

Abdomen

The abdomen is the region of the body between the thorax above and the pelvis below. It consists of a roof, an anatomically defined lower boundary, and circumferential walls that define an inner body cavity called the abdominal cavity. The abdominal cavity is more extensive than suggested on the exterior of the body; it extends superiorly beneath the thoracic cage to the diaphragm (which forms its roof) and is continuous inferiorly with the pelvic cavity. No anatomical structure separates abdomen from pelvis (accounting for the term abdominopelvic cavity and the lack of a true abdominal “floor”) and as such viscera pass uninterrupted between the two body cavities either permanently (e.g. ureters, sigmoid colon) or variably (e.g. filled vs. empty urinary bladder, gravid vs. non-gravid uterus). Nonetheless, it is customary both clinically and anatomically to address the abdominal and pelvic regions separately. The abdomen contains organs associated with the digestive, urinary, endocrine, and immune systems.

Abdominal Walls

The abdominal walls serve to protect the underlying viscera and aid in maintaining their positions within the abdominal cavity. Muscles of the abdominal walls move the trunk of the body and serve as accessory muscles of respiration. The lumbar portion of the vertebral column houses the spinal cord and cauda equina, contributes to the upright posture of humans, and transmits the weight of the trunk of the body to the lower limbs via its articulation with the sacrum. Clinically the abdominal walls are susceptible to injury and disease and many diagnostic and therapeutic procedures are performed on or through the abdominal walls.

Although continuous the walls that circumscribe the abdominal cavity are typically divided into two subregions, the anterolateral abdominal wall and the posterior abdominal wall. The two subregions are constructed differently to reflect different functions.

Endoabdominal fascia

- 1) lines the deep surface of the abdominal walls and the underside of the diaphragm
- 2) regionally named according to what it lies deep to, e.g. inferior diaphragmatic fascia, psoas fascia, etc.

Anterolateral Abdominal Wall

- 1) referred to as “the abdominal wall” by clinicians and anatomists
- 2) constructed to be pliable and distensible with broad, narrow muscles
- 3) fascia
 - a) superficial
 - i) fatty (Camper’s) layer – favorite site for fat deposition
 - ii) membranous (Scarpa’s) layer – below fatty layer, like a second layer of deep fascia; only present inferior to umbilicus
 - b) deep
- 4) aponeurosis – a broad, sheet-like tendon
- 5) anterior muscle of the abdominal wall
 - a) rectus abdominis – runs vertically; thoracic cage to pubis & pubic symphysis
 - b) rectus sheath – encloses the muscle
 - i) formed by the aponeuroses of the three lateral muscles
 - ii) anterior and posterior sides; deficient posteriorly in the lower abdominal wall
 - iii) tendinous intersections – horizontal connective tissue bands in the rectus muscle that attach to the anterior side of the sheath

- c) linea semilunaris – a slightly curved line denoting the lateral margin of the rectus muscle and sheath
- 6) three lateral muscles of the abdominal wall
 - a) external oblique – most superficial; thoracic cage to hip bone and linea alba
 - i) lower margin forms the inguinal ligament
 - b) internal oblique – intermediate layer; hip bone & inguinal ligament to thoracic cage, linea alba, & pubis
 - c) transverse abdominal – deepest; thoracic cage, hip bone, and inguinal ligament to linea alba & pubis
 - d) linea alba (L. white line) – vertical, midline fusion of the aponeuroses from the two sides of the body; the geometry of the fusion (single, double, or triple decussations) varies among individuals
- 7) functions
 - a) protect underlying viscera
 - b) help maintain the positions of viscera (support the viscera)
 - c) change body cavity pressures
 - i) increase intraabdominal pressure, e.g. defecation, vomiting, childbirth
 - ii) increase intrathoracic pressure during forced expiration, e.g. push up the diaphragm, pull down the thoracic cage [accessory muscles of respiration]
 - d) indirectly move the vertebral column (flex and rotate the trunk of the body)
 - i) anterolateral muscles often work in concert with members of the opposite side, although not necessarily their mirror images
- 8) neurovascular supply
 - a) motor and sensory innervation from anterior rami of T7 to T12 and L1 (iliohypogastric and ilioinguinal nerves)
 - i) sensory innervation to skin – T7 xiphoid, T10 umbilicus, L1 pubis
 - b) principle blood vessels
 - i) lower five posterior intercostal arteries and subcostal arteries – branches of the thoracic aorta
 - ii) lumbar arteries – 4 pairs that originate from the abdominal aorta
 - iii) superior and inferior epigastric arteries - within the rectus sheath
 - (1) superior epigastric – terminal branch of the internal thoracic artery
 - (2) inferior epigastric – branch of the external iliac artery
 - c) lymphatic drainage
 - i) skin and fascia - above umbilicus to axillary nodes, below umbilicus to superficial inguinal nodes
 - ii) abdominal wall muscles and endoabdominal fascia – follow the blood vessels supplying the region to lymph nodes near the vessel origins
- 9) umbilicus – scar marking site of attachment of the umbilical cord

Inguinal Region and Inguinal Canal

- 1) inguinal region – junction of anterolateral abdominal wall and anterior thigh; characterized by a longitudinal depression called the inguinal groove
- 2) inguinal ligament
 - a) lower margin of the aponeurosis of the external oblique muscle
 - b) attached to anterior superior iliac spine and pubic tubercle
 - c) fused to the deep fascia of the thigh
- 3) inguinal canal
 - a) an oblique passageway through the lower anterior abdominal wall that interconnects the abdominal cavity with the perineal region; up to 5 cm long in an adult
 - b) created during fetal development by the descent of the processus vaginalis

- c) transmits spermatic cord in males and round ligament of the uterus in females
- d) walls of the inguinal canal (anatomist's orientation; rotate to supine position for surgeon's orientation)
 - i) floor – inguinal ligament, i.e. curved inferior margin of aponeurosis of external oblique
 - ii) anterior wall - aponeurosis of the external oblique
 - iii) posterior wall – transversalis fascia (endoabdominal fascia deep to the transverse abdominal muscle)
 - iv) roof – arching fibers of the internal oblique and transverse abdominal muscles
- e) openings of the inguinal canal
 - i) deep (internal) inguinal ring – outpouching of the transversalis fascia; located about midway between the anterior superior iliac spine and pubic tubercle
 - ii) superficial (external) inguinal ring – a defect in the aponeurosis of the external oblique; located above and medial to the pubic tubercle
- f) support for the inguinal canal
 - i) displacement of the two openings
 - ii) muscle tone and contraction of the musculoaponeurotic structures bounding the canal – compresses the openings to the canal and the canal itself
- 4) inguinal (Hesselbach's) triangle – the portion of the abdominal wall bounded by the inferior epigastric blood vessels, the lateral border of rectus abdominis, and the inguinal ligament

Clinical Notes: 1) Herniation – the abnormal protrusion of a structure, typically an organ or part of an organ, beyond the limits of its normal confines; typically passes through a defect or natural opening in another structure. 2) Three parts of an abdominal wall hernia – a) hernial sac (a pouch of peritoneum that leads the protrusion; the neck of the sac lies at the site at which the protrusion traversed the abdominal wall), b) hernial contents (the structures, e.g. small intestine, contained within the hernial sac), and c) hernial coverings (the layers of the abdominal wall through which the hernial sac protrudes). 3) Prevalence of abdominal wall hernias - estimates are that 5% to 10% of U.S. population will develop an abdominal wall hernia over their lifetime; about 80% of the total are inguinal hernias (male prevalence of 7:1), 14% are umbilical or paraumbilical hernias (female prevalence of 2:1), 5% are femoral hernias (female prevalence of 2:1), and all else are rare at 1%. 4) Indirect inguinal hernia – a herniation through the deep inguinal ring. The hernial sac follows the path of the inguinal canal and may extend into the scrotum or labium majus; the more common of the two types of inguinal hernias. 5) Direct inguinal hernia – a herniation projecting anteriorly against the abdominal wall at the position of the inguinal (Hesselbach's) triangle; does not traverse the inguinal canal. Usually presents as a dull ache and bulge in the region of the inguinal triangle that is exacerbated with an increase in intraabdominal pressure, e.g. when coughing. 6) Major factors contributing to abdominal wall hernias – a) chronic injury, including overstretching, of musculoaponeurotic structures comprising the lower abdominal wall (e.g. direct inguinal hernias are more common in athletically competing young people than their sedentary counterparts), b) weakness and loss of muscle tone in the lower abdominal wall associated with aging, c) chronically increased intraabdominal pressure (e.g. pregnancy, chronic cough), and d) a patent processus vaginalis. 7) Femoral hernia – herniation down the femoral canal in the upper region of the anterior thigh. Femoral hernias present similarly to direct inguinal hernias, i.e. a dull aching bulge, but are located inferior to the pubic tubercle while the inguinal triangle, through which a direct inguinal hernia protrudes, lies superior to the pubic tubercle. 8) Umbilical and paraumbilical hernias – herniation through the umbilicus or the linea alba near the umbilicus. If a congenital defect at the umbilicus, so considered for all children and about 10% of adults, it is called an umbilical hernia. If there is no congenital defect then it is referred to as a paraumbilical hernia, which are most common in multiparous women (two or more pregnancies resulting in viable fetuses) and individuals with a single aponeurotic decussation of the linea alba. 9) Incisional hernia – herniation through a surgical incision or scar; over 115,000 incisional hernia repairs are performed annually in the U.S. (1999 data). 10) Three potential complications of abdominal wall hernias – a) incarceration (the hernial contents become trapped inside the hernial sac, usually due to the formation of adhesions [fibrous connections that abnormally bind structures] between the content structures and the hernial sac or adhesions around the neck of the sac; significantly complicate surgical repair), b) bowel

obstruction (blockage of the bowel lumen), and c) strangulation (a compromise in the blood supply to the hernial contents).

Surface Anatomy of the Anterolateral Abdominal Wall

Surface Landmarks

- 1) xiphoid process
- 2) costal margins
- 3) shallow skin grooves ("six pack abs") - depend on the amount of subcutaneous fat and muscle development
 - a) linea alba
 - b) lineae semilunares
 - c) tendinous intersections
- 4) umbilicus
- 5) iliac crests and anterior superior iliac spines
- 6) pubic symphysis, pubic crests, and pubic tubercles
- 7) inguinal grooves

Abdominal Quadrants

- 1) four quadrants divisible by the umbilical and median planes (horizontal and vertical planes respectively)
 - a) RUQ = right upper quadrant
 - b) LUQ = left upper quadrant
 - c) RLQ = right lower quadrant
 - d) LLQ = left lower quadrant
- 2) convenient way to reference within the abdomen, e.g. pain in the RLQ (e.g. contains the appendix) or a mass in the LUQ (e.g. enlarged spleen).
- 3) other common midline regional terms
 - a) epigastric – region between the costal margins
 - b) umbilical – region around the umbilicus
 - c) hypogastric (suprapubic) – region below the anterior superior iliac spines

Peritoneum

Peritoneum (syn. Peritoneal Membrane)

- 1) the largest serous membrane (mesothelium sitting on a loose connective tissue framework) in the human body
- 2) a continuous, uninterrupted membrane that is subdivided into
 - a) visceral peritoneum - intimately attached to the outer surface of an organ
 - b) parietal peritoneum - lines the deep surface of the abdominal walls and the inferior surface of the diaphragm; lies deep to the endoabdominal fascia
- 3) regional subdivisions of visceral peritoneum – each comprised of two layers of peritoneum
 - a) mesentery of the small intestine ("the mesentery") - attaches small intestine to the posterior abdominal wall
 - b) mesocolon - attaches large intestine (colon) to the posterior abdominal wall
 - c) omentum - attaches the stomach to other organs
 - d) peritoneal "ligaments" - attach to organs other than small intestine, colon, or stomach
- 4) functions
 - a) helps to hold viscera in position
 - b) permits viscera to change size and shape in a frictionless environment
 - c) storage site for fat

- d) conduit for the passage of the neurovascular supply to many organs
- 5) nerve and blood supply
 - a) derived from the structures over which it lies
 - b) visceral peritoneum – autonomic innervation of underlying organs
 - c) parietal peritoneum – somatic innervation of the adjacent abdominal wall or diaphragm
- 6) retroperitoneal versus intraperitoneal organs
 - a) retroperitoneal – much of the organ surface is not covered with peritoneum; organ is more fixed
 - b) intraperitoneal – most of the organ surface is covered with peritoneum; organ is more freely movable
 - c) secondarily retroperitoneal – originally intraperitoneal but later became retroperitoneal

Peritoneal Cavity & Peritoneal Fluid

- 1) peritoneal cavity
 - a) the very narrow space between opposing layers of peritoneum
 - b) very complex in its arrangement, reflecting rotation of the GI system and fusion/obliteration of different portions of the peritoneum during development; results in numerous pockets and recesses within the peritoneal cavity
 - c) two main subdivisions called greater and lesser sacs – continuous at the omental foramen (of Winslow)
- 2) peritoneal fluid – within the peritoneal cavity
 - a) production – derived from the interstitial fluid underlying the mesothelium
 - b) removal – via stoma, which are direct channel communications between mesothelial cells of parietal peritoneum and the endothelial cells of underlying lymphatic vessels
 - c) not static but continuously produced and removed
 - d) subphrenic spaces (regions of the peritoneal cavity adjacent to the diaphragm) – particularly active in the absorption of peritoneal fluid (thought facilitated by respiratory movements of the diaphragm)
- 3) abdominal ostium of a female uterine (Fallopian) tube
 - a) opening of a uterine tube into the peritoneal cavity
 - b) the only natural openings into a serous cavity in the human body
- 4) dependent areas of the peritoneal cavity – lowest regions of the peritoneal cavity as defined from the supine and erect positions of the body; supine is the hepatorenal recess between the right lobe of the liver and the right kidney, erect is the pelvic part of the peritoneal cavity.

Clinical Notes: 1) Surgical approaches - when possible abdominal surgery is performed retroperitoneally (behind the peritoneum) in order to preserve the structural integrity of the peritoneum. 2) Surgical endoscopy – a surgical approach in which small "portals" are made through the body wall for the insertion of instruments that allow the surgical procedure to be performed via video display; if the peritoneum is breached as part of the procedure, an inert gas is pumped into the peritoneal cavity to expand it and provide the surgical field. 3) Internal hernias - the entrapment of an organ, typically a loop of bowel, within an opening or recess of the peritoneal cavity. While the defect may reflect a developmental abnormality in the peritoneum, e.g. failure of obliteration/fusion of the mesocolon of the ascending or descending colon that allows the entrapment of a segment of small intestine, the most common cause of internal hernias is iatrogenic (resulting from treatment by a physician) and due to the failure of a surgeon to close a defect in the peritoneum created during a previous surgery. 4) Ascites – the abnormal accumulation of fluid in the peritoneal cavity; reflects an imbalance between fluid production and removal. Increased fluid production can result from a multitude of diseases or injuries associated with abdominal organs; the most common cause of ascites in the U.S. is cirrhosis of the liver. 5) Paracentesis – the insertion of a needle through the abdominal wall and into the peritoneal cavity for the purpose of withdrawing ascitic fluid. 6) Peritonitis – a bacterial infection of the peritoneum with resulting ascites. The origin of the bacteria is often a local source, such as a perforated hollow organ (e.g. an ulceration extending through the stomach wall) or an infection in the female genital tract that extends up the uterine tubes. 7) Guarding – sustained involuntary contraction of the abdominal wall musculature that overlies inflamed regions of the peritoneum (e.g.

appendicitis); guarding is a reflex contraction, initiated by parietal peritoneum pain fibers, that is designed to protect the underlying viscera from pressure. 8) Peritoneal dialysis - used to replace kidney function in chronic renal failure (end stage renal disease). In this procedure the peritoneal membrane serves as a semipermeable membrane placed between and in close proximity to a large volume of blood (the extensive capillaries of the vast peritoneal membrane) and a large volume of artificial fluid (the dialysate). The dialysate is placed into the peritoneal cavity and periodically replaced through cannulas implanted in the abdominal wall.

Authored by:

Raymond J. Walsh, Ph.D.

Professor & Chair

Department of Anatomy & Cell Biology

The George Washington University

School of Medicine & Health Sciences

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