Anatomy of the Peritoneum

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The peritoneum is a transparent serous membrane lining the interior of the abdominal cavity. It is extensive and encloses almost all the intra-abdominal organs.

Overview

The peritoneum is the serous membrane that forms the lining of the abdominal cavity or coelom. It covers most of the intra-abdominal (or coelomic) organs, and is composed of a layer of mesothelium supported by a thin layer of connective tissue. The outer layer, called the parietal peritoneum, is attached to the abdominal wall. The inner layer, the visceral peritoneum, is wrapped around the internal organs that are located inside the
intraperitoneal cavity. The potential space between these two layers is the peritoneal cavity.

The serous membrane forming the peritoneum is transparent and is made of mesothelium and connective tissue.

The mesothelium forms the free surface of the peritoneum and is lubricated by serous fluid (peritoneal fluid), which allows intra-abdominal organs to move easily against each other as well as against the abdominal wall.

The peritoneum supports and suspends organs within the abdominal cavity and transports arteries, veins, nerves and lymphatics.

The peritoneum is a closed sac in men while in women, the free ends of the fallopian tubes are open into the peritoneum.

The peritoneum folds into five key components (see below): the greater omentum, the lesser omentum, the falciform ligament, the small bowel mesentery, and the mesocolon. The folds extend over the viscera and also line the abdominal cavity.

Embryology of the Peritoneum

At four weeks of gestation, the mesoderm of the tri-laminar embryo gives rise to the peritoneum. During mesodermal differentiation, the lateral plate mesoderm splits into two layers which are separated by the intraembryonic coelom. The parietal and visceral peritoneum develop from these two layers of the mesoderm.

As the embryo continues to grow, at seven weeks of gestation the abdominal organs grow from structures within the abdominal wall into the abdominal cavity and are covered with a layer of peritoneum.

As the abdominal organs continue to grow, they carry their blood supply from the abdominal wall. These blood vessels are also covered by peritoneum which forms the mesentery. The ventral and dorsal mesentery of the embryo gives rise to the peritoneal folds.

Layers of the Peritoneum

The peritoneum consists of two layers with a potential space between them. The potential space is called the peritoneal cavity and the two layers are the parietal and visceral layer.

Parietal layer

This is the outer layer of the peritoneum and is attached to the pelvic and abdominal walls. One of its out-pouchings, the tunica vaginalis is derived embryologically from the somatic mesoderm. Its nerve supply is the same as that of the abdomino-pelvic wall, which it lines. For this reason the parietal peritoneum is sensitive to somatic pain, pressure and temperature and its pain is well localized.
Visceral layer

The visceral layer is the inner layer of the peritoneum and it envelops almost all the abdominal organs. It is thinner than the parietal peritoneum.

Embryologically, it is derived from the splanchnic mesoderm and has the same nerve supply as the abdominal organs that it covers. So the visceral peritoneum is only sensitive to stretch and chemical irritation while pain originating from it is poorly localized. Pain can be referred to the cutaneous dermatomes innervated by the sensory ganglia and the spinal cord segments innervating the abdominal organs it covers.

Peritoneal Cavity

This is a potential space between the visceral and parietal peritoneum. It normally contains 100ml of serous lubricating fluid. It forms the dialysate compartment during peritoneal dialysis through which solutes can be exchanged with blood.

The lymphatic system drains the peritoneal cavity and the 70-80% of the peritoneal lymphatic flow is through the subdiaphragmatic lymphatic system, which also removes macromolecules and foreign substances.

According to the three-pore model, solute and water transport occurs across the peritoneal capillary through pores of various sizes and the critical barrier to peritoneal transport is the peritoneal capillary system. The peritoneal surface area can be affected in peritonitis.

Subdivisions of Abdominal Organs

The abdominal organs can be subdivided into intraperitoneal, retroperitoneal, secondary retroperitoneal and infra-peritoneal depending on whether the visceral peritoneum envelops them or whether they are connected by the mesentery.

Intra-peritoneal

This includes organs which are completely surrounded by the visceral peritoneum, e.g. stomach, first part of duodenum, jejunum, ileum, cecum, appendix, transverse colon, sigmoid colon, upper 1/3rd of rectum, liver, spleen and tail of pancreas.

Primarily retro-peritoneal

This refers to organs which are located between the posterior abdominal wall and the peritoneum, e.g. kidneys, adrenal glands, proximal ureters, renal vessels, second and third part of duodenum, ascending colon, descending colon, middle 1/3rd of the rectum, pancreas (except the tail), blood vessels to the gonads, uterus, fallopian tubes, aorta and inferior vena cava.

Secondarily retroperitoneal

This includes abdominal organs which were formed intra-peritoneally during embryonic life, later lost their mesentery and became retroperitoneal as the small intestine expanded. So, only their anterior surface is covered with peritoneum, e.g. ascending and descending colon (but not the transverse colon, sigmoid or the cecum), the head, neck,
and body of the pancreas (but not the tail, which is located in the splenorenal ligament),
the duodenum, except for the proximal first segment, which is intraperitoneal.

**Infra-peritoneal or subperitoneal**

These are organs located below the intraperitoneal space (or peritoneal cavity), e.g. the lower 1/3rd of the rectum, urinary bladder and distal ureters.

**Peritoneal Folds and Ligaments**

The peritoneum is a complex membrane which forms folds, covers various abdominal organs and contains neurovascular structures within its folds. The peritoneal folds connect the various organs to the abdominal wall or to each other.

The peritoneal folds include the *omenta* (greater and lesser omentum), the *mesentery*, and the *ligaments*.

The *omentum* is a layer related to the stomach and divided into the greater omentum and lesser omentum. The omenta is fat laden, which helps to keep the intra-abdominal organs warm and contains infections, such as perforations and abscesses.

**Greater omentum**

This layer is fat laden and stretches down from the greater curvature of the stomach and the anterior aspect of the proximal duodenum like an apron and then turns upwards to attach to the anterior surface of the transverse colon.

It prevents the visceral peritoneum from adhering to the parietal peritoneum. It is very mobile, acts like a protective covering, has a role in *immunity* and is often called the *abdominal policeman* as it can move to *surround and seal inflamed organs*. It consists of three ligaments:

- **Gastrocolic** – extending from the stomach to the transverse colon
- **Gastrosplenic** – stretching from the stomach to the spleen
- **Gastrophrenic** – stretching from the stomach to the diaphragm

**Lesser omentum**

This extends from the lesser curvature of the stomach and first part of the duodenum to the liver. The free edge of the lesser omentum contains the *epiploic foramen*. The lesser omentum has two ligaments: *the hepatoduodenal* and *the hepatogastric ligament*.

Other ligaments and folds include the falciform ligament, the round ligament of the liver, coronary ligament, ligamentum venosum, phrenocolic ligament, left and right triangular ligaments of the liver, the umbilical folds, the ileocecal fold, the broad ligament of the uterus, the ovarian ligaments and the suspensory ligament of the ovary.

The *mesentery* is fan shaped, formed by two layers of the visceral peritoneum and connects intraperitoneal organs to the posterior abdominal wall and conveys neurovascular structures as well as lymphatics from the abdominal wall to the organs.

The mesentery is thicker than the omenta. While the mesentery connected to the small intestine is called “mesentery”, the mesentery connecting other organs is named
according to the organ it is attached to, e.g. mesoappendix, mesocolon etc.

The greater sac is the intra-abdominal cavity and is divided into the supra-colic and the infra-colic compartments.

The supra-colic compartment contains the stomach, spleen and the liver while the infra-colic compartment has the small intestines, the ascending and the descending colon. The space between the parietal peritoneum covering the right kidney and the liver is called hepato-renal pouch or Morrison pouch, and is the lowermost recess of the peritoneal cavity in the supine position. The infra-colic compartment is further divided into two compartments by the mesentery. The supra and infra-colic compartments communicate freely via the paracolic gutters.

The lesser sac is also called the omental bursa. It is located posterior to the stomach and the lesser omentum. It is related anteriorly to the stomach/lesser omentum, posteriorly to the pancreas, laterally to the spleen and medially to the caudate lobe of the liver.

The greater and lesser sacs are connected to each other through the epiploic foramen, which is bounded by the hepatoduodenal ligament (portal triad) anteriorly, by the inferior vena cava posteriorly, the caudate lobe of the liver superiorly, and the first part of the duodenum inferiorly.

In the pelvic cavity, several peritoneal folds are defined by the areas which they are related to e.g. rectovesical pouch between the rectum and urinary bladder in men (the lowermost space of the peritoneal cavity in men in a standing position), rectouterine pouch between the rectum and uterus in women (the lowermost space of the peritoneal cavity in women in a standing position), vesicouterine pouch between the urinary bladder and the uterus in women, pararectal fossa surrounding the rectum in men and women, paravesical fossa surrounding the urinary bladder in men and women.
Clinical Relevance of the Peritoneum

Peritonitis

Peritonitis is a condition in which rupture of an infected abdominal organ, commonly the appendix, or a hollow viscus (commonly a diverticulum of the sigmoid colon) leads to inflammation of the peritoneum.

It is characterized by severe abdominal pain, vomiting and fever. It can be diagnosed clinically by palpation and percussion. The patient will wince and guard the abdominal wall when it is tapped with a percussing finger or when the abdominal wall is gently depressed and then released.

Emergency surgery to remove the infection and repair the viscera may be required as frequently antibiotics are unable to contain the infection.

Peritoneal adhesions

Following infection, injury or surgery, there is inflammation followed by healing of the peritoneum with fibrosis and scar formation. This leads to scar tissue connecting the visceral peritoneum of adjacent organs abnormally or formation of abnormal connections between the parietal and visceral layers of the peritoneum.

Peritoneal adhesions can lead to pain, bowel obstruction and volvulus. The treatment is usually symptomatic but surgical division of adhesions may occasionally be necessary.

Peritoneal dialysis (PD)

In patients with chronic kidney disease, peritoneal dialysis is an alternative method to hemodialysis in order to remove impurities from the blood.
In this method, the patient's own peritoneum functions as a membrane through which various substances in the blood like glucose, electrolytes, urea, smaller molecules and other active osmotic particles can be exchanged.

A permanent tube is surgically introduced in the patient's abdomen through which the exchange can be performed either every night in **automatic peritoneal dialysis** or all day in **continuous ambulatory peritoneal dialysis**. It is a cheaper method of dialysis as the patient does not have to visit a dialysis unit periodically and the process can be performed at the patient's home.

The main complication of PD is **infection** due to an indwelling peritoneal catheter. The disadvantage of PD is that it is less effective as compared to hemodialysis in removing wastes from the body.

**Peritoneal metastasis**

It is also called **peritoneal carcinomatosis** and is often encountered in **abdominal and pelvic tumors**. It is associated with a poor prognosis.

The common sites of the primary tumor are ovaries, stomach, esophagus, colon-rectum, appendix, gallbladder, pancreas and primary peritoneal malignancy.

Patients may be asymptomatic or may present with abdominal bloating or distension or features of bowel obstruction.

Diagnosis is confirmed radiologically with **abdominal ultrasonography**, **CT scan** or **MRI**. Of these, MRI is the most sensitive modality in detecting metastasis. The treatment is palliative.

**Primary peritoneal cancer (PPC)**

This is a rare type of cancer related to **epithelial ovarian cancer**. The cause of PPC is unknown. It is relatively more common in women. It affects the surface of any of the organs within the peritoneum. The symptoms are similar to those in ovarian cancer and are often due to **ascites**. Treatment involves **chemotherapy** and **palliative therapies**.
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