



GIS 4.1

ANATOMY



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In The Name Of The Most Merciful

A quick review for the previous sheet :

Abdominal Wall:

❖ Borders:

- Superior
- Inferior
- Umbilicus

❖ Abdominal Quadrants :

- Upper left
- Upper right
- Lower left
- Lower right

❖ Abdominal Regions :

- Right Hypochondriac Region, Epigastric Region, Left Hypochondriac Region
- Right Lumber Region, Umbilical Region, Left Lumber Region
- Right Iliac Region, Suprapubic Region, Left Iliac Region

❖ Layers of Anterior Abdominal Wall :

- Skin
- Superficial Fascia
- Deep Fascia
- Muscular Layer
- Transversalis Fascia
- Extraperitoneal Fascia
- Parietal Peritoneum

❖ Muscles Abdominal Wall :

Table 4.1 Abdominal wall muscles

Muscle	Origin	Insertion	Innervation	Function
External oblique	Muscular slips from the outer surfaces of the lower eight ribs (ribs V to XII)	Lateral lip of iliac crest; aponeurosis ending in midline raphe (linea alba)	Anterior rami of lower six thoracic spinal nerves (T7 to T12) +L1	Compress abdominal contents; both muscles flex trunk; each muscle bends trunk to same side, turning anterior part of abdomen to opposite side
Internal oblique	Thoracolumbar fascia; iliac crest between origins of external and transversus; lateral two-thirds of inguinal ligament	Inferior border of the lower three or four ribs; aponeurosis ending in linea alba; pubic crest and pectineal line	Anterior rami of lower six thoracic spinal nerves (T7 to T12) and L1	Compress abdominal contents; both muscles flex trunk; each muscle bends trunk and turns anterior part of abdomen to same side
Transversus abdominis	Thoracolumbar fascia; medial lip of iliac crest; lateral one-third of inguinal ligament; costal cartilages lower six ribs (ribs VII to XII)	Aponeurosis ending in linea alba; pubic crest and pectineal line	Anterior rami of lower six thoracic spinal nerves (T7 to T12) and L1	Compress abdominal contents
Rectus abdominis	Pubic crest, pubic tubercle, and pubic symphysis	Costal cartilages of ribs V to VII; xiphoid process	Anterior rami of lower seven thoracic spinal nerves (T7 to T12)	Compress abdominal contents; flex vertebral column; tense abdominal wall
Pyramidalis	Front of pubis and pubic symphysis	Into linea alba	Anterior ramus of T12	Tenses the linea alba

Here We Go On The 4th Sheet;

But before we start, please note that most of the pictures in this sheet are from Gray's & Netter, so please refer to the slides' pictures. Thanks a lot 😊 .

We will discuss 9 Topics :

- Rectus Sheath
- Others Fascia in the Anterior Abdominal wall
- Action of the Anterior Abdominal Muscle
- Blood Supply of the Anterior Abdominal Wall
- Nerve Supply of the anterior Abdominal Wall
- Lymphatic Drainage of Anterior Abdominal Wall
- Clinical Notes
- Inguinal Canal
- Inguinal Triangle

1-Rectus Sheath :

It's a long fibrous sheath, formed mainly by the aponeuroses of the three lateral abdominal muscles. It starts from linea semilunaris(lateral edge of the rectus abdominis muscle) to linea alba.

✓CONTENTS :

- **Rectus abdominis muscle** : firmly attached to the anterior wall of the sheath by the muscle's tendinous intersections↓ ,but separated from the posterior wall by the presence of arteries (sup. & inf. Epigastric) .
- **Pyramidalis muscle (if present)** : anterior to the rectus abdominis muscle .
- **The anterior rami of the lower six thoracic nerves** : which gives innervation to the abdominal muscles .
- **The superior and inferior epigastric vessels** : inferior epigastric artery is a branch from the external iliac artery-it indicates the difference between direct & indirect hernia-,& superior epigastric artery is a branch from the internal thoracic(mammary) artery, which is a branch from subclavian artery .
Note// the superior & inferior epigastric veins will run in the opposite direction.
- **Lymphatic vessels.**

✓DESCRIPTION THE RECTUS SHEATH IS CONSIDERED AT THREE LEVELS ;

for each level we must know the anterior wall, the posterior wall, and contents (which are constant):

1-Above the costal margin:

- Anterior wall -> Aponeurosis of the external oblique.
- Posterior wall -> Thoracic wall;5th&6th&7thcostal cartilages and the intercostal spaces.

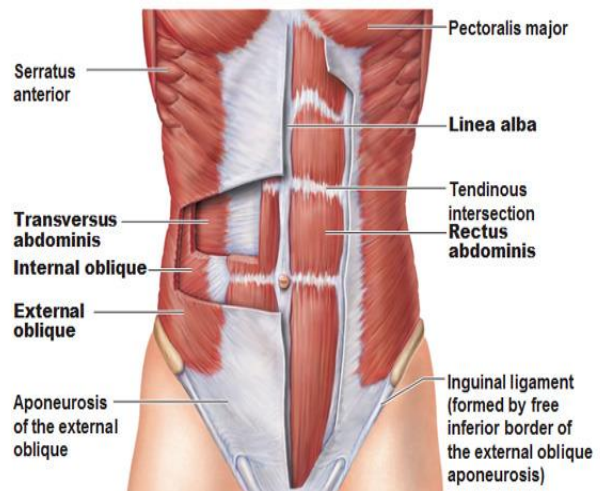
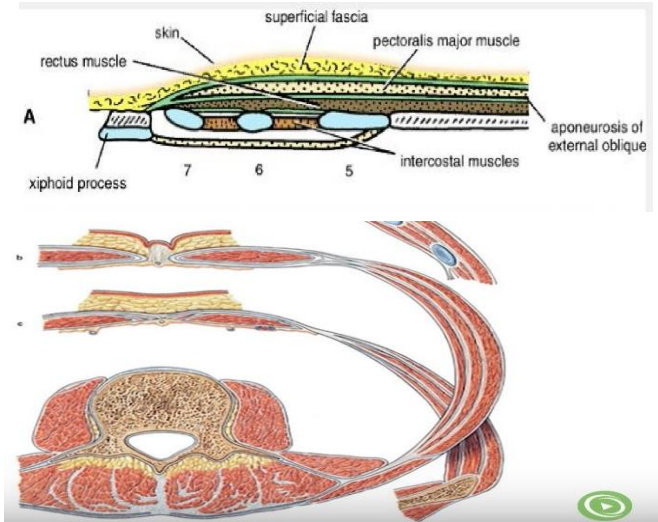
2-Between the costal margin and the level of the anterior superior iliac spine:

- Anterior wall ->the external oblique aponeurosis is directed in front of the muscle.
- Posterior wall ->the transversus aponeurosis is directed behind the muscle.

The aponeurosis of the internal oblique splits to enclose the rectus muscle;so it has two layers , one in the anterior wall and one in the posterior wall.

3-Between the level of the anterosuperior iliac spine and the pubis:

- Anterior wall -> the aponeurosis of all three muscles form.
- Posterior wall is absent &the rectus muscle lies in contact with the fascia transversalis



The three levels

Tendinous intersections

SO; It is important to know the layers of the rectus sheath in each level. A surgeon needs to be aware of the structures that pass in through the sheath at all the levels when making an incision.

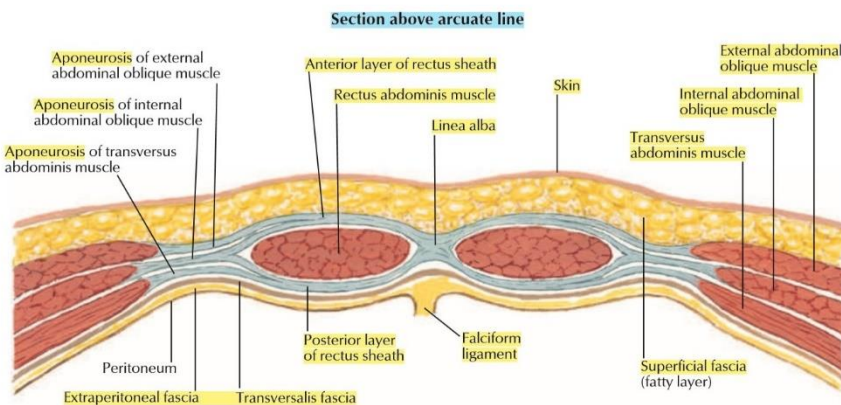
✓ **ARCuate LINE (LINEA SEMICIRCULARIS) :**

Is a crescent-shaped line marking the inferior limit of the posterior layer of the rectus sheath just below the level of the iliac crest.

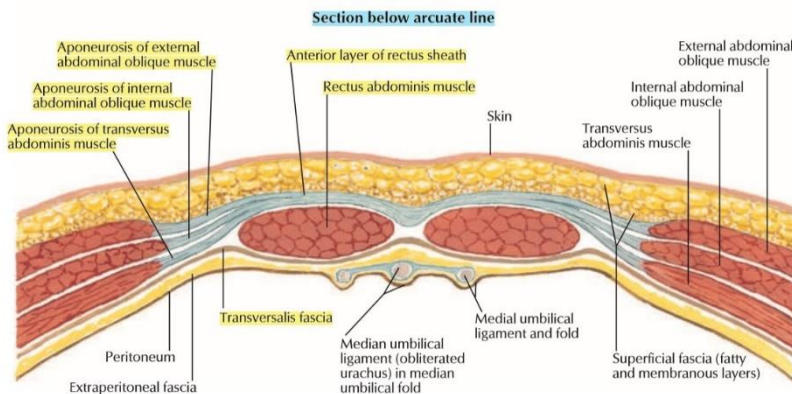
DON'T FORGET ;

what is the structure found in the posterior wall of the rectus sheath, below the level of arcuate line / the level of anterior superior ilia spine ??

TRANSVERSALIS FASCIA
(the third region).

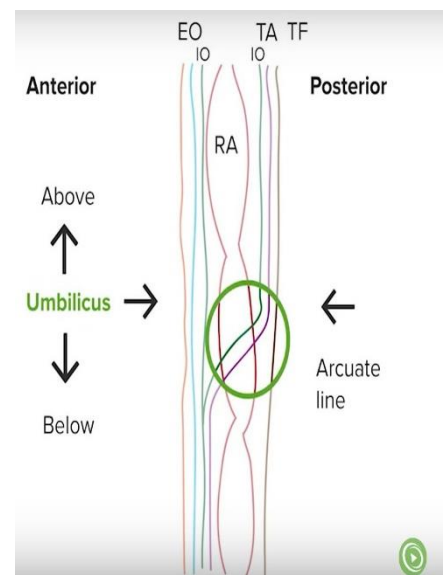


Aponeurosis of internal abdominal oblique muscle splits to form anterior and posterior layers of rectus sheath. Aponeurosis of external abdominal oblique muscle joins anterior layer of sheath; aponeurosis of transversus abdominis muscle joins posterior layer. Anterior and posterior layers of rectus sheath unite medially to form linea alba.



Aponeurosis of internal abdominal oblique muscle does not split at this level but passes completely anterior to rectus abdominis muscle and is fused there with both aponeurosis of external abdominal oblique muscle and that of transversus abdominis muscle. Thus, posterior wall of rectus sheath is absent below arcuate line, leaving only transversalis fascia.

f. Netter



2-Other Fascia in the Anterior Abdominal wall :

✓ TRANSVERSALIS FASCIA

- a thin layer of fascia that lines the Transversus Abdominis muscle(deep to it).
- continue to diaphragm (below it),it goes anterior to the iliac muscle making pelvic fascia.
- contribute to femoral sheath.

✓ EXTRAPERITONEAL FASCIA

- The thin layer of C.T and adipose tissue between the peritoneum and fascia transversalis.

✓ PARIETAL PERITONEUM

- It is a thin serous membrane (تذكروا دكتور ماهر وجدار البالون المنفوخ)
- Continuous below with the parietal peritoneum lining the pelvis-To be discussed later-.

3-Action of the Anterior Abdominal Muscles : -they work as one unit-

✓ DEEP EXPIRATION:

- The contraction of the abdominal muscles help in the deep expiration
- Usually after exercise
- The 2 types respiration: 1-shallow 2- deep .
- Inspiration → active movement , needs energy .
- Expiration → passive movement , doesn't need energy because the diaphragm relaxes back by itself.

✓ INCREASE THE INTRAABDOMINAL PRESSURE IN: when it is needed in the following processes:

- Vomiting
- Coughing
- Defecation (معناها الإخراج؛وخصوصاً في حالات الإمساك)
- Labour (حيث ينصح الأطباء الحوامل بلعب الرياضة التي تساعد على تقوية هذه العضلات في الشهرين الأخيرين من الحمل)

✓ PROTECT VISCERA: prevent the traumas from reach the viscera, by their contraction any hit on the abdomen will be reflected.

✓ KEEP VISCERA IN POSITION.

✓ RECTUS ABDOMINIS->BENDS TRUNK FORWARD

✓ MOVEMENT:

- Bending forward → bilateral contraction
- Bending laterally → one side contraction

✓ LIFTING OF HEAVY OBJECTS: when an athlete lifts weights ; he :

- Opens his legs
- Hold his breath & increase the abdominal pressure
- Lift the weight

4-Blood Supply of the Anterior Abdominal Wall

✓ ARTERIES

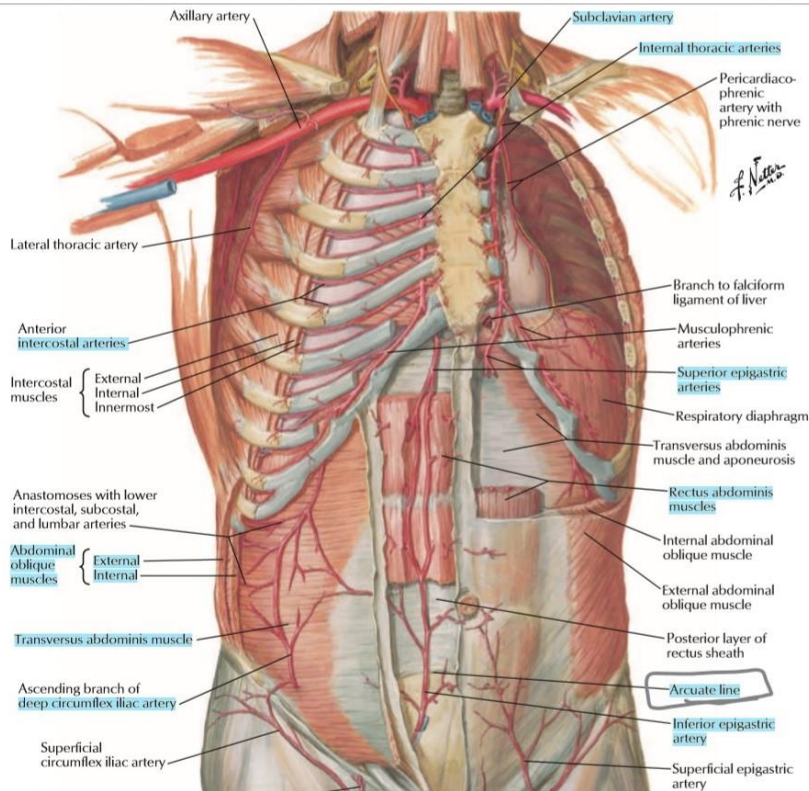
- Superior Epigastric artery
- Inferior Epigastric artery
- Intercostal arteries (lower 6)
- Lumbar arteries : the abdominal aorta gives four lumbar arteries in the posterior abdominal wall ; supply the abdominal muscles, from the back forward .

- Deep circumflex artery ; branch from external iliac artery goes to anterior superior iliac spine and supplies the abdomen in this region .

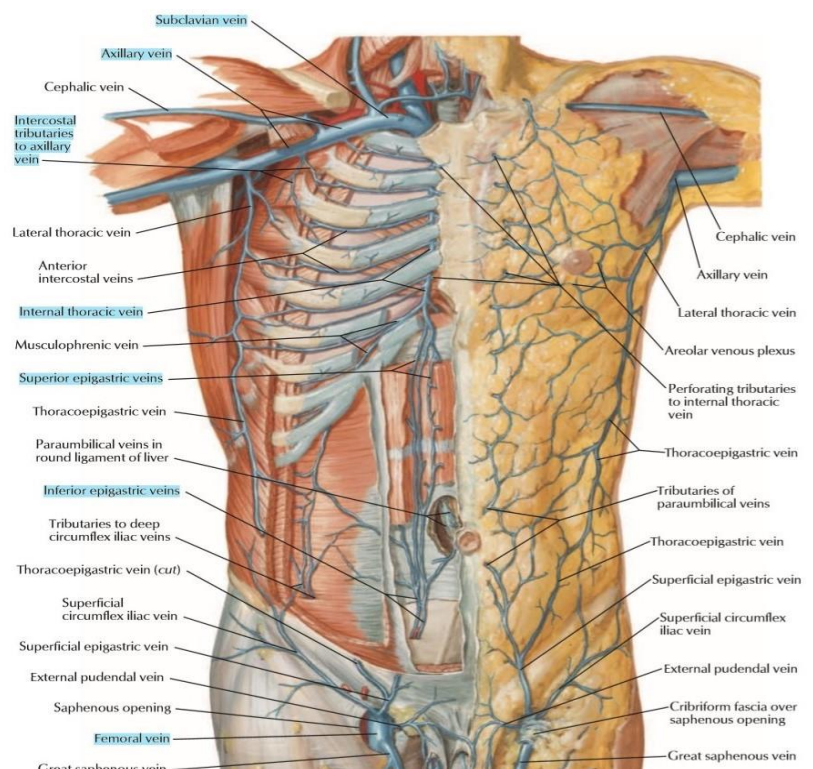
✓ VEINS

- Lateral Thoracic Vein drains into Axillary Vein
- Superior Epigastric drains into Internal Thoracic Vein → Above the umbilicus
- Inferior Epigastric drains into External Iliac Vein → Below the umbilicus
- Paraumbilical Veins ;
- Ligamentum teres* → portal vein {Porto-systemic anastomosis (to be discussed later)}
- *The remnant of the umbilical vein that exists in the free edge of the falciform ligament of the liver (it was present in the fetus but then got obliterated).

*The Arterial Blood Supply



*The Venous Blood Supply



5-Nerve Supply of Ant. Abdominal wall

✓ THORACOABDOMINAL NERVE:

- Lower 6th thoracic nerves & 12th subcostal nerve
- They come from chest to abdomen
- They enter from lateral to medial ; from linea semilunaris to linea alba, then they end as cutaneous to the abdominal wall ; that's why when we do a surgery, we tighten the rectus abdominis muscle laterally ; because if we tighten them medially, they may get torn .

✓ DERMATOMES: (nerves to the skin of abdomen , Anterior lateral cutaneous nerve terminal branches of Thoracoabdominal nerve)

- T7.
- T10.
- L1.

{for example ; the pain of appendicitis starts in the region around umbilicus , then it moves to the right iliac fossa. The reason is that the innervation to the appendix is from T10 ; and T10 gives dermatome around the umbilicus}.

✓ LI NERVE

- Iliohypogastric nerve
- Ilioinguinal nerve

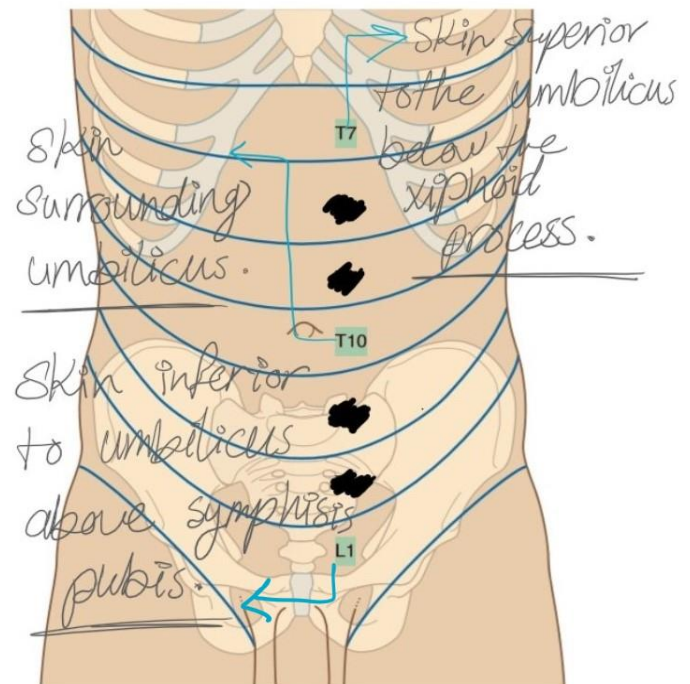
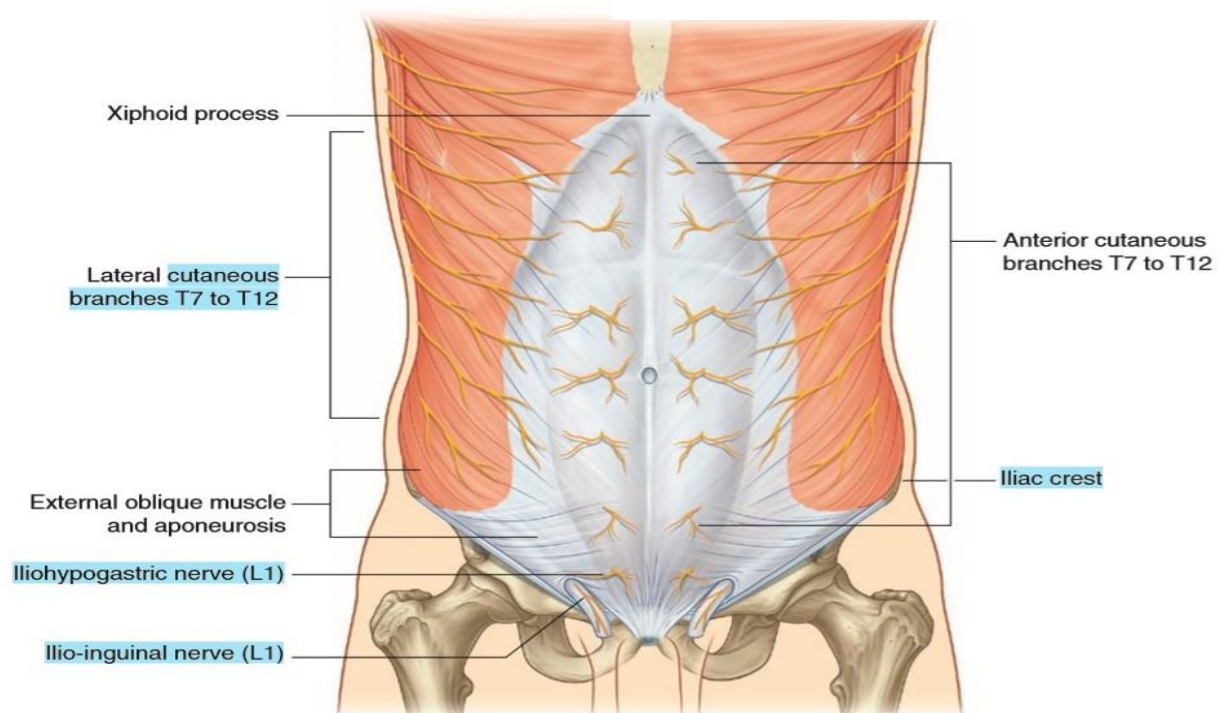


Fig. 4.38 Dermatomes of the anterolateral abdominal wall.



6-Lymphatic drainage of Ant. Abdominal wall :

Abdominal lymph nodes are distributed in the anterior wall of the abdomen as following:

- **Above the umbilicus**→Ant. Axillary L.N; which are deep to the pectoralis major muscle.
 - **Below the umbilicus**→Sup. Inguinal L.N, they're located in the femoral triangle.
 - **Above the iliac crest**→Post. Axillary L.N, anterior to the subscapularis muscle on the back.
 - **Below the iliac crest**→Sup. Inguinal L.N.
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7-Clinical Notes :

Now; let's get in some applied medicine~. ~:

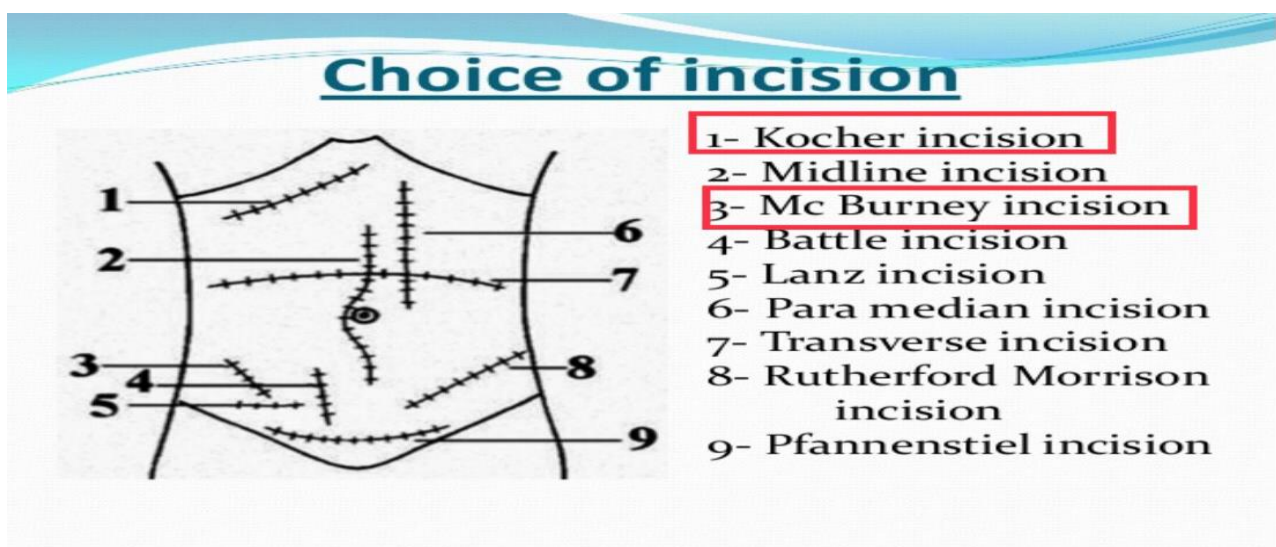
1-A lot of abdominal incisions that you'll see, can be a result of street conflicts, mainly the stab wounds. We care most to detect the site of the penetration & the layers that got injured (anatomical location).For example:

- If the stab injured the abdomen anterior to the rectus sheath, this indicates harm to the rectus abdominus muscle, increasing a risk to find an injury in the superior & inferior epigastric arteries which are part of the content of the rectus sheath.
- When a lateral injury wouldn't affect neither the muscle nor the vessels, the nerves crossing from lateral to medial will get harmed.
- A midline injury is a very rare case, causing an incision in the linea alba.

2-The length and direction of surgical incision through the ant. Abdominal wall to expose the underlying viscera in a surgery are largely controlled by many factors:

- ✓ position & direction of nerves.
- ✓ direction of muscle fibers.
- ✓ arrangement of the aponeurosis forming the rectus sheath.

So, the incision should be made In the direction of the line of cleavage in the skin, so that the hairline scar is produced. The most common incision in a surgery is a midline incision. But let's say we have to operate on a gallbladder. It's incision will be applied under the ribs on the right side of the abdominal wall, which we call a **KOCHER INCISION**. While the appendix surgery is opened by a **MC BURNEY INCISION**



Common types of incisions:

- Paramedian incision.
- Midline incision.
- Transverse incision.
- Abdominothoracic incision.
- Pararectus incision.
- Transrectus incision.
- Muscle splitting.

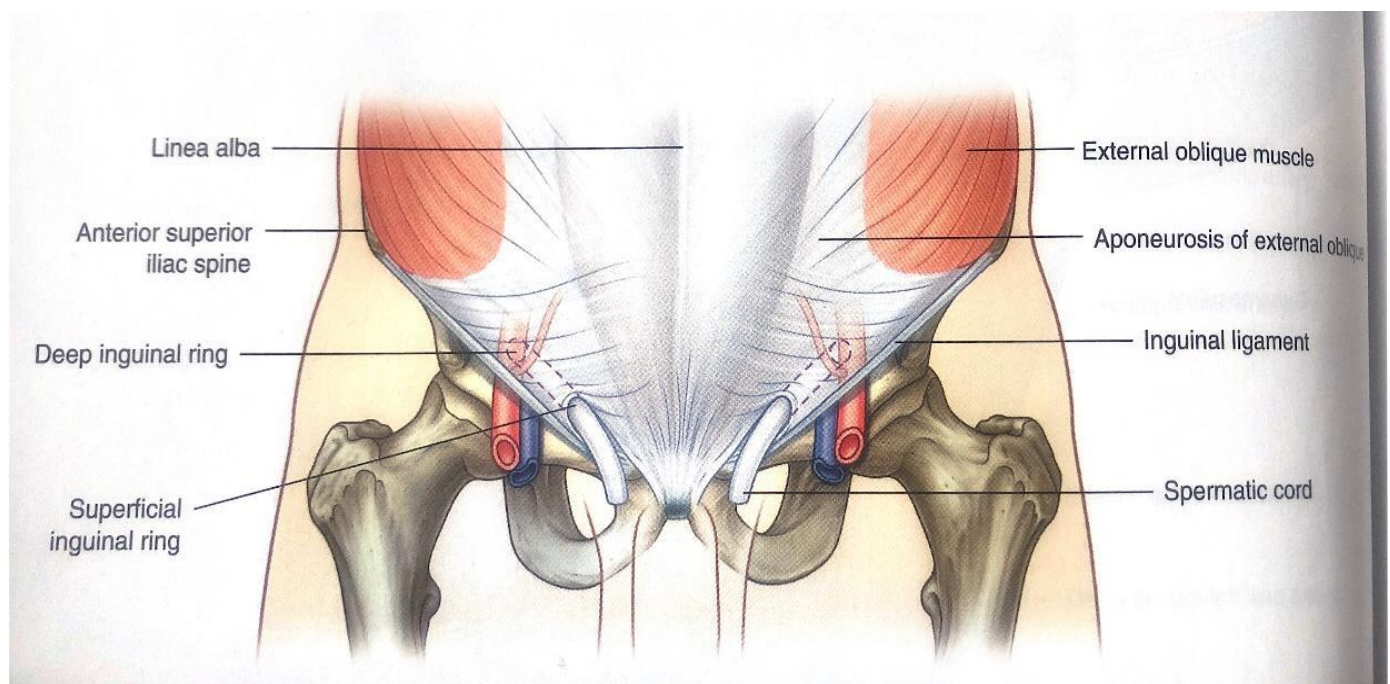
Incision through the rectus sheath are widely used. The rectus abdominis muscle and its nerve supply are kept intact. On closure the ant & post wall of the sheath are sutured separately and the rectus muscle back into position between the suture lines.

8-Inguinal Canal :

It is an oblique passage through the lower part of the anterior abdominal wall, which is present in both sexes. In males, it allows structures to pass from the testis to the abdomen and vice versa (mainly the spermatic cord). In females, it permits the passage of the round ligament of the uterus, from the uterus, to the labium magus. It transmits ilioinguinal nerve in both sexes and genital branch of the genitofemoral nerve.

This canal is about 1 ½ inches (4cm) long in the adults. It extends from the deep inguinal ring downward and medially to the superficial inguinal ring, parallel to and immediately above the inguinal ligament in the iliac fossa.

In the newborn child, the deep ring lies almost directly posterior to the superficial ring above each other.

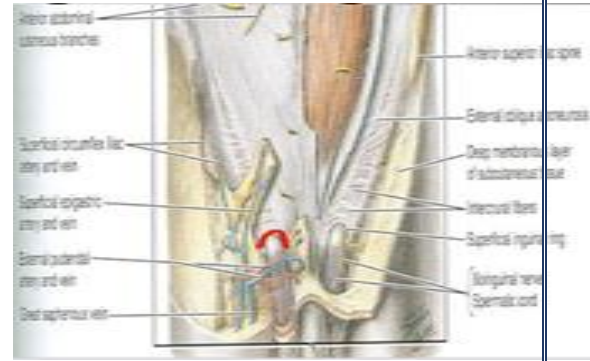


Deep Inguinal Ring is an oval opening in the fascia transversalis. It lies about ½ inch (1.3cm) above the inguinal ligament, midway between the anterosuperior iliac spine and the symphysis pubis. Margins of the ring give attachment to the internal spermatic fascia covering the spermatic cord, which means it's formed by the transversalis fascia. The deep inguinal ring can be detected by sensing the pulse of the femoral artery then moving vertically to it.

Superficial Inguinal Ring Triangular in shape. It's considered a defect in the aponeurosis of the external oblique muscle which lies immediately above and medial to the pubic tubercle. Its margins (sometimes called crura)(Med. & Lat. crus)create an apex/arch above the spermatic cord & giving attachment to the external spermatic fascia.

Note//The external spermatic fascia is formed by the aponeurosis of the external oblique muscle.

Anterior Wall of Inguinal Canal is formed from the external oblique muscle, along its entire length. It is reinforced in its lateral third in front of the deep inguinal ring by the origin of the internal oblique from the inguinal ligament. This wall is strongest where it lies opposite the weakest part of posterior wall*. This means that the deep inguinal ring provides support & protection for it and its content (vas deferens + arteries, veins, nerves + 3 spermatic fascia).



***MORE EXPLANATION ;** The strongest part in the anterior wall offers support to the weakest part of the posterior wall, which is located exactly behind it (the deep inguinal ring); **Remember:** the deep inguinal ring is an opening in fascia transversalis which forms the posterior wall.

In the embryo, the ovaries/testis are formed in the posterior abdominal wall at the level of L1 lumbar vertebrae, during the 8th month of embryonic development. The gubernaculum + processus vaginalis guide & pull the testis/ovaries, allowing them to enter to the inguinal canal and continuing their tract. Remember that the testis pass until they reach the scrotum, thus they must be seen in a newborn. While the destination of the ovaries would be through the iliac fossa. The spermatic cord-formed during the descending of the testis-starts from the deep ring and extends in the canal behind the urinary bladder, leaving through the superficial ring, then extends to the scrotum, while the vas deferens-it's a muscular tube that carries the sperms from epididymis to ejaculatory duct-starts at epididymis then ascends up inside the spermatic cord to continue its journey in the pelvic cavity. So the deep inguinal ring is super important for the passage of these structures as we said before. Although the gubernaculum & processus vaginalis have a critical function they will undergo obliteration & fibrosis to close the deep ring tightly, preserving the passing structures fixed in place. A defect in the closure of the deep ring would allow parts of the small intestines/the greater omentum to enter the deep ring & canal causing a **congenital indirect inguinal hernia**.

Posterior Wall of Inguinal Canal It is formed, along its entire length, by the fascia transversalis. It is reinforced in its medial third by the conjoint tendon, which is the common tendon of insertion of internal oblique and transversus. The conjoint tendon is attached to the pubic crest and pectineal line. We track the conjoint tendon's borders to define the posterior wall. This wall is strongest where it lies opposite the weakest part of the anterior wall, the superficial inguinal ring.

Inferior Wall of Inguinal Canal = floor formed by the rolled-under inferior edge of the aponeurosis of the external oblique muscle called inguinal ligament and at its medial end, the lacunar ligament.

Superior Wall of Inguinal Canal = Roof formed by the arching lowest fibers of the internal oblique and transversus abdominis muscles.

Please be alert that we have 2 nerves passing through the canal:

Genital branch of the genitofemoral nerve: it enters the deep ring, passes through the canal, & leaves the superficial ring to supply the cremaster muscle inside the scrotum. It has a sensory role since it has a cremasteric effect.

Ilioinguinal nerve: it enters the canal through the posterior wall (**doesn't** pass through the deep ring), leaving the canal from the superficial ring to take sensation from the scrotum.

9-Ilioinguinal (Hwsselbach's) Triangle :

It is a region of the anterior abdominal wall above the inguinal ligament; formed by three borders:

- Medial border: Lateral margin of the rectus sheath, also called linea semilunaris.
- Superolateral border: Inferior epigastric vessels.
- Inferior border (base): Inguinal ligament.

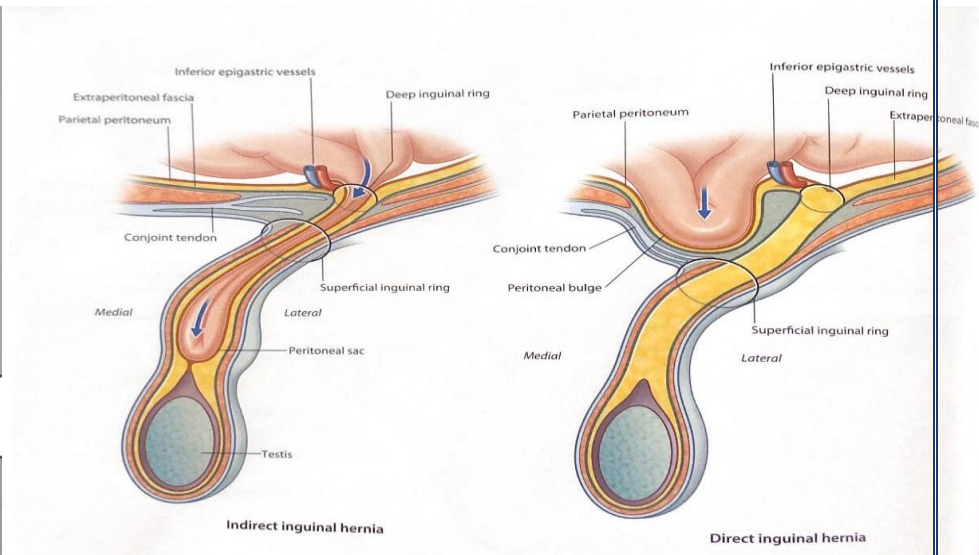
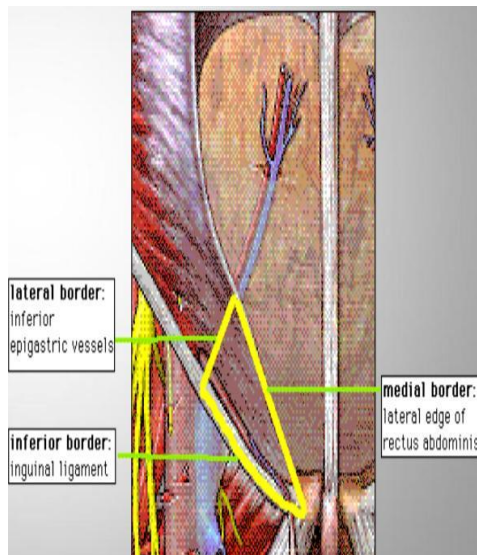
This triangle is considered a weak point, causing an old age patient with weakened abdominal muscles, chronic cough, chronic constipation, smoker or performs any other behavior that increases the abdominal pressure on that triangle, to suffer from **direct hernia**.

Direct hernia is a medical case in which the increased abdominal pressure would cause the small intestines to push the wall creating a swelling bulge in the ilioinguinal area.

So Remember ;

Indirect Inguinal Hernia → **Inguinal Canal**

Direct Inguinal Hernia → **Inguinal Triangle**



"إن يوماً باقياً من العمر هو للمؤمن عُمرٌ ما ينبغي أن يُستهانَ به"
-الرافعي



• اسع؛ فما سعى لله ساعٍ إلا بَلَّغ..

The underlined sentences were not mentioned by the doctor , "Lumbar triangle" topic isn't required , and finally don't forget ; we didn't put all the pictures in the slides .

We hope to understand before memorize, we are sorry for any mistake.

DO NOT HESITATE TO ASK ABOUT ANY THING IN THIS SHEET.

Test Your Self :

1] A 2-year-old boy presents with pain in his groin that has been increasing in nature over the past few weeks. He is found to have a degenerative malformation of the transversalis fascia during development. Which of the following structures on the anterior abdominal wall is likely defective?

- (A) Superficial inguinal ring
- (B) Deep inguinal ring
- (C) Inguinal ligament
- (D) Sac of a direct inguinal hernia

2] A 9-year-old boy was admitted to the emergency department complaining of nausea, vomiting, fever, and loss of appetite. On examination, he was found to have tenderness and pain on the right lower quadrant. Based on signs and symptoms, the diagnosis of acute appendicitis was made. During an appendectomy performed at McBurney point, which of the following structures is most likely to be injured?

- (A) Deep circumflex femoral artery
- (B) Inferior epigastric artery
- (C) Iliohypogastric nerve
- (D) Genital branch of Genitofemoral nerve

3] A physical fitness trainer for a young Hollywood movie star explains the reasons for 100 stomach crunches a day. The young star, a medical student before "hitting it big," reaffirms to his trainer that the lateral margin of the rectus abdominis, the muscle responsible for a washboard stomach, defines which of the following structures?

- (A) Linea alba
- (B) Linea semilunaris
- (C) Linea semicircularis
- (D) Transversalis fascia

4] A boy presents to the hospital with a stab wound in the right iliac fossa, which nerve may be affected?

- (A) T12
- (B) L2
- (C) L1
- (D) T11

5] Which one is wrong about tendinous intersection?

- (A) Fibrous band passes transversely or obliquely
- (B) Attaches to posterior border of rectus sheath
- (C) It defines the anatomy of the rectus abdominis
- (D) It assists with physiological movement.

Wish you all the Best ✨

Answers