Anatomy

Anatomy of the Posterior Abdominal Wall

The abdominal cavity is bounded by the abdominal wall which is divided into an anterior wall, lateral wall and the posterior wall. The posterior abdominal wall is a musculoskeletal structure formed by the posterior abdominal muscles, their fascia, the lumbar vertebrae and the pelvic girdle. It is related to the lower thoracic and lumbar vertebrae, the abdominal aorta, the inferior vena cava as well as important retroperitoneal organs like the kidneys, the suprarenal glands, the pancreas and the duodenum.

Boundaries of the Posterior Abdominal Wall

The posterior abdominal wall is bounded:

- Anteriorly by the anterolateral abdominal muscles, the retroperitoneal organs, and the parietal peritoneum
- Posteriorly by the lumbar vertebrae, muscles, and fascia
- Superiorly by the 12th rib and diaphragm
- and Inferiorly by the pelvic rim

Structures Forming the Posterior Abdominal Wall

The posterior abdominal wall skeleton includes the 12th vertebrae, the intervertebral discs, the sacrum, and the 11th rib.
Lumbar vertebrae

The 12th thoracic vertebra, all 5 lumbar vertebrae, and their intervertebral discs support the posterior abdominal wall. The transverse processes, as well as the body of the vertebrae and the 12th rib, provide attachment to the muscles of the posterior abdominal wall.

There is a ventral curvature or lordosis of the lumbar vertebrae, which is enhanced by the Inferior vena cava and the aorta. In addition, the lordotic lumbar spine has the right and left paravertebral gutters on either side. The psoas and quadrates muscles lie in the paravertebral gutter.

Iliac crest

The iliac crest forms the inferior boundary of the posterior abdominal wall and the iliacus muscle originates from its inner lip.
Muscles

The posterior abdominal wall is constituted by several muscles: the **diaphragm**, the **psoas major**, the **psoas minor**, the **iliacus muscle**, and the **quadrates lumborum**.

**Diaphragm**

This is an important respiratory muscle. It forms the upper limit of the posterior abdominal wall. It contains three apertures: the **inferior vena caval opening** at the level of the **T8 vertebra**, the **esophageal hiatus** at the level of the **T10 vertebra** and the **aortic hiatus** at the level of the **T12 vertebra**.

The diaphragm is composed of three parts: sternal, costal and the vertebral part.

- **Origin**: The vertebral part originates from the medial and lateral arcuate ligaments and from the lumbar vertebrae and forms the right crura. The left crura arise from the L1, L2 vertebrae, and their intervertebral discs. The coastal part arises from the lower six ribs (7th to 12th rib) and their costal cartilages. Lastly the sternal part. It consists of small left and right strips that arise from the posterior surface of the xiphoid process.
- **Insertion**: The diaphragm is inserted into the central tendon: that is a thin but strong aponeurosis that provides attachment (insertion) for the moving end of the muscle fibers.
- **Nerve supply**: The motor nerve supply of the diaphragm is mainly by the phrenic nerve. It is formed within the cervical plexus and has nerve fibres from the third, fourth and fifth cervical nerves (C3-C4–C5).
- **Actions**: It is the main muscle of respiration. During inspiration, it causes lung expansion while during expiration it reduces thoracic cavity volume.

**Psoas major**

- **Origin**: from the transverse processes, sides of vertebral bodies and the intervertebral discs of the lumbar vertebrae.
- **Insertion**: lesser trochanter of the femur as the iliopsoas muscle
- **Nerve supply**: L2–L4 anterior rami from the lumbar plexus
- **Actions**: it flexes the thigh at the hip and helps to laterally flex the trunk when sitting.

**Psoas minor**

It is located in front of the psoas major and is present in only 60% of individuals

- **Origin**: from the T12 and L1 vertebral bodies
- **Insertion**: attaches to the pectineal line on the superior pubic ramus
- **Nerve supply**: anterior rami of L1 spinal nerve
- **Actions**: flexes the vertebral column.

**Iliacus**

This is a flat-shaped muscle which along with the psoas major forms the iliopsoas - a major flexor of the thigh. The iliopsoas is considered as a muscle of locomotion due to its insertion and attachment to the lower limb.

- **Origin**: Iliac crest.
- **Insertion**: lesser trochanter of the femur as iliopsoas.
- **Nerve supply**: femoral nerve (L2 –L4).
- **Actions**: flexes the thigh.

**Quadratus lumborum**

- **Origin**: from the transverse processes of the lumbar vertebrae and the 12th rib.
- **Insertion**: iliac crest.
- **Nerve supply**: L1-L4 nerves.
- **Actions**: it laterally flexes and extends the vertebral column.

**Vasculature of the Posterior Abdominal Wall**

**Abdominal aorta**

It enters the abdomen through the *aortic hiatus in the diaphragm* at the level of the T12 vertebra, runs down anterior to the lumbar vertebrae and then divides into the *common iliac arteries* at L4. Point of reference: the umbilicus.

The common iliac artery further divides into the *internal iliac* (which supplies the pelvis) and the *external iliac* (which supplies the lower limb). The abdominal aorta gives off the following branches:

- **Unpaired visceral**: to the GI tract e.g. *celiac trunk, superior and inferior mesenteric arteries*
- **Paired visceral**: to the kidneys e.g. middle suprarenal, renal and testicular and ovarian arteries
- **Paired parietal posterior branches**: e.g. lumbar arteries, inferior phrenic artery, median sacral artery.

**Inferior vena cava**

It is formed at the level of the L5 vertebra by the two *common iliac veins*. It then ascends to the right of the aorta and leaves the abdominal cavity at the level of the T8 vertebra through the caval opening in the diaphragm. It receives blood from the lower limbs, abdomino-pelvic organs via the portal system and the posterior body wall.

The main tributaries draining into the inferior vena cava are:

- Renal veins
- Right gonadal vein (the left gonadal enters the left renal vein which drains into the Inferior vena cava)
- Suprarenal veins
- Hepatic veins

**Nerves**
Subcostal nerve: the T12th thoracic nerve.

Somatic nerves: they contain both sensory and motor fibres which supply the skin of the abdomen and the skeletal musculature.

Lumbar plexus: is known for its variable pattern of branching nerves which supply the abdominal wall. It consists of ilioinguinal (L1) nerve, iliohypogastric nerve (L1), genitofemoral (L1-2), branches to the psoas major and minor, nerve to the quadratus lumborum, nerve to the superior and inferior gluteal muscles, nerve to the obturator internus, quadratus lumborum, piriformis, lateral cutaneous nerve of the thigh (L2-3), obturator nerve (L2-4), femoral nerve (L2-4), sciatic nerve, pudendal nerve, nerve to the pelvic diaphragm and pelvic splanchnic nerve.

Lumbosacral trunk (L4-5) is considered to be a part of the sacral plexus.

Lymphatics and Lymph Nodes

Several lymphatics and lymph nodes are located beside the vascular channels running along the posterior abdominal wall. These include the inferior phrenic nodes, the lateral and pre-aortic nodes (the celiac, superior and inferior mesenteric nodes) and the lumbar nodes.

They all drain the abdominal viscera into the cisterna chyli through the right and the left lumbar and intestinal trunks. The cisterna chyli runs along the right side of the vertebral column and represents the abdominal part of the thoracic duct.

The lymph from the musculoskeletal structures and tissues of the posterior abdominal wall drains to the lateral aortic and retro-aortic lymph nodes. Either side of the upper part of the posterior abdominal wall drains into the ipsilateral axillary lymph nodes.
Posterior Abdominal Fascia

A continuous sheet of fascia covers the posterior abdominal muscles and connects to the parietal peritoneum. It is also connected and continuous with the anterolateral abdominal wall fascia – the transversalis fascia. The posterior abdominal wall fascia is named according to the structures which it overlies.

Thoracolumbar fascia

This fascia consists of a posterior, a middle and an anterior layer. The anterior layer is attached to the iliac crest, the anterior part of the transverse processes of lumbar vertebrae and the 12th rib. Superiorly, it thickens to form the lateral arcuate ligament and laterally it is continuous with the aponeurosis of the transversus abdominis muscle.

The posterior layer of the thoracolumbar fascia stretches from the 12th rib to the iliac crest and laterally extends to the internal oblique and transversus abdominis muscles. It overlies the latissimus dorsi muscle.

The anterior and middle layer of the thoracolumbar fascia encloses the quadratus lumborum muscle while the middle and posterior layers enclose the deep muscles of the back.

Psoas fascia

This fascia is attached to the lumbar vertebrae and is continuous with the iliac fossa inferiorly and the thoracolumbar fascia laterally. It derives its name from the fact that it overlies the psoas major muscle.

Iliac fascia

This fascia cannot be recognized as a distinct entity from the thoracolumbar fascia. It is inserted into the inner side of the iliac crest.

Lumbar Triangles

The lumbar triangles are two. The inferior lumbar (Petit) triangle and the superior lumbar(Grynfeltt) triangle. The inferior triangle lies superficially and for this reason, it is often referred to as simply the lumbar triangle. The superior triangle however, is deep and is more consistently found in cadavers and is more commonly the site of herniation.
Inferior lumbar triangle (Petit’s)

The boundaries of the triangle are:

- Anterior: external oblique
- Posterior: latissimus dorsi
- Inferior: iliac crest
- Floor: internal oblique

Superior lumbar triangle (Gyrnfelt-Lesshaft)

The boundaries of the triangle are:

- Roof: external oblique
- Floor: transversalis fascia
- Superiortly: 12th rib
- Medially: quadratus lumborum
- Laterally: internal oblique

Organs in the Posterior Abdominal Wall

The following organs are related to the posterior abdominal wall: 2nd and 3rd part of the duodenum, the pancreas, the kidneys, the suprarenal glands and the ureters.
Clinical Relevance of the Posterior Abdominal Wall

Low back pain

This is one of the commonest disorders affecting the musculoskeletal structures of the posterior abdominal wall. In a majority of the cases, the cause for the pain cannot be identified and is labeled as muscle strain.

Usually, the pain is relieved with pain medication and activity as tolerated. Surgery may be indicated in chronic, unrelenting back pain due to intervertebral disc herniation or spinal canal stenosis with accompanying neurological deficits or disability.

Renal diseases/enlargement

The kidneys can be clinically examined through the costovertebral angle of the posterior abdominal wall. The angle is formed by the 12th rib and the vertebral column.

Enlarged kidneys can be palpated by ballottement while the patient is supine. Costovertebral angle tenderness may indicate pylonephritis which is an inflammation of the kidneys. Enlarged kidneys may indicate either a tumor or hydronephrosis.

Psoas sign

This clinical sign is an indication of irritation of the iliopsoas muscle. A positive psoas sign on the right is indicative of acute appendicitis. The sign can be elicited by asking the patient to flex the hip. The sign is considered positive if the patient has pain and is unable to flex the hip.
Psoas abscess

Rarely an abscess can form along the psoas muscle primarily (S. aureus, P. aeruginosa) and more often secondary to vertebral body infection or appendix infection (E. coli, streptococci or M. tuberculosis). Patients may present with fever and difficulty flexing their hip (positive psoas sign). Surgical drainage may be required to treat this abscess.

Trans-psoas approach

This is a minimally invasive approach to the lumbar and thoracic vertebral bodies and intervertebral discs used for fusing vertebral bodies. It has gained popularity in recent times as it is associated with reduced blood loss, shorter operative time as well as short hospital stays and lesser post-operative morbidity and pain. However, this approach can be associated with intra-operative vascular injuries (to the great vessels) and post-operative neurological deficits.

Diaphragmatic paralysis

This can occur due to phrenic nerve lesion, cervical cord injury or brainstem lesion. The commonest cause is traumatic damage or compression of the phrenic nerve or myopathy/neuropathy.

Diaphragmatic paralysis causes paradoxical movement of the diaphragm. Unilateral paralysis is usually asymptomatic but bilateral paralysis can lead to orthopnea, poor exercise tolerance and respiratory fatigue, as the diaphragm is the main muscle of respiration at rest.

Posterior abdominal hernias

This condition is also called lumbar hernias. These can occur through the superior triangle (triangle of Grynfelt-Lesshaft) or the inferior triangle (Petit’s triangle) which are rare. They may be either congenital or acquired.
Congenital lumbar hernias are more common than the acquired type. Acquired hernias may be either primary or secondary.

Primary lumbar hernias occur spontaneously while secondary hernias follow infection, trauma or a surgical procedure. Severe blunt trauma can lead to “diffuse” hernias by devascularization or scarring of muscles. These hernias are not through the two lumbar triangles and are difficult to repair. They are diagnosed clinically as they present with flank hematomas or ecchymoses, bulges or localized or referred pain.

The diagnosis can be confirmed with a CT scan and treatment consists of emergency celiotomy if there are associated intra-abdominal injury to organs associated with trauma.

References


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