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Anatomy and physiology of the peritoneum

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ABSTRACT

The peritoneum is commonly encountered in abdominal surgery. The development and rotation of the primitive gut tube lead to the normal adult arrangement of the peritoneal cavity, which forms bloodless planes allowing the retroperitoneal portions of the bowel to be safely mobilised. The arrangement of the peritoneum also forms spaces in which infected fluid or pus can collect. The microcirculation of peritoneal fluid is now well understood, and the large absorptive surface of the peritoneum can be exploited in peritoneal dialysis. The absorption of gas by the peritoneum following abdominal surgery is faster in neonates than in older children, and understanding this process contributes to the interpretation of post-operative radiographs.

Introduction

An understanding of the normal anatomy and function of the peritoneum is essential to the understanding of abdominal and groyne surgery in children. This article addresses the embryology, anatomy and physiology of the peritoneum as a prelude to the articles that follow in this issue and provides an aid in understanding this important layer of tissue.

The anatomy of the peritoneum

Embryology

The peritoneum is derived from the mesoderm lining the body cavity of the primitive embryo. Within this body cavity, the primitive gut tube is formed. It is described to have a parietal layer, lining the body wall, and a visceral layer, which lies over the abdominal organs. The primitive foregut separates the upper part of the body cavity into left and right cavities by the virtue of its dorsal and ventral mesenteries. The primitive midgut and hindgut are supported by a dorsal mesentery but have no ventral mesentery.

Foregut rotation

The cavities formed within the abdominal cavity by the peritoneum are best understood by considering the rotation of the foregut separately from the midgut and hindgut (Figure 1). The foregut gives rise to the liver, within the ventral mesentery, and the spleen, within the dorsal mesentery. Rotation of the foregut then occurs 90° to the right, such that the ventral mesentery comes to lie to the right of the stomach, and the dorsal mesentery to the left. The differential growth of the contained structures then somewhat distorts this arrangement, such that the liver comes to occupy the entire right upper quadrant and the stomach takes on a curve to the right. The ventral mesentery persists as the lesser omentum, containing the common bile duct, hepatic artery and portal vein within its lower free border. The lower edge of the lesser omentum forms the anterior border of the epiploic foramen (of Winslow), which allows communication from the space in front of the stomach and its associated primitive mesenteries, the greater sac and the space behind, the lesser sac. The epiploic foramen is bordered posteriorly by the inferior vena cava, superiorly by the caudate lobe and inferiorly by the duodenum, meaning that none of its borders can be safely divided.[1] The dorsal mesentery persists as the gastro-splenic ligament, and then ensheathes the spleen, attaching to the posterior abdominal wall over the left kidney—the lieno-renal ligament (Figure 2).

Midgut rotation

The rotation of the midgut is perhaps more familiar to paediatric surgeons. The midgut is suspended by a dorsal mesentery and outgrows the body cavity, herniating through the umbilicus before returning at 8–10 weeks gestation. As it does so, it rotates through a total of 270° anticlockwise, such that the DJ flexure comes to lie on the left of the midline and the caecum in the right iliac fossa.

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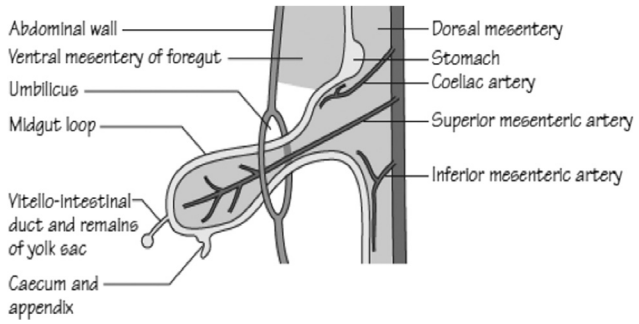

Fig. 1. Lateral view of the primitive gut tube at the point of herniation of the primitive gut tube through the umbilicus. Note the presence of a ventral mesentery to the foregut only, but a dorsal mesentery to all parts of the bowel. (Reproduced with permission from Faiz et al.[25])

The process of fixation of parts of the bowel to the posterior abdominal wall renders them "retroperitoneal," although it should be remembered that they are not retroperitoneal in the developmental sense, but intra-abdominal. This process fuses the duodenum, ascending colon and descending colon to the posterior abdominal wall. These places of fusion (sometimes referred to as planes of Zygosis) can, of course, be divided surgically in a relatively bloodless fashion, allowing the right and left hemicolons to be mobilised without compromising their blood supply, and the duodenum to be Kocherized medially without damaging the biliary structures entering its medial side.

Peritoneal attachments

Having discussed the embryology of some of the peritoneal attachments, the course of the entire peritoneum may be considered. This can be conveniently started on the anterior abdominal wall just above the umbilicus. The parietal peritoneum inferiorly covers the anterior abdominal wall, being raised in a series of folds: the median, medial, and lateral umbilical folds. These folds overly the obliterated urachus, obliterated umbilical arteries and inferior epigastric vessels, correspondingly. The peritoneum continues down and is reflected over the dome of the bladder. In males, the peritoneum sweeps down to the back of the bladder and then onto the anterior surface of the rectum, whereas in females, it first covers the uterus before dipping down to form the recto-uterine pouch (of Douglas). The peritoneum then passes up the posterior abdominal wall before being reflected over the root of the mesentery and the small bowel. The root of the mesentery runs from the DJ flexure to the ileocecal junction. Laterally at this level, the peritoneum overlies the retroperitoneal portions of the descending and ascending colon and is reflected over the mobile sigmoid colon and caecum.

Superior to the mesenteric root, the peritoneum again gains the posterior abdominal wall and is reflected onto the inferior surface of the transverse mesocolon, before contributing to the greater omentum. At the distal limit of the greater omentum, this layer then passes over the anterior surface of the stomach and forms the anterior layer of the lesser omentum, before passing over the liver and then onto the anterior abdominal wall. The peritoneum is reflected at this level around the obliterated umbilical vein (ligamentum teres) forming the falciform ligament, which represents the most anterior remnant of the embryonic ventral mesentery.

The peritoneal lining of the lesser sac contributes to the lieno-renal and gastro-splenic ligaments before passing over the posterior wall of the stomach, where it folds into the greater omentum before passing posteriorly, covering the posterior portion of the transverse colon and gaining the posterior abdominal wall. Thus, the lesser sac can be entered surgically by creating a window in either the transverse mesocolon or the greater omentum.

Peritoneal spaces

The reflections of the peritoneum over the various viscera form a number of potential spaces, notable because they may be the site of abdominal collections. Pelvic collections can occupy the pouch of Douglas in a female. The right and left paracolic gutters may also contain fluid as may the subhepatic spaces. The right subhepatic space (Morrison's pouch) lies between the inferior portion of the liver superiorly and is related to the hepatic flexure of the colon, duodenum and right kidney posteriorly. The left subhepatic space is the lesser sac. The right subphrenic space lies above the liver and is limited by the right coronary ligament. The left is in free communication with the greater sac via the space around the anterior surface of the spleen.

Peritoneal reflections on and over the liver

The attachments of the peritoneum to the liver need to be divided if mobilisation of the liver is to be safely accomplished. The peritoneum forming the falciform ligament divides into two parts once it abuts the liver surface, thus dividing the left and right subphrenic spaces, and defining a part of the liver surface free of a peritoneal covering, the bare area (Figure 1). The right leaflet

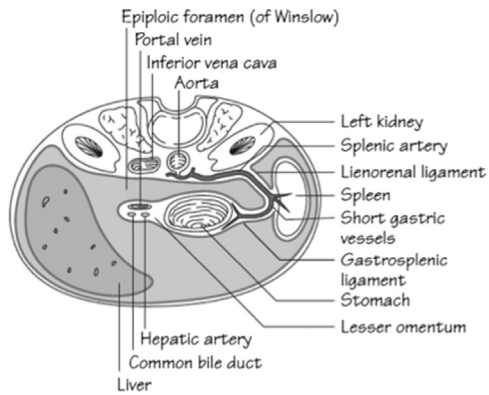

Fig. 2. Transverse section through the abdomen viewed from below and demonstrating the relationship of the lesser sac to the stomach, lieno-renal and gastro-splenic ligaments. (Reproduced with permission from Faiz et al.[25])

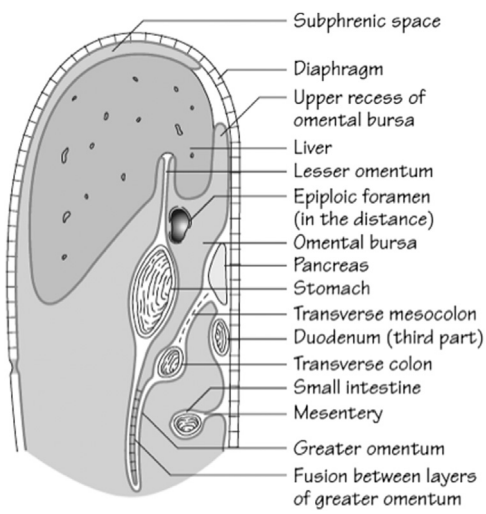

Fig. 3. Sagittal section through the abdomen demonstrating the reflection of the peritoneum over the small bowel, transverse colon, stomach and liver. (Reproduced with permission from Faiz et al.[25])