## **Anterior Adominal Wall**

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#### **Boundaries of the Abdomen**

- Superior Boundary:
  - Midline: Xiphoid process
  - Laterally: Lower five costal cartilages
- Inferior Boundary:
  - Midline: Pubic bone
  - Laterally: Iliac crest, located at the level of the L4 vertebra
- The abdomen is separated from the thoracic cavity superiorly by the diaphragm.
- Inferiorly, there is no anatomical separation between the abdominal cavity and the pelvic cavity.
- The umbilicus is located at the level of L3–L4 vertebrae.

### **Abdominal Divisions**

#### **Traditional Division (Four Quadrants)**

The abdomen was classically divided into four quadrants by one vertical and one horizontal line crossing at the umbilicus:

- 1. Right Upper Quadrant (RUQ)
- 2. Left Upper Quadrant (LUQ)
- 3. Right Lower Quadrant (RLQ)
- 4. Left Lower Quadrant (LLQ)

For example:

- Pain in the RLQ often indicates appendicitis
- Pain in the RUQ may indicate liver or gallbladder issues
- Pain in the LUQ may indicate stomach issue

#### **Modern Division (Nine Regions)**

A more precise anatomical division uses two vertical and two horizontal lines:

- Vertical Lines:
  - Right and left midclavicular lines, drawn vertically from the midpoint of each clavicle
- Horizontal Lines:
  - Subcostal line: Below the 9th costal cartilage, at the level of L3 vertebra
  - Intertubercular line: Through tubercles of iliac crest, at the level of L5 vertebra

These lines divide the abdomen into nine regions:

- 1. Upper Row:
  - Epigastric region (central upper area)

- Right hypochondriac region (to the right of the epigastric region, beneath the right costal cartilage)
- Left hypochondriac region (to the left of the epigastric region, beneath the left costal cartilage)

#### 2. Middle Row:

- Umbilical region (central middle area)
- Right lumbar region (to the right of the umbilical region, associated with the right kidney)
- Left lumbar region (to the left of the umbilical region, associated with the left kidney)

#### 3. Lower Row:

- Hypogastric (or suprapubic) region (central lower area)
- Right iliac (or inguinal) region (to the right of the hypogastric region)
- Left iliac (or inguinal) region (to the left of the hypogastric region)

Definitions & Clinical Correlations:

- Epigastric = (stomach)
- Umbilical = central abdomen (small intestines)
- Iliac/Inguinal (Right) = appendix

## **Abdominal Wall**

- The abdominal wall is divided into:
  - Anterior abdominal wall
  - Posterior abdominal wall

### **Abdominal Wall Layers (From Superficial to Deep)**

#### 1. Skin

- 2. Superficial Fascia
  - Above the umbilicus: Single layer (mainly fatty Camper's fascia)
  - Below the umbilicus:
    - Camper's fascia (fatty layer)
    - Scarpa's fascia (membranous layer) below fatty layer
  - In males:
    - Camper's fascia continues as Dartos muscle in the scrotum
    - Scarpa's fascia continues as Colles' fascia in the scrotum
  - Attachments of Scarpa's fascia:
    - Inferiorly with fascia lata of the thigh (about 4 cm below the inguinal ligament) closing the space above membranous layer
    - Attached to the pubic arch in each sides
    - Perineal body (fibrous tissue in the perineum) posteriorly

## **Clinical Correlation: Urethral Injury and Urine Extravasation**

• In case of a rupture of the penile urethra, urine can leak (extravasate) into areas deep to the membranous layer (Scarpa's fascia):

- It may ascend toward the umbilicus (membranous layer at the umbilicus)
- It does not enter the lower limbs because Scarpa's fascia is firmly attached to the fascia lata of the thigh. It may spread around the scrotum and penis in males

### 3. Deep Fascia

- Thin connective tissue layer investing the abdominal muscles
- Often absent in females, allowing expansion during pregnancy
- In males, may be present but is very thin

### 4. Muscular Layer

The abdominal muscles are among the strongest muscles in the body. They originate as fleshy (muscular) fibers and end as aponeuroses (connective tissue). These aponeuroses converge in the midline to form the **linea alba**, which:

- Extends from the xiphoid process to the pubic symphysis (a cartilaginous joint between the two pubic bones).
- Serves as the insertion point for all abdominal muscles.
- 1. External Oblique Muscle
  - Fiber direction: Downward, forward, and medially
  - Most superficial muscle layer
- 2. Internal Oblique Muscle
  - Fiber direction: Upward, forward, and medially
  - Lies beneath the external oblique
- 3. Transversus Abdominis Muscle
  - Fiber direction: Horizontally (transverse)
- 4. Rectus Abdominis Muscle
  - Runs vertically along the midline
  - Separated by the **linea alba**
  - Laterally bordered by the **linea semilunaris**
  - Interrupted by **tendinous intersections**, giving it a segmented appearance
  - Derived from embryonic myotomes

All these muscles end in aponeuroses that contribute to the formation of the rectus sheath, which encloses the rectus abdominis:

- The anterior layer of the sheath comes from external and part of internal oblique aponeuroses.
- The posterior layer includes aponeuroses of internal oblique and transversus abdominis and ends near the iliac fascia.

## **Strength and Functional Arrangement**

- The abdominal muscles are arranged like a meshwork:
  - With fibers crossing in different directions (oblique, vertical, and transverse)
  - This configuration provides strong structural support
- All muscles contribute to the linea alba and rectus sheath, forming a powerful wall that supports abdominal organs.

### 5. Transversalis Fascia

• A layer that lies deep to the abdominal muscles and superficial to the extraperitoneal fascia.

- It forms the posterior wall of the rectus sheath below the arcuate line (below the level of the anterior superior iliac spine).
- Forms the deep inguinal ring, through which the spermatic cord (in males) or round ligament of the uterus (in females) passes.
- Contributes to the anterior wall of the femoral sheath (posterior from iliac fascia).
- $\circ$   $\;$  It is continuous with the diaphragmatic fascia superiorly.

#### 6. Extraperitoneal Fat/Fascia

 $\circ$  Lies between the transversalis fascia and parietal peritoneum

#### 7. Parietal Peritoneum

• A membrane covering the abdominal cavity

## **Muscles of the Anterior Abdominal Wall**

## **1. External Oblique Muscle**

- Fiber Direction: Downward, forward, and medially
- Origin: Outer surfaces of the lower eight ribs
- Insertion:
  - Linea alba
  - Xiphoid process
  - Pubic crest and pubic tubercle
  - Iliac crest
- Nerve Supply:
  - Lower six thoracic nerves (T7–T12)
  - L1 via the iliohypogastric and ilioinguinal nerves

#### **Aponeurosis of External Oblique Forms Key Structures**

- Inguinal Ligament:
  - Inferior margin of the aponeurosis
  - Extends from the anterior superior iliac spine (ASIS) to the pubic tubercle
  - Folds backward to form the ligament
- Superficial Inguinal Ring:
  - A triangular opening (defect) in the aponeurosis
  - Located superior and medial to the pubic tubercle
  - Passage for:
    - Spermatic cord (in males)
    - Round ligament of uterus (in females)
- Lacunar Ligament:
  - Crescent-shaped extension of the inguinal ligament
  - o Attached to the pubic ramus and curves upward to the pectineal line
  - $\circ$  Medial boundary of the femoral ring
- Pectineal Ligament (of Cooper):
  - Continuation of the lacunar ligament
  - Attached to the pectineal line
  - $\circ$   $\;$  Blends with periosteum of the pubic bone
- Anterior wall of the Inguinal Canal is formed by the external oblique aponeurosis
- Formation of recuts sheath

### 2. Internal Oblique Muscle

- Fiber Direction: Upward, forward, and medially
- Origin:
  - Iliac crest
  - lumbar fascia
  - Inguinal ligament
- Insertion:
  - o Lower three ribs and costal cartilages
  - Linea alba
  - Xiphoid process
- Nerve Supply:
  - Lower six thoracic nerves (T7–T12)
  - L1 (iliohypogastric and ilioinguinal nerves)

#### **Functions and Contributions**

- Forms part of the rectus sheath
- Forms roof of the inguinal canal
- Contributes to the conjoint tendon (fusion with transversus abdominis aponeurosis)
  - $\circ$  Inserts to the pubic bone
  - Attached medially to the linea alba
  - Has lateral free boarder
  - Support the inguinal canal
  - Used in herniorrhaphy (hernia repair) due to its strength
- Gives rise to cremaster muscle and cremasteric fascia (in males)
  - Internal oblique has free lower border arches over the spermatic cord and give fascia around Cremastric muscle present in the inguibnal canal

#### 3. Transversus Abdominis Muscle

- Fiber Direction: Horizontally (transverse)
- Origin:
  - Inner surfaces of the lower six costal cartilages (7th–12th)
  - Thoracolumbar fascia
  - Iliac crest
  - o Inguinal ligament
- Insertion:
  - o Xiphoid process
  - o Linea alba
  - Symphysis pubis
  - Nerve Supply:
    - $\circ$  Lower six thoracic nerves (T7–T12)
    - L1 (iliohypogastric and ilioinguinal nerves)

#### **Functions and Contributions**

• Shares in forming the conjoint tendon with internal oblique. Contributes to the rectus sheath

#### 4. Rectus Abdominis Muscle

- Fiber Direction: Vertical
- Origin:
  - Pubic symphysis
  - Pubic crest
- Insertion:
  - 5th, 6th, and 7th costal cartilages
  - Xiphoid process
- Nerve Supply:
  - $\circ$  Lower six thoracic nerves (T7–T12)
  - No L1 innervation (does not reach it)

#### **Special Features**

- Separated in the midline by the linea alba
- Laterally bordered by the linea semilunaris
- Interrupted by tendinous intersections (commonly 3):
  - One at the xiphoid level
  - One at the umbilicus
  - $\circ$   $\,$  One between the two; sometimes a fourth may be present
- Lies within the rectus sheath

## 5. Pyramidalis Muscle

- Small triangular muscle, sometimes absent
- Located anterior to the lower part of rectus abdominis inside the rectus sheath
- Origin: Anterior surface of the pubis
- Insertion: Linea alba, tenses it
- Nerve Supply: Subcostal nerve (T12)

### **Fascial Landmarks**

- Linea Alba:
  - Midline fibrous structure from xiphoid process to pubic symphysis
  - Insertion site for aponeuroses of all three flat abdominal muscles
  - Midline incisions are made here in surgery to minimize bleeding (as it is avascular), though healing is slower due to poor vascularity
- Linea Semilunaris:
  - o Curved lateral border of the rectus abdominis muscle

## **Rectus Sheath**

## Definition

The rectus sheath is a fibrous compartment formed by the aponeuroses of the three flat abdominal muscles (external oblique, internal oblique, and transversus abdominis). It encloses the rectus abdominis muscle on both sides of the linea alba.

#### Boundaries

- Medial: Linea alba (midline fibrous seam)
- Lateral: Linea semilunaris (lateral edge of rectus abdominis)

### **Contents of the Rectus Sheath**

- 1. Rectus abdominis muscle
- 2. Pyramidalis muscle (if present)
- 3. Anterior rami of the lower six thoracic nerves (T7–T12):
  - These enter the sheath laterally
  - o Travel between internal oblique and transversus abdominis
  - Supply rectus abdominis, then emerge anteriorly as anterior cutaneous nerves to thabdomen
- 4. Superior epigastric vessels
- 5. Inferior epigastric vessels
- 6. Lymphatic vessels

## **Cross-Sectional Description by Levels**

To describe the layers of the rectus sheath, we divide it into three levels:

#### 1. Above the Costal Margin (Level of Xiphoid & Costal Cartilages 5–7)

- Anterior wall of sheath:
  - o Skin
  - Superficial fascia
  - Deep fascia to the muscles
  - Pectoralis major muscle
  - Aponeurosis of external oblique muscle
- Posterior wall of sheath:
  - o Xiphoid
  - o costal cartilages and intercostal muscles

#### 2. Between Costal Margin and Anteroir superior iliac spine (Above and Below Umbilicus)

- Anterior wall:
  - o Skin
  - Superficial fascia
  - Aponeurosis of external oblique
  - Anterior layer of internal oblique
- Posterior wall:
  - Posterior layer of internal oblique
  - Transversus abdominis

Layers from anterior to posterior:

- Skin
- Superficial fascia
- External oblique aponeurosis
- Internal oblique (splits: one part anterior, one posterior)
- Rectus abdominis muscle
- Transversus abdominis (posterior aponeurosis)
- Transversalis fascia
- Extraperitoneal fat
- Parietal peritoneum

#### 3. Below the Anteroir superior iliac spine (Inferior to Anterior Superior Iliac Spine)

- Anterior wall:
  - Aponeuroses of all three muscles: external oblique, internal oblique, and transversus abdominis (they all pass anterior to rectus)
- Posterior wall:
  - Transversalis fascia, extraperitoneal fat, and parietal peritoneum

Layers from anterior to posterior:

- Skin
- Superficial fascia
- Aponeuroses of all three abdominal muscles
- Rectus abdominis muscle
- Transversalis fascia
- Extraperitoneal fat
- Parietal peritoneum

### **Arcuate Line**

- A horizontal line that marks the lower limit of the posterior layer of the rectus sheath
- Below this line, all aponeuroses pass anterior to rectus abdominis, leaving no posterior aponeurotic wall

## **Clinical Significance**

- Surgical Incisions:
  - Midline incisions are often made through the linea alba, especially above the umbilicus, to minimize bleeding (avascular fibrous tissue)
  - However, healing is slower due to poor vascularity
- Epigastric Hernias:
  - May occur in the linea alba, especially above the umbilicus
- Weak posterior sheath (below arcuate line) makes this area more susceptible to hernias

# **Functions of Anterior Abdominal Muscles**

- Assist in deep expiration
- Increase intra-abdominal pressure during:
  - Vomiting
    - Coughing
    - Defecation
    - o Labor
- Protect abdominal viscera
- Maintain viscera in position
- Rectus abdominis specifically helps in flexion of the trunk (bending forward)

# **Blood Supply of the Anterior Abdominal Wall**

## **Arterial Supply**

- Superior and Inferior epigastric artery (Both arteries run within the rectus sheath)
- Intercostal arteries (accompany the thoracic nerves)
- Lumbar arteries (from abdominal aorta)
- Deep circumflex iliac artery

### **Venous Drainage**

- Above the umbilicus:
  - o Drains into the lateral thoracic vein, which then drains into the axillary vein
- Below the umbilicus:
  - Drains via the inferior epigastric vein to the femoral vein
- Paraumbilical veins (anastomose with portal venous system)

# **Nerve Supply**

- Lower six thoracic nerves (T7–T12):
  - T7: superior to the umbilicus
  - $\circ$  T10: area around the umbilicus

- L1: below the umbilicus above symphysis pubis
- L1 nerve branches:
  - Iliohypogastric nerve
  - Ilioinguinal nerve
  - Supply the lower abdominal wall and scrotum

# Lymphatic Drainage

- Above the umbilicus:
  - o Drains to anterior axillary lymph nodes
- Below the umbilicus:
  - Drains to superficial inguinal lymph nodes
  - Above the iliac crest (posteriorly):
    - Drains to posterior axillary lymph nodes
- Below the iliac crest:
  - Drains to superficial inguinal lymph nodes

## **Clinical Notes**

#### **Stab Wounds**

- The effect depends on which layer is penetrated:
  - Midline wounds may involve the linea alba, which is avascular but has poorer healing
  - o Lateral wounds may involve rectus sheath or muscles

### **Surgical Incisions**

- Ideally follow (cleavage lines) of the skin to:
  - Minimize scarring

Common types of incisions

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

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