety of clinical presentations ranging from a bulge in the groin region on routine physical examination (with or without pain) to life-threatening complications. Incarcerated or strangulated hernias can present as acute mechanical intestinal obstruction without obvious symptoms or signs of a groin hernia, particularly in patients with obesity.

The most common symptom associated with hernia is a heaviness or dull discomfort in the groin, which may or may not be associated with a visible bulge. Groin hernias in females can also result in vague pelvic discomfort.

Groin discomfort is most pronounced when intra-abdominal pressure is increased, such as with heavy lifting, straining, or prolonged standing. Very little pressure is needed to create the discomfort, which resolves when the patient stops straining or lies down. This pain is due to constriction of the contents of the hernia (eg, bowel, fat) at the neck of the hernia sac. Typically, discomfort is more pronounced at the end of the day or after prolonged standing. Thus, patients who work in manual or physically active professions will notice the discomfort more frequently than sedentary workers. Pain with standing or straining may also arise from stretching of the ilioinguinal nerve, which is typically described as a radiating "twinge" when the nerve is stretched with prompt dissipation of the pain when the stretch is released.

Moderate-to-severe pain with hernias is unusual and, when present, should raise the possibility of incarceration or strangulation. Strangulated hernias may manifest with symptoms of bowel obstruction, including nausea, vomiting, abdominal pain and bloating, and possibly systemic symptoms if strangulation and bowel necrosis have occurred.

## PHYSICAL FINDINGS

The most common physical finding in adults is a bulge in the groin. Patients will frequently be aware of the bulge and bring it to the attention of the examiner. In many cases, it is easier and more reliable to demonstrate a hernia bulge with the patient standing, although some hernias, particularly strangulated hernias, can be appreciated while the patient is supine. Two-thirds of groin hernias are located on the right side.

Examination for hernia is best done with the patient standing and the clinician seated in front of the patient. Observation of the groin will occasionally reveal an obvious bulge. This can be confirmed as a hernia by placing the hand over the bulge and asking the patient to cough or perform a Valsalva maneuver. When coughing, hernias produce a distinct, soft impulse that increases the protrusion. The sensation is distinct from the firmer impulse that is felt when the intact abdominal wall is tensed with coughing.

If a visible or palpable hernia is not evident, additional maneuvers may be performed in male or female patients to detect the hernia:

- 1) Male patients – Many groin hernias in males are obvious on physical examination. Smaller hernias can be identified by invaginating some of the redundant scrotal skin into the inguinal canal, traversing as best as possible the external ring (Fig. 11). When the patient is instructed to cough or Valsalva, occult hernias may be felt extending into the canal and touching the tip of the finger. Using the index finger, the examiner places the finger at the base of the scrotum, gently pushing and directing the finger toward the pubic tubercle. The finger will rest adjacent to the spermatic cord, and the fingertip will be just within the external ring. There will always be some degree of pressure against the finger with this maneuver, but a true hernia can typically be felt as a "silky" impulse tapping against the finger when the patient coughs or strains.

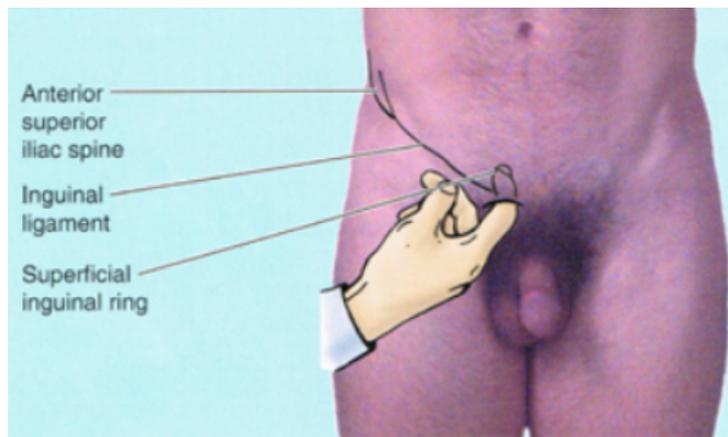


Fig 11. Inguinal canal examination

2) Female patients – Groin hernias in females often do not have a visible bulge. Moreover, the examination used in a male (ie, invagination of scrotal skin) is not possible in females. In females, the layers of the abdominal wall absorb the hernia impulse, making the external ring difficult to locate. Ultrasound or other imaging tests may be needed to detect hernias in female patients.

The femoral region should also be examined with particular attention to the area medial to the femoral canal. The space is found by identifying the femoral artery pulsation caudal to the inguinal ligament in the upper portion of the thigh and moving medial from it toward the pubic tubercle (Fig. 12). Femoral hernias may be difficult to clinically differentiate from inguinal hernias preoperatively on physical examination when located overlying the inguinal ligament or superior to it.



Fig. 12. Femoral hernia

On physical examination, an incarcerated or strangulated hernia may be painful to palpation. The patient may also be febrile, and erythema of groin skin may be apparent. Generalized peritonitis typically does not occur, since the ischemic or necrotic tissue is trapped within the hernia sac. However, if a strangulated segment of bowel is reduced (spontaneously or unwittingly), generalized peritoneal signs may be present.

**Diagnosis.** In the majority of cases, a diagnosis of inguinal or femoral hernia can be made based upon history and physical examination, without the need for further studies. Although the data are limited, one study reported a sensitivity of 75 percent and specificity of 96 percent for a diagnosis of inguinal hernia on physical examination by surgeon. Diagnosis may be more difficult in females and those with obesity, for whom additional diagnostic evaluation may be necessary.

## **DIAGNOSTIC EVALUATION**

When the diagnosis is not apparent, imaging can help to identify occult hernia, differentiate inguinal from femoral hernia, and distinguish hernia from other clinical entities. Imaging is also important for evaluating patients for hernia-related complications.

In the absence of suspected intra-abdominal complications, we suggest groin ultrasound (US) as the initial diagnostic modality. Pelvic US is noninvasive and inexpensive and overall has a high sensitivity and specificity for hernia (confirmed by surgery), particularly in the presence of a palpable mass, distinguishing hernia from other inguinal and scrotal pathologies.

Other modalities, including computed tomography (CT), magnetic resonance imaging (MRI), and herniography (peritoneography), may be useful under specific clinical circumstances but may be associated with varying degrees of accuracy.

Identifying occult hernia — US is the best initial imaging modality for identifying occult inguinal hernia in patients with suggestive symptoms but no detectable hernia on physical examination. US increases the sensitivity of detecting an occult hernia from 80 percent with physical examination alone to 96 percent.

Other experts consider US operator dependent and instead prefer cross-sectional imaging. If that is the local practice, and when groin US is negative or nondiagnostic, MRI with Valsalva maneuver may be performed to establish a diagnosis. Besides groin hernia, MRI can also diagnose other conditions that could cause groin pain, such as adductor tendonitis, pubic osteitis, hip arthrosis, bursitis iliopectinea, and endometriosis. CT with Valsalva is another option when MRI is not available.

Differentiating inguinal from femoral hernia — Distinguishing inguinal from femoral hernia can be difficult, particularly in patients with obesity, but has clinical implications. Watchful waiting may be an option for asymptomatic or minimally symptomatic inguinal hernia but is not recommended for femoral hernia due to the high risk for complications.

For most groin hernias, the location will be obvious on physical examination: femoral hernias most commonly present inferior to the inguinal ligament and medial to the femoral artery, while inguinal hernias present superior to the inguinal ligament. However, when the clinical examination is uncertain, we perform groin ultrasound to differentiate inguinal from femoral hernia.

If US is negative or nondiagnostic, CT of the groin region can help further differentiate femoral from inguinal hernias. Sufficiently thin slices using multidetector CT may allow localization of the hernia sac. If the hernia sac extends medial to the pubic tubercle on CT, a diagnosis of inguinal can be made with certainty, but a hernia sac located lateral to the pubic tubercle associated with venous compression suggests a diagnosis of femoral hernia.

MRI appears to differentiate inguinal from femoral hernia with a sensitivity and specificity of more than 95 percent, which is superior to CT. However, cost and lack of uniform availability limit the practicality of MRI.

Evaluating hernia complications — For patients who present with nausea, vomiting, and abdominal distention associated with a history of groin pain or mass, bowel obstruction due to bowel incarceration or strangulation should be suspected. For most patients with incarcerated hernia and/or strangulation, clinical

examination alone is sufficient to establish a diagnosis; additional imaging is generally not necessary and may delay surgical exploration and repair.

For patients with clinical features of bowel obstruction in whom the diagnosis of groin hernia is not clear and who do not have indications for immediate surgical exploration, CT is generally more useful than ultrasound. Although obtaining CT scan may not alter the management plan for exploration and repair, it may add valuable information concerning the organs involved or the extent of bowel strangulation.

### **DIFFERENTIAL DIAGNOSIS**

The differential diagnosis of inguinal hernia includes any pathology that can produce pain or a mass within the groin region, including soft tissues, lymphoid tissue, bony structures, associated vessels, or structures associated with male or female reproduction.

For most patients, groin hernia can be distinguished from other inguinal and scrotal pathologies on physical examination, but when this is not the case, ultrasound is usually the initial imaging modality.

Acute and nonacute scrotal pathologies can produce groin mass and/or groin pain and may appear similar to groin hernia. The pain associated with testicular pathologies is more likely to be localized to the scrotum instead of the inguinal or femoral region.

Acute scrotum: testicular torsion, epididymitis. Nonacute scrotal conditions: hydrocele, varicocele, spermatocele, epididymal cyst, testicular tumor.

In females, a clinical diagnosis of inguinal hernia during pregnancy can be challenging; not every groin bulge during pregnancy is a hernia. Round ligament varicosities may first appear during pregnancy and can be easily mistaken for a hernia.

Orthopedic causes of groin pain include osteitis pubis, sports hernia, adductor muscle strain, lumbar radiculopathy, and hip problems. A groin bulge will be absent, but the nature of the groin pain may raise the question of occult

hernia. If ultrasound is unrevealing, magnetic resonance imaging (MRI) is useful for differentiating inguinal hernia from musculoskeletal causes of groin pain.

The term "sports hernia" refers to groin pain related to athletic participation but is not necessarily associated with an anatomic hernia.

Aneurysms and pseudoaneurysms of the iliac or common femoral arteries present as a mass in the pelvic or groin region, respectively; however, these are pulsatile, are rarely confused as a hernia, and can be easily identified on ultrasound. On occasion, a thrombosed aneurysm may present as a nonpulsatile mass, or a vascular infection will present with overlying erythema, mimicking strangulated hernia.

Skin and soft tissue conditions, especially when inflamed, can produce pain and a mass in the groin region that could mimic a hernia. These include sebaceous cyst, cellulitis/skin abscess, or enlarged lymph nodes. A groin ultrasound can localize the pathology to the skin and soft tissue, rather than the much deeper inguinal or femoral canal.

## **TREATMENT**

Treatment of inguinal hernia is only surgical. Patients who refuse surgery or have contraindications to planned hernioplasty are recommended to wear a special inguinal truss (Fig. 13).



Fig 13. Inguinal support truss

The purpose of the truss wearing is to reduce the chance for complications of hernia, reduce patient complaints during physical activity and hold back the progression of the hernia size.

## **INDICATIONS AND CONTRAINDICATIONS**

The existence of an inguinal hernia has traditionally been considered sufficient reason for operative intervention. However, the following considerations should be taken into account:

- Some studies have shown that the presence of a reducible hernia is not, in itself, an indication for surgery and that the risk of incarceration is less than 1%.
- Symptomatic patients should undergo repair.
- Even asymptomatic patients who are medically fit should be offered surgical repair.
- Because of the higher frequency of femoral hernias in women, procedures that provide coverage of the femoral space (eg, laparoscopic repair) at the time of initial operation may be better suited for women as primary repairs.

Inguinal hernia repair has no absolute contraindications. However, the following considerations should be taken into account:

- Any medical issues should be fully addressed beforehand and the operation delayed accordingly
- Patients with elevated American Society of Anesthesiologists (ASA) scores and high operative risk should undergo a full preoperative workup and determination of the risk-to-benefit ratio
- Recurrences after a primary posterior technique may be treated with Lichtenstein hernioplasty; recurrences after a primary anterior technique should be treated with TEP, TAPP, or open posterior repair
- Asymptomatic reducible direct inguinal hernia in an elderly patient with multiple uncontrollable comorbidities and an elevated ASA score does not require repair and may be left alone for close observation and follow-up

## **PRINCIPLES OF OPEN INGUINAL HERNIA REPAIR**

All surgical procedures in open anterior hernia repair can be divided into two steps: separation and dissection of the hernial sac from adjacent structures, including the cord, followed by repositioning of the contents of the sac into the preperitoneal space or peritoneal cavity. Once this has been achieved, the second step is reconstruction of the inguinal floor by suture or augmentation by prosthetic mesh.

### **Step I: The Preparation.**

- Skin incision
- Dissection of the inguinal canal
- Management of the hernial sac

### **Step II: The Reconstruction**

After the preparation an assessment of the hernial orifice is possible. This is also the moment to look for the femoral orifice to rule out a concomitant femoral hernia. The repair of the defect can be achieved by an impressive variety of different procedures. The main differentiation is a repair by suture or by augmentation with nonabsorbable mesh prosthesis, in an anterior or posterior position:

- Suture repair
  - Bassini
  - Shouldice
  - McVay
- Anterior mesh repair
  - Lichtenstein
- Anterior plug and patch

## **BASSINI REPAIR**

The Bassini technique for inguinal hernia repair involves suturing the transversalis fascia and the conjoined tendon to the inguinal ligament behind the spermatic cord with monofilament nonabsorbable suture. It also involves the so-

called Tanner slide, which is a vertical relaxing incision in the anterior rectus sheath intended to prevent tension.

Reconstruction of the inguinal floor by opening the transversalis fascia from the internal inguinal ring to the pubic tubercle, thereby exposing the preperitoneal fat. Bluty dissected undersurface of the superior flap of the transversalis fascia. “Tripple layer” approximation (Fig. 14). The layer of transversalis fascia and the transversus abdominis is sutured, with the internal oblique muscle, to the reflected inguinal ligament.

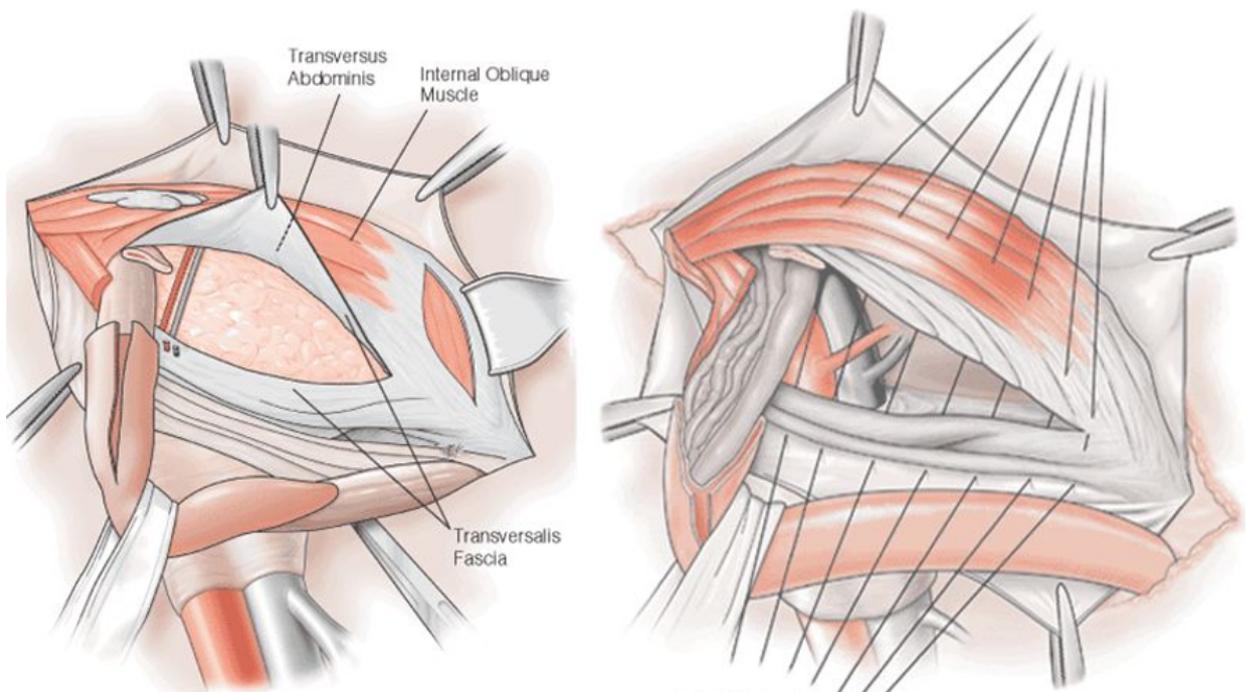


Fig 14. Steps of the Bassini repair

### **SHOULDICE REPAIR**

The Shouldice technique is a four-layer inguinal hernia repair performed with the patient under local anesthesia. The transversalis fascia is incised from the internal ring laterally to the pubic tubercle medially, and upper and lower flaps are created. These flaps are then overlapped (double-breasted) with two layers of sutures.

The conjoint tendon is then sutured to the inguinal ligament, again in two overlapping layers (Fig. 15). This reinforces the posterior wall and narrows the deep inguinal ring. The Shouldice repair is classically done with a continuous

suture of 32- to 34-gauge stainless steel wire, but synthetic monofilaments (eg, polypropylene) can also be used. The external oblique aponeurosis is then closed in a double-breasted fashion in front of the spermatic cord.

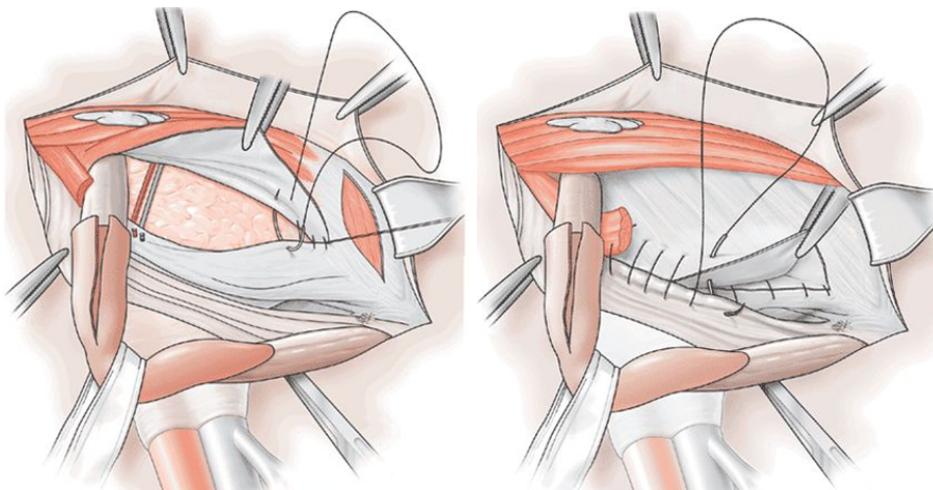


Fig 15. Steps of the Shouldice repair

### **MCVAY REPAIR**

In the McVay repair, the conjoined (transversus abdominis and internal oblique) tendon is sutured to the Cooper ligament with interrupted nonabsorbable sutures.

Similar to the Bassini repair, except that it uses Cooper's ligament instead of the inguinal ligament. Interrupted sutures are placed from the pubic tubercle laterally along Cooper's ligament, progressively narrowing the femoral ring. The last stitch in Cooper's ligament is known as a transition stitch and includes the inguinal ligament.

### **LICHTENSTEIN REPAIR**

Lichtenstein tension-free mesh inguinal hernia repair is a simple, safe, comfortable, effective method, with extremely low early and late morbidity and remarkably low recurrence rate and therefore it is our preferred method for hernia repair since 1994.

The Lichtenstein tension-free mesh repair, which is an example of hernioplasty and is currently one of the most popular open inguinal hernia repair techniques, includes the following components:

- Opening of the subcutaneous fat along the line of the incision
- Opening of the Scarpa fascia down to the external oblique aponeurosis and visualization of the external inguinal ring and the lower border of the inguinal ligament
- Opening of the deep fascia of the thigh and exposure of the femoral canal to check for a femoral hernia
- Division of the external oblique aponeurosis from the external ring laterally for up to 5 cm, safeguarding the ilioinguinal nerve
- Mobilization of the superior (safeguarding the iliohypogastric nerve) and inferior flaps of the external oblique aponeurosis to expose the underlying structures
- Mobilization of the spermatic cord, along with the cremaster, including the ilioinguinal nerve, the genitofemoral nerve, and the spermatic vessels; all of these structures may then be encircled in a Penrose drain or tape
- Opening of the coverings of the spermatic cord and identification and isolation of the hernia sac
- Inversion, division, resection, or ligation of the sac, as indicated
- Placement and fixation of mesh to the edges of the defect or weakness in the posterior wall of the inguinal canal (Fig. 16) to create a new artificial internal ring, with care taken to allow some laxity to compensate for increased intra-abdominal pressure when the patient stands
- Resection of any nerves that are injured or of doubtful integrity
- In males, gentle pulling of the testes back down to their normal scrotal position
- Closure of spermatic cord layers, the external oblique aponeurosis, subcutaneous tissue, and the skin.

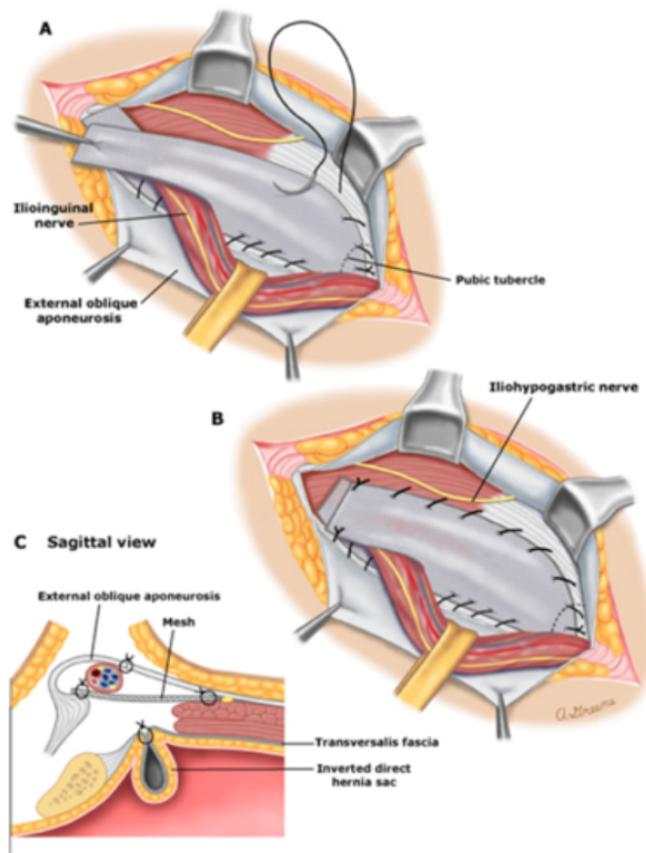


Fig. 16. Position of synthetic mesh in Lichtenstein repair

## FEMORAL HERNIA REPAIR

***Femoral (low, Lockwood's) approach.*** This is a simple and quick approach to deal with a small uncomplicated femoral hernia, and can be performed under local anesthesia. A transverse groin-crease incision is made below the inguinal ligament to deal with the sac and its coverings. The content, usually omentum, is freed of adhesions and assessed for viability and either return back or excised. If necessary, a small incision can be made in lacunar ligament medially to ease reduction; however, abnormal branch of obturator artery can be injured. The neck is pulled down and ligated as high as possible. Finally, the canal is closed by suturing inguinal ligament to iliopectineal line using prolene 0 or 2/0 sutures; a mesh plug can also be used to close the defect.

***Inguinal (Lotheissen's) approach.*** This is an easy approach as most of the steps are similar to that of open inguinal hernia repair. This should be the preferred approach in cases of complicated femoral hernia as it provides good exposure of femoral ring and facilitates in dealing with non-viable contents that necessitates

resection. This approach also allows easy control of injured abnormal obturator artery. Inguinal canal is opened by giving an incision about 1.25 cm above the medial two-thirds of inguinal ligament, and incising external oblique aponeurosis in line of its fibers. The cord is mobilized and retracted upward, and blunt dissections are made to reach the transversalis fascia, which is opened medial to epigastric vessels from deep inguinal ring to pubic tubercle. The femoral hernia lies below this incision, which is reduced by both pulling from above and pushing from below. The peritoneum can be opened to help in reduction. The content is assessed for viability and dealt accordingly. In cases of obstruction at the narrow neck of the sac, the neck can be gently stretched with a hemostat. The neck is then closed with sutures or mesh plug. The defect is closed by suturing the conjoint tendon to ilio-pectineal line, so as to form a shutter. The layers of inguinal canal are then closed. The classical McVay repair (suturing conjoint tendon to Cooper's ligament) is strong but with high tension which eventually break resulting in recurrence.

*Preperitoneal (high, McEvedy's)* approach. This is the best approach in emergency setting to deal with bowel strangulation as it allows generous incision in peritoneum to give proper exposure for bowel resection. A horizontal (or vertical) incision is made in lower abdomen at the lateral edge of rectus muscle. Anterior rectus sheath is incised and rectus muscle retracted medially. Dissection is carried out deep to this muscle in the preperitoneal space. The femoral hernia is delivered and its sac opened to assess the viability of contents, which is then dealt accordingly. The sac is first closed and the defect is then closed with sutures, mesh or plug. Placement of mesh in preperitoneal space is advantageous, as it avoids reoperating through scar tissue in cases of recurrence. The mesh-plug repair offers tension free easy repairs, with low recurrence rate and less postoperative pain.

## **PRINCIPLES OF LAPAROSCOPIC INGUINAL HERNIA REPAIR**

Laparoscopic inguinal hernia repair originated in the early 1990s as laparoscopy gained a foothold in general surgery.

A number of studies have shown laparoscopic repair of inguinal hernias to have advantages over conventional repair, including the following:

- Reduced postoperative pain
- Diminished requirement for narcotics
- Earlier return to work

Laparoscopic repair has some disadvantages as well, including the following:

- Increased cost
- Lengthier operation
- Steeper learning curve
- Higher recurrence and complication rates early in a surgeon's experience

The term laparoscopic inguinal herniorrhaphy can refer to any of the following three techniques:

- Totally extraperitoneal (TEP) repair
- Transabdominal preperitoneal (TAPP) repair
- Intraperitoneal onlay mesh (IPOM) repair

The IPOM repair has largely fallen from favor, and currently, the most commonly performed laparoscopic techniques are the TEP and TAPP repairs. Although many facets of laparoscopic inguinal hernia repair continue to be debated – such as the possible superiority of one laparoscopic approach to another, comparisons between laparoscopic and open surgery, the learning curve and training issues, and the socioeconomic implications – both TAPP and TEP have been shown to be acceptable and safe for repair of inguinal hernias. Both procedures viable for groin (direct, indirect) and femoral hernia.

## **VENTRAL HERNIAS**

Ventral hernias are a classification of hernias affecting the abdominal wall. Included in this definition are epigastric, umbilical, Spigelian, and incisional hernias. In addition to the cosmetic detriment, these hernias also pose a risk for bowel ischemia and strangulation, which can result in grave consequences.

Causes of ventral hernia may be congenital (Ehlers-Danlos syndrome, Marfan's syndrome, etc.) or acquired (surgery, trauma). If patient developed abdominal hernia having no previous surgery at the hernia site, these are often due to weakness in the abdominal wall present at birth. As the patient becomes older or injured, these weaknesses can worsen, leading to hernia. Other risk factors are:

- Pregnancy
- Obesity
- History of previous hernia
- History of abdominal surgeries
- Injuries to abdominal wall
- Family history of hernia
- Frequently lifting or pushing heavy objects
- Chronic cough
- Straining during defecation or micturition
- Some medicines, such as steroid

Incision hernia (ventral) can occur after any abdominal surgery, but they are more common in some patients, such as:

- Old patient
- Obese patient
- Diabetics
- Patients using steroid
- Lung disease
- Smoking
- Surgical site infection

- Postoperative repeated vomiting
- Postoperative abdominal distention (intestinal obstruction)

All these have been related to increased incisional hernia rate. This occurs most often after a long incision in the middle of the abdomen, but they can occur through incisions anywhere on the abdomen. Sometimes these hernias developed only in part of the incision.

### **CLINICAL SYMPTOMS AND SIGNS**

Ventral hernia usually presents as a painless bulge or lump in the abdomen under the skin, which increases in size over time. Sometimes it presents as only discomfort in the abdomen and sometimes discomfort or pain with a bulge. Sometimes ventral hernia may cause pain when a patient:

- Cough
- Strains during defecation
- Stands or sits for long time
- Lifts or pushes heavy objects

Usually in the initial stage, the hernia disappears when the patient lies down and then reappears or enlarges when a patient stands or lifts or pushes something heavy; this is a reducible hernia. When the tissues or content inside the hernia become adherent to the sac or with each other, then the hernia becomes irreducible. When hernia content becomes stuck or trapped in the abdominal muscle, it can cause pain, nausea, vomiting, constipation, etc. If the hernia content, especially intestine, gets tightly trapped in the tear in the muscles, the layer or intestine loop is constricted at the narrow neck of the hernia sac or apex of the loop of intestine adherent to the hernial sac, especially at the fundus, and becomes twisted; the blood supply to the intestine can become cut off or reduced, resulting in bowel necrosis or rupture; this may lead to a potentially life-threatening condition known as “strangulation.” This condition requires emergency surgery. Other symptoms of a strangulated hernia include severe abdominal pain, abdominal distention, severe nausea and vomiting, profuse sweating, increased pulse rate, and fever. Initially, pain is colicky in nature;

if strangulation is not relieved, it will change in character and become continuous or disappear; this is an ominous sign that the intestine becomes necrosed or dead.

## **DIAGNOSIS AND EVALUATION**

Usually, ventral hernia can be diagnosed by history and clinical examination only. If there is confusion in diagnosis or hernia is complex and complicated, one can advise ultrasound, CT scan or MRI scan, to make the diagnosis confirm and elaborate the anatomy of hernia.

Ultrasonography is commonly used to confirm the clinical diagnosis. The ultrasonography in hernia can reveal the fascial gap with protruding hernia contents. The hernia should increase in size or change location when the patient coughs. Bowels are characterized by peristaltic movement and inside air, whereas the omentum appears as a stationary, space-occupying structure.

In some patients of ventral hernia, detailed diagnostic imaging (ultrasonography, CT scan, and MRI) is indicated; these are:

- Obese patients (BMI > 35)
- Patients with recurrent incisional hernia
- Patient having huge hernia (second abdomen)
- Patients having pain within the abdominal wall but with no physical and detectable hernia.

In these patients CT scan with 3D reconstruction is useful. Occult hernia is accurately delineated; the content of sac is defined.

## **TREATMENT**

Whenever the patient develops hernia, it will not get better on its own and can get worsen (enlarge) over time. The most common treatment of ventral hernia is surgery. Some hernias are repaired on an elective basis like asymptomatic hernia, but hernia which presents with strangulation requires immediate surgery. Irreducible or incarcerated hernia without strangulation is not a surgical emergency. The risks and benefits of surgery should be discussed with the patient. The patients with reasonable operative risks should have their hernia repaired

within a sensible time frame. Nonsurgical management of ventral hernias with the use of binders, trusses, or corsets is considered to be ineffective. This may be the only option in a patient who is not a reasonable candidate for surgery.

In the past, before appropriate meshes and techniques for implanting them were available, sutures alone were used to close the weakness in the abdominal wall. These often were unsuccessful in the long term, as in most patients' hernia would recur. For some very small ventral hernias, suturing alone remains acceptable.

Commonly ventral hernias are repaired by making an incision over the fascial defect in the abdominal wall. The intestine, fat, or other organs in the hernia are placed back in the abdomen. The defect in muscle or fascia is then closed with sutures alone or is reinforced with mesh. The abdominal wall is then closed with suture over the mesh. Sometime drainage tubes are placed through the skin to prevent serum or blood collection.

At present many types of surgical techniques have been developed to repair hernias. The most important tension-free repair is using mesh. If mesh is used, it should be placed 3 to 5 cm overlapping the edges of the fascial defect. Mesh should be handled meticulously to prevent surgical site infection. The most basic approach is primary open repair without mesh; this is typically reserved for defect in the fascia of less than 2 cm. Open mesh repair has several options, including what type of mesh and where to place the mesh. Main methods of ventral hernia repair are:

- Open hernia repair
- Minimally invasive hernia repair (laparoscopic)

Open hernia repair includes non-mesh and mesh techniques.

Non-mesh techniques are Mayo and Sapezhko repair.

## **MAYO TECHNIQUE**

Hernia is surrounded by two cross convergent arch forming cuts. Reveal the hernial sac, take out the adhesion, adherent omentum separated and internal organs

are reduced to the abdominal cavity (Fig. 17). Bag excised and the edges sutured in the transverse direction. Hernial orifice is expanded by two transverse incisions to internal edges of the muscles. Then apply U-shaped stitches (bottom flap under the top). The second series of sutures (upper flap to the bottom forming duplicate).

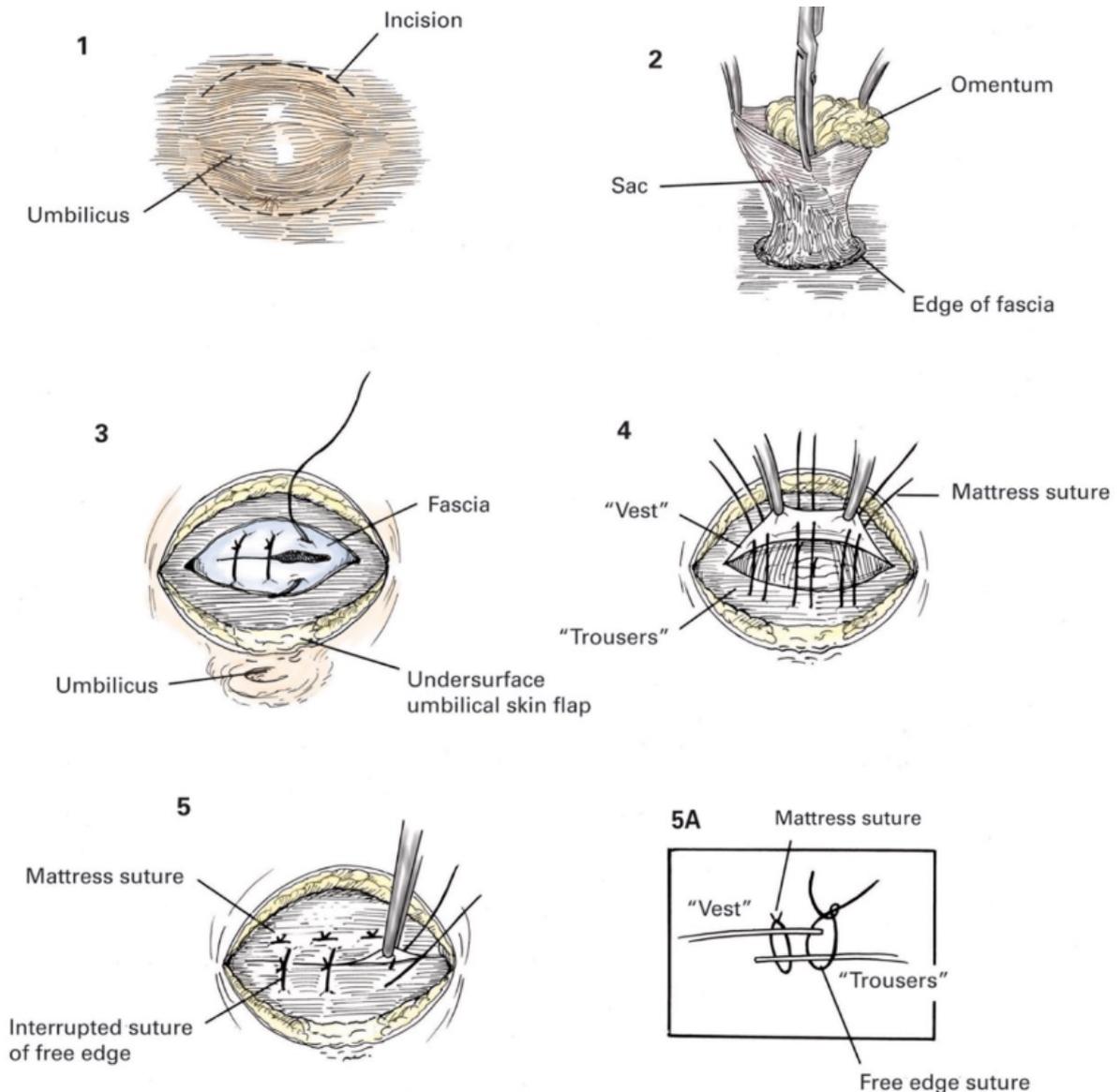


Fig. 17. Steps of the Mayo repair

### METHOD SAPEZHKO

Produce two longitudinal curved incision with excision of loose skin and umbilical button (Fig. 18). Scared edges excised. Peritoneum from the posterior surface of one muscle detach at 2-4 cm. Stitch on the peritoneum. Then it created is duplicate in the longitudinal direction of 2-4 cm in width (edge aponeurosis on the one hand sutured to the posteromedial part of the vaginal rectus muscle, which was

the prepared peritoneum. The second layer stitched by duplicating). Method Sapezhko is more physiological (reduced width of the white line, straightened the course of rectus muscle fibers).

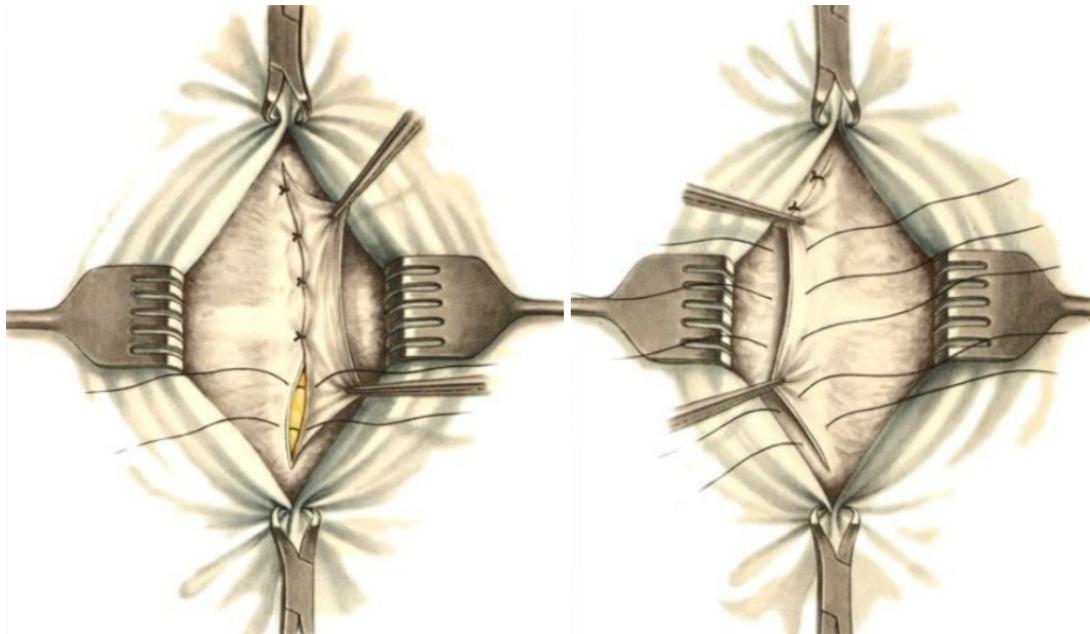


Fig. 18. Steps of Sapezhko repair

With the age of tension-free hernia repair surgical prosthetic meshes are used for closing abdominal wall defects. Mesh techniques divides depending on mesh position (Fig. 19).

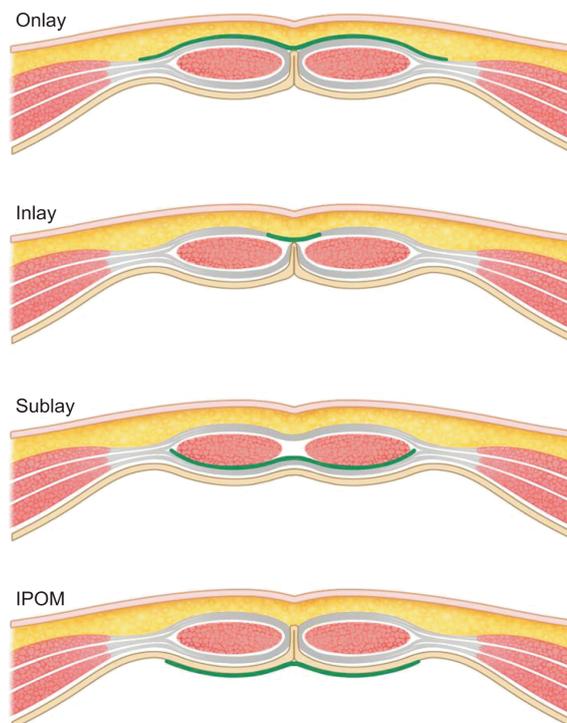


Fig. 19. Syntetic mesh positions

## **RIVES-STOPPA TECHNIQUE**

Dissecting a retromuscular plane between the muscle bellies and the posterior aponeurosis of the abdominal rectus muscles provides a vascularized space where the mesh can be placed, and frees the muscles for a tension-free closure of the musculo-aponeurotic flap in the midline, thus reconstructing the anatomy of the abdominal wall. In adults, the Rives-Stoppa retromuscular technique (sublay) is considered as the technique of choice when it comes to repairing > 5 cm midline hernias.

Laparoscopic approach includes several different types of surgeries: IPOM, IPOM plus, TAPP, eTEP. IPOM technique requires dual-layered mesh that has a special cover on one side that reduce incidence of adhesion formation. Simple polypropylene mesh should avoid to contact with intraabdominal viscera. Otherwise, the incidence of adhesion with complications (bowel obstruction, bowel perforation with peritonitis) may be up to 90%.

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