Peritoneum

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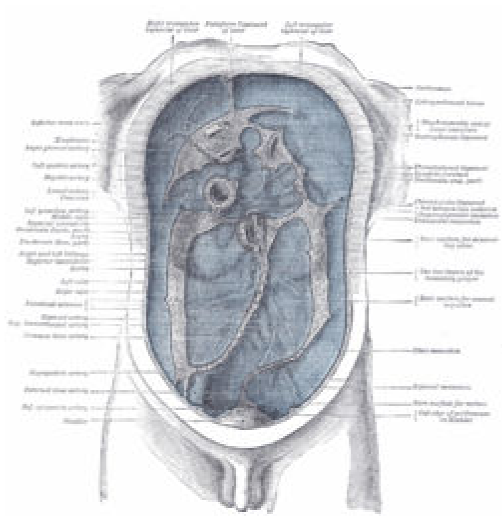
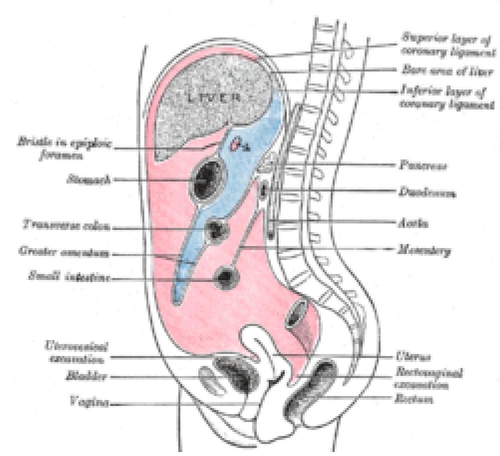


The peritoneum, coloured in blue



The epiploic foramen, greater sac or general cavity (red) and lesser sac, or omental bursa (blue). (Areas outlined in blue and red correspond to above diagram.)

In higher vertebrates, the peritoneum is the serous membrane that forms the lining of the abdominal cavity - it covers most of the intra-abdominal organs. It is composed of a layer of mesothelium supported by a thin layer of connective tissue.

The peritoneum both supports the abdominal organs and serves as a conduit for their blood and lymph vessels and nerves.

Structure

Layers

Do not confuse the abdominal cavity (the space bounded by the vertebrae, abdominal muscles, diaphragm and pelvic floor) with the intraperitoneal space (located within the abdominal cavity, but wrapped in peritoneum). For example, a kidney is inside the abdominal cavity, but is retroperitoneal.

Although they ultimately form one continuous sheet, two types or layers of peritoneum and a potential space between them are referenced:

- 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; it is filled with a small amount (about 50 ml) of slippery serous fluid that allows the two layers to slide freely over each other.
- The term mesentery is often used to refer to a double layer of visceral peritoneum. There are often blood vessels, nerves, and other structures between these layers. It should be noted that the space between these two layers is technically outside of the peritoneal sac, and thus not in the peritoneal cavity.

Subdivisions

There are two main regions of the peritoneum, connected by the epiploic foramen:

- the greater sac (or *general cavity of the abdomen*), represented in red in the diagrams above.
- the lesser sac (or *omental bursa*), represented in blue. The lesser sac is divided into two "omenta":
  - The lesser omentum (or *gastrohepatic*) is attached to the lesser curvature of the stomach and the liver.
  - The greater omentum (or *gastrocolic*) hangs from the greater curve of the stomach and loops down in front of the intestines before curving back upwards to attach to the transverse colon. In effect it is draped in front of the intestines like an apron and may serve as an insulating or protective layer.

The mesentery is the part of the peritoneum through which most abdominal organs are attached to the abdominal wall and supplied with blood and lymph vessels and nerves.

Structures include:

SOURCES	STRUCTURE OMENTA	FROM	TO	CONTAINS
dorsal mesentery	* greater omentum	greater curvature of stomach (and spleen)		
dorsal mesentery	** gastrosplenic ligament	stomach	spleen	short gastric artery, left gastro-omental artery
dorsal mesentery	** gastrophrenic ligament	stomach	diaphragm	-
dorsal mesentery	** gastrocolic ligament	stomach	transverse colon	-
dorsal mesentery	** splenorenal ligament	spleen	kidney	splenic artery, tail of

				pancreas
ventral mesentery	* lesser omentum	lesser curvature of the stomach (and duodenum)		
ventral mesentery	** hepatogastric ligament	stomach	liver	
ventral mesentery	** hepatoduodenal ligament	duodenum	liver	hepatic artery proper, hepatic portal vein, bile duct
	MESENTERIES			
dorsal mesentery	* Mesentery proper	small intestine – jejunum and ileum	posterior abdominal wall	superior mesenteric artery
dorsal mesentery	* transverse mesocolon	transverse colon	posterior abdominal wall	middle colic
dorsal mesentery	* sigmoid mesocolon	sigmoid colon	pelvic wall	sigmoid arteries
dorsal mesentery	* mesoappendix	mesentery of ileum	appendix	appendicular artery
	OTHER LIGAMENTS AND FOLDS			
ventral mesentery	* falciform ligament	liver	thoracic diaphragm, anterior abdominal wall	round ligament of liver, paraumbilical veins
left	* round ligament	liver	umbilicus	

umbilical vein	of liver			
ventral mesentery	* coronary ligament	liver	thoracic diaphragm	
ductus venosus	* ligamentum venosum	liver	liver	
	* phrenicocolic ligament	left colic flexure	thoracic diaphragm	
ventral mesentery	* left triangular ligament, right triangular ligament	liver		
	* umbilical folds	urinary bladder		
	* ileocecal fold	ileum	cecum	
	* broad ligament of the uterus	uterus	pelvic wall	mesovarium, mesosalpinx, mesometrium
	* ovarian ligament	uterus	inguinal canal	
	* suspensory ligament of the ovary	ovary	pelvic wall	ovarian artery

In addition, in the pelvic cavity there are several structures that are usually named not for the peritoneum, but for the areas defined by the peritoneal folds:

Name	Location	Genders possessing structure
Rectovesical pouch	between rectum and urinary bladder	male only
Recto uterine	between rectum and	female only

pouch	uterus	
Vesicouterine pouch	between urinary bladder and uterus	female only
Para rectal fossa	surrounding rectum	male and female
Para vesical fossa	surrounding urinary bladder	male and female

Development

The peritoneum develops ultimately from the mesoderm of the trilaminar embryo. As the mesoderm differentiates, one region known as the lateral plate mesoderm splits to form two layers separated by an intraembryonic coelom. These two layers develop later into the visceral and parietal layers found in all serous cavities, including the peritoneum.

As an embryo develops, the various abdominal organs grow into the abdominal cavity from structures in the abdominal wall. In this process they become enveloped in a layer of peritoneum. The growing organs "take their blood vessels with them" from the abdominal wall, and these blood vessels become covered by peritoneum, forming a mesentery.

Clinical aspects

Pathology

- Pneumoperitoneum is the presence of gas within the peritoneal cavity, as may occur when a perforation forms in the stomach or intestines, and heralds a perilous situation.
- Peritonitis refers to inflammation of the peritoneal lining or cavity, as may occur with either a perforation or by spread of infection through the wall of one of the abdominal organs. This too is a serious condition, and often requires emergency surgery.

- Ascites is an accumulation of excess fluid within the peritoneal cavity.

Peritoneal dialysis

In one form of dialysis, the peritoneal dialysis, a glucose solution is run through a tube into the peritoneal cavity. The fluid is left there for a prescribed amount of time to absorb waste products, and then removed through the tube. The reason for this effect is the high number of arteries and veins in the peritoneal cavity. Through the mechanism of diffusion, waste products are removed from the blood.

Classification of abdominal structures

The structures in the abdomen are classified as intraperitoneal, retroperitoneal or infraperitoneal depending on whether they are covered with visceral peritoneum and have a mesentery or not.

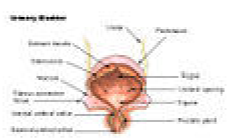
Intraperitoneal	Retroperitoneal	Infraperitoneal / Subperitoneal
Stomach, First part of the duodenum [5 cm], jejunum, ileum	The rest of the duodenum	
Cecum, appendix, transverse colon, sigmoid colon	Ascending colon, descending colon	
Rectum, upper 1/3	Rectum, middle 1/3	Rectum, lower 1/3
Pancreas (tail), liver, spleen	Pancreas (head and body)	
	Kidneys, suprarenal glands, ureters, renal vessels	Urinary bladder, ureters(end)
In women: Uterus, Fallopian tubes, ovaries	Gonadal blood vessels	
	Inferior vena cava,	

Aorta

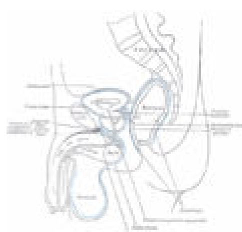
Structures that are *intraperitoneal* are generally mobile, while those that are *retroperitoneal* are relatively fixed in their location.

Some structures, such as the kidneys, are "primarily retroperitoneal", while others such as the majority of the duodenum, are "secondarily retroperitoneal", meaning that structure developed intraperitoneally but lost its mesentery and thus became retroperitoneal.

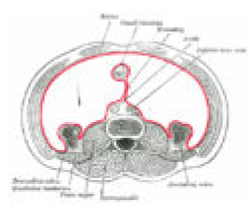
Additional images



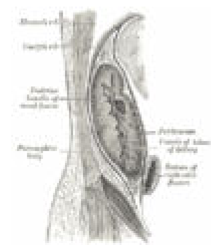
Bladder



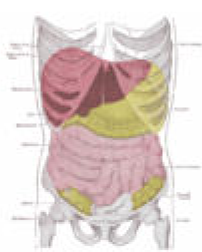
Median sagittal section of pelvis, showing arrangement of fasciæ.



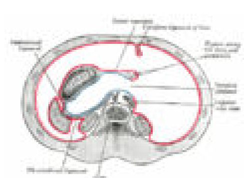
Horizontal disposition of the peritoneum in the lower part of the abdomen.



Sagittal section through posterior abdominal wall, showing the relations of the capsule of the kidney.



Topography of thoracic and abdominal viscera.



Horizontal disposition of the peritoneum in the upper part of the abdomen

Peritoneal ligaments, mesenteries, and folds	
From ventral mesentery	Lesser omentum: Hepatoduodenal ligament - Hepatogastric ligament Liver: Coronary ligament (Left triangular ligament, Right triangular ligament, Hepatorenal ligament) - Falciform ligament (Round ligament of liver and Ligamentum venosum *in* it, but not *of* it)
From dorsal mesentery	Greater omentum: Gastrophrenic ligament - Gastrocolic ligament - Gastrosplenic ligament Mesentery: Transverse mesocolon - Sigmoid mesocolon - Mesoappendix - Root of the mesentery Splenorenal ligament - Phrenicocolic ligament
Uterus/ovaries	Broad ligament of the uterus (Mesovarium, Mesosalpinx, Mesometrium) - Ovarian ligament - Suspensory ligament of the ovary
Folds	Umbilical folds (Supravesical fossa, Medial inguinal fossa, Lateral inguinal fossa) - Ileocecal fold - Recto uterine folds
Recesses	Recto uterine pouch - Vesicouterine excavation - Rectovesical excavation - Pararectal fossa - Paravesical fossa
Peritoneal cavity	Greater sac - Lesser sac - Foramen of Winslow

Etymology

Peritoneum is derived from Greek. *Peri-* means *around*, while *-ton-* refers to stretching. Thus, peritoneum means *stretched around* or *stretched over*.

Diagnosis and Surgical Management of Peritonitis

The peritoneum is a bi-directional, semi permeable barrier and it is important for the surgeon to consider that the circulation and dispersal of fluids within the peritoneal cavity are dynamic processes. Water and low molecular weight solutes diffuse between sub-mesothelial capillaries and the peritoneal fluid according to Starlings Law. Pressure in the capillaries of the visceral peritoneum are higher than elsewhere in the body due to resistance to portal blood flow; therefore, the peritoneal cavity is more susceptible to the accumulation of excessive fluid than most other body cavities.

Fluids move ventrally and cranially as a result of gravity and diaphragm movement. Lymphatic drainage from the diaphragmatic peritoneum is the most important means of keeping the peritoneal cavity from filling with fluid; the diaphragm acts as a muscular pump which contracts to drive fluid into the lymphatics. Inflammation within the peritoneal cavity will result in blockage of the lymphatics, which causes fluid accumulation. Increased protein in the peritoneal fluid and therefore increased colloid oncotic pressure, leads to the attraction of still more fluid from the intravascular and interstitial spaces.

Peritonitis can be classified as either primary or secondary. Primary peritonitis is inflammation of the peritoneum without initial intra-abdominal pathology, such as feline infectious peritonitis. Secondary peritonitis, which makes up 99% of all cases of peritonitis, is inflammation of the peritoneum subsequent to contamination due to abdominal cavity disruption or hollow viscus disruption. Secondary peritonitis can be further classified as aseptic (due to foreign body, chemical, or mechanical irritation), septic/infectious peritonitis, or miscellaneous (including contamination secondary to vascular diseases, neoplasms, allergy, etc.).

Septic peritonitis occurs when bacterial endotoxin and cellular proteases activate the complement cascade. This causes peritoneal vascular dilation and increased capillary permeability, which allows significant quantities of fluid, electrolytes, plasma proteins and red blood cells to accumulate in the peritoneal cavity. As the free abdominal fluid becomes turbid /purulent, the lymphatics are blocked with fibrin and cellular debris, and even more fluid accumulates. Systemic hypovolemic and septic shock results as there is loss of circulating fluid volume and further absorption of bacterial endotoxins and exotoxins.

Clinical signs of a patient with peritonitis can range from extremely mild and non-specific, to severe. Symptoms may include lethargy, anorexia, vomiting, diarrhea, abdominal pain, pyrexia, collapse and shock. History and signalment in combination with the above symptoms should prompt further diagnostics.

The diagnosis of peritonitis can be made by visualization of free air or fluid in the abdomen on plain radiographs, by abdomenocentesis and cytology, and by diagnostic peritoneal lavage. It is important to remember that a mild inflammatory reaction is produced every time the peritoneal cavity is entered surgically, and that air introduced into the abdomen during surgery can be seen on radiographs for at least one week post-operatively. Cytologic evaluation of abdominal fluid can reveal the hallmarks of septic peritonitis: degenerate neutrophils with intracellular bacteria, and possibly organic debris. Bile peritonitis can be diagnosed reliably by comparing the bilirubin concentration of the abdominal effusion to the serum bilirubin concentration: the abdominal effusion will yield a bilirubin concentration at least twice that of the serum.

Immediate medical management prior to emergency surgery should include aggressive shock therapy, and correction of metabolic and acid-base imbalances, Colloids and/or blood products may be indicated based on clinical signs and initial blood work results. Potassium and blood glucose concentrations must be evaluated. Broad spectrum antibiotic therapy should be initiated immediately, unless emergency surgery can be performed promptly and there is desire for abdominal fluid culture/sensitivity. A "safe" antimicrobial protocol includes a fluoroquinolone plus metronidazole.

The goals of exploratory surgery are to arrest ongoing contamination, remove all foreign and purulent material, and to provide drainage of the peritoneal exudate. Provision for enteral nutritional support should also be considered via placement of gastrostomy or jejunostomy feeding tubes. Complete exploration and assessment of all abdominal structures is vital. Leaking viscus structures must be repaired or resected. Cholecystectomy is preferred to repair of a necrotizing gall bladder with poor viability. A thorough and exhaustive lavage of the entire peritoneal cavity is absolutely crucial, with complete removal of all free fluid.

Drainage of the abdomen may be accomplished by placement of peritoneal drains or by open abdominal management. Most peritoneal drains will seal within 6 hours due to fibrin/adhesions or omentum, and Penrose drains are relatively worthless to maintain abdominal fluid drainage. Commercial silastic peritoneal column disc catheters seem the preferable method of providing continuous drainage; omentectomy must be performed to allow any drains to function. Open abdominal drainage has been the mainstay of management of peritonitis, but the morbidity and effort/expense to manage these patients is not to be underestimated. Open drainage requires aseptic technique and usually general anesthesia during bandage changes, which may be as frequent as every 4 hours initially.