



Role of Multidetector CT in evaluation of Traumatic Retroperitoneal Injuries

Essay

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Introduction

Abdominal and pelvic trauma can cause significant and sometimes life-threatening injuries to retroperitoneal structures. Retroperitoneal injuries are known to occur in a significant minority of abdominal trauma cases (**Porter et al., 2013**).

Physical examination and laboratory tests can be unreliable in detecting abdominal injuries, particularly retroperitoneal injuries (**Fang et al., 2011**).

Bedside tests such as diagnostic peritoneal lavage and focused ultrasonography for the assessment of trauma can yield negative findings or fail to help detect signs of retroperitoneal injury, even in the presence of significant retroperitoneal injury, since these methods principally help assess the peritoneal space (**Friese et al., 2012**).

Imaging, particularly computed tomography (CT), plays a central role in the assessment of retroperitoneal structures following blunt trauma. Clinically significant imaging findings of retroperitoneal injury can be subtle initially and thus potentially overlooked unless specifically sought out on CT scans by the radiologist (**Jurkovich et al., 2011**).

Historically, conventional CT has demonstrated only limited sensitivity in identifying retroperitoneal injuries, particularly injuries of the pancreas. Only 68% of pancreatic injuries were detected with single-section helical CT in the setting of blunt abdominal trauma in a retrospective review of cases from 2011 to 2014 at a major level one trauma center (**Ilahi et al., 2012**).

CT technology has improved significantly since then with the introduction of multidetector CT. This modality offers greater acquisition

speed, improved spatial resolution, intravenously administered contrast material bolus timing, and reduced motion artifacts (*Fang et al., 2011*). Multidetector CT has recently been shown to have a high degree of accuracy in the setting of trauma, with a reported sensitivity approaching 100% for the identification of active bleeding as well as bowel, mesenteric, and pancreatic injuries in the initial assessment of blunt abdominal trauma (*Ahvenjarvi et al., 2012*).

Aim of the work

The aim of this work is to highlights the role of multidetector CT imaging in the diagnosis and characterization of retro-peritoneal organs damage after abdominal trauma.

Relevant Anatomy of the Retroperitoneal Space

A. Overview

The relevant anatomy of the retroperitoneum can be summarized as that portion of the abdomen posterior to the peritoneal cavity extending from the diaphragm to the pelvic inlet. It is separated from the peritoneum anteriorly by the posterior peritoneal fascia and is bounded posteriorly by the transversalis fascia. (Figure 1).

It contains portions of the esophagus, duodenum, colon and pancreas, as well as the kidneys, ureters, adrenal glands, abdominal aorta, and the inferior vena cava.

Traditionally, the retroperitoneum is divided up into several spaces according to their relationships to the fascial layers that surround the kidneys and ureters. In this description the layers of the perirenal fascia enclose a **perirenal space**, which contains the kidneys, upper ureters, adrenal glands, the respective neovascular supply, and the perirenal fat. The anterior layer of the perirenal fascia is continuous across the midline allowing the right and left perirenal spaces to communicate. This continuation is anterior to the neovascular structures. Anterior to the anterior layer of the perirenal fascia is the **anterior pararenal space**. This space contains the retroperitoneal segments of the abdominal esophagus; the duodenum, except for the proximal portion of the first part and the most distal portion of the fourth part; the ascending and descending colon; the pancreas, except for its tail, which is located in the splenorenal ligament; and the root of the mesentery of the small intestine (*Ahvenjarvi et al., 2013*).

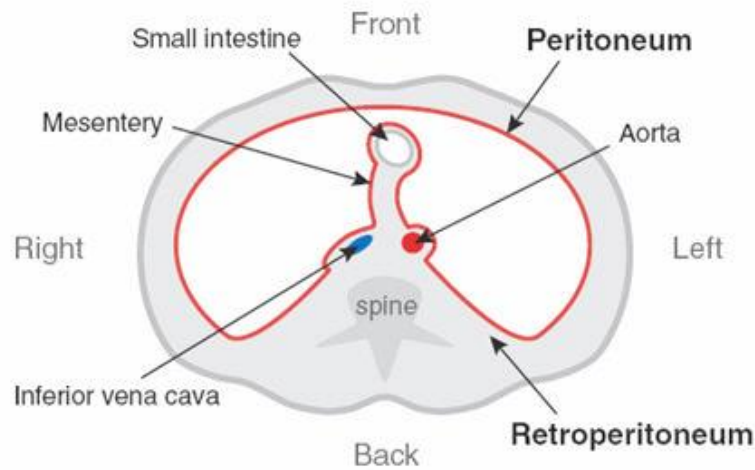


Figure 1: Drawing showing the location of the inferior vena cava and aorta in the retroperitoneal space. (Alsikafi et al., 2014).

The **anterior pararenal spaces** are also continuous across the midline and are limited posteriorly by the anterior communicating layers of the perirenal fascia and anteriorly by the parietal peritoneum. Behind the posterior layer of the perirenal fascia lies the **posterior pararenal space**, which contains only fat. These anatomic distinct spaces helps to explain why small to moderate amounts of fluid, blood or pus collecting within one or these spaces tends to remain confined to the space in which it is formed (Figure 2) (Agran et al., 2014).

However, recent evidence has demonstrated the fascia separating these spaces is arranged in a laminar fashion and shows considerable variation in the degree of fusion between the lamina thus, there are inter-fascial connections between the spaces (Alonso et al., 2013).

Consequently, retroperitoneal hemorrhage or rapidly *expanding* fluid collections can spread through these inter-fascial connections.

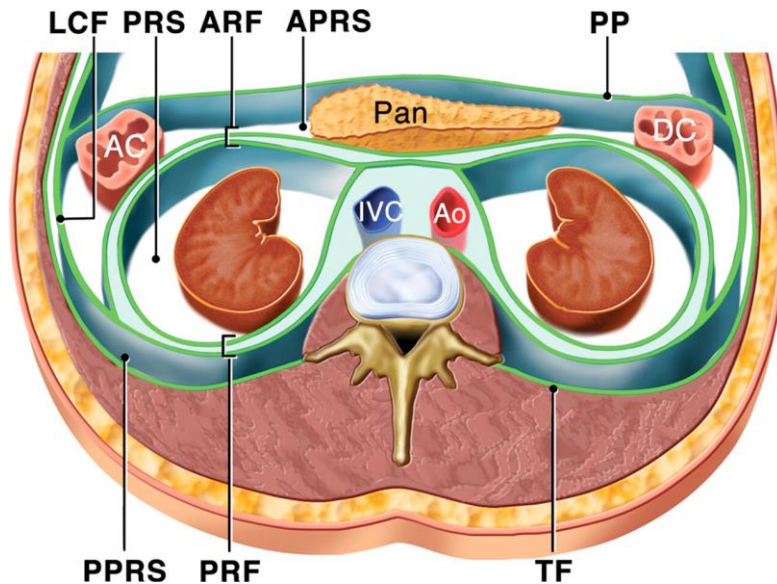


Figure 2: Shows the traditional tricompartiment model of the retroperitoneum, which is accordingly divided into the anterior pararenal space (APS), perirenal space (PS), and posterior pararenal space (PPS). The anterior renal fascia (ARF), posterior renal fascia (PRF), and lateroconal fascia (LCF) divide the spaces. (Kawashima et al., 2013).

Below the kidneys, the anterior and posterior pararenal spaces become continuous, forming a single retroperitoneal space. Thus, retroperitoneal fluid or hemorrhage can spread from the abdominal retroperitoneum into the extraperitoneal plevus along the anterior and posterior perirenal fascia, which ultimately combine to form the fascial plane in the iliac fossa. Superiorly, the anterior and posterior perirenal fascia are attached to the diaphragm (Berni et al., 2015).

B. Retroperitoneal Visceral Anatomy

A. Pancreas

The pancreas is a large elongated pink retroperitoneal organ except for its tail occurring at the level of the second and third lumbar vertebrae.

It lies in the concavity formed by the duodenum, extending behind the peritoneum of the posterior abdominal wall toward the left, reaching the hilum of the spleen. (Figure 3) (**Berthet et al., 2014**).

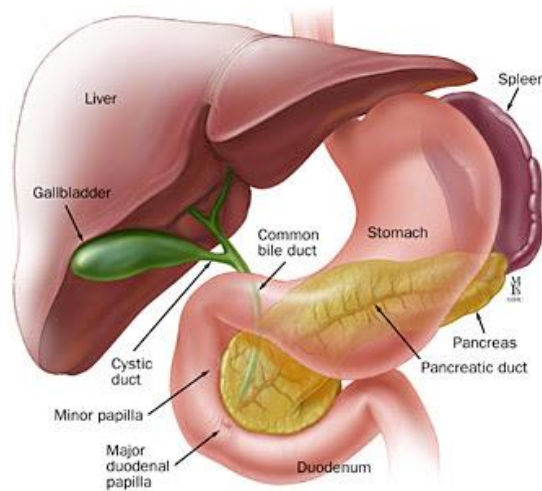


Figure 3: Showing the anatomical relationships of the pancreas. (*Feliciano et al., 2013*).

It is one of two abdominal organs connected to the digestive tract by means of a duct system, the other being the liver. In the adult it measures from 12 to 25 cm in length, varying in weight from 65 to 160 grams with an average weight of 110 grams. It has no definitive fibrous capsule, but is covered by a thin layer of connective tissue from which thin connective tissue septa extend into the gland dividing it into lobules. Grossly the

pancreas is divided into four anatomic areas: head, neck, body, and tail (**Campbell *et al.*, 2013**).

The head of the pancreas lies within the concavity of the duodenum, covering the inferior vena cava and the renal veins as they enter it. There is a portion of the head of the pancreas, which is referred to as the uncinate process, that is inserted behind the superior mesenteric vessels.

The neck is a very short constricted segment, which is grooved posteriorly by the superior mesenteric artery and vein. The body of the pancreas continues to the left from the neck, passing somewhat upward. It lies in front of the aorta, left renal vessels, left adrenal gland, and the left kidney (**Berthet *et al.*, 2014**).

The tail of the pancreas is usually blunted and turned upward, reaching the hilum of the spleen inferiorly, and is in relation with the left flexure of the colon (**Cogbill *et al.*, 2013**).

Within the parenchyma of the pancreas, and traversing its length is a large duct, the pancreatic duct. The pancreatic duct begins in the tail, extending to the head where it unites with the common bile duct at the ampulla of Vater (**major duodenal papilla**). In the head it is often quite large measuring 2 to 4 mm in diameter. Often there is an accessory pancreatic duct within the head above the main duct, which empties into the **minor duodenal papilla** located 2 cm above the ampulla of Vater. Occasionally, this duct empties directly into the main pancreatic duct. (Figure 4) (**Craig *et al.*, 2012**).

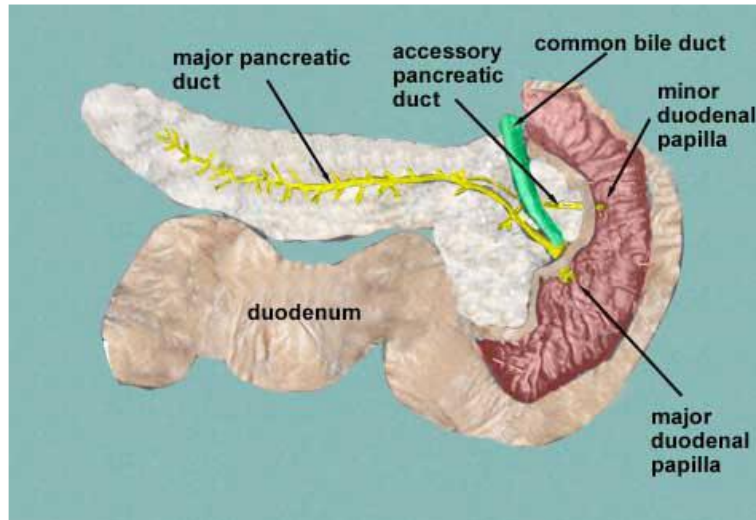


Figure 4: This is an illustration showing the major pancreatic duct (duct of Wirsung), which provides the pancreatic secretions from the exocrine pancreas to aid in digestion, the accessory pancreatic duct (duct of Santorini), the common bile duct, the major duodenal papilla (ampulla of Vater) and the minor duodenal papilla. The muscular wall of the ampulla of Vater may be thickened, forming the sphincter of Oddi. (Feliciano et al., 2013)

The pancreas is an organ, which next to the liver is the second largest gland connected to the duodenum. As a gland it performs two distinct functions. One function is to serve as a digestive organ, which is designated the **exocrine portion** of the pancreas. The other function is to play an important part in the control of carbohydrate metabolism, which is referred to as the **endocrine portion** of the pancreas. Unlike the liver, in which the exocrine and endocrine functions are carried out by the same cells, the pancreas's exocrine and endocrine functions are carried out by different cell groups (Baandrup et al., 2012).

The arterial blood supply to the pancreas arises from the **celiac axis** and the **superior mesenteric artery**. (Figure 5) The principal arteries from the celiac axis to the duodenum and the pancreas are branches of the **gastroduodenal artery**, the **anterior superior pancreaticoduodenal** and the **posterior superior pancreaticoduodenal arteries**. The anterior superior pancreaticoduodenal supplies the head of the pancreas.

The posterior superior pancreaticoduodenal supplies the head of the pancreas and the first and second parts of the duodenum. The principal arteries from the superior mesenteric are the **anterior inferior pancreaticoduodenal** and the **posterior inferior Pancreatico-duodenal arteries**. Both arteries supply the pancreatic head, uncinate process and the second and third parts of the duodenum. The **splenic artery** gives off **pancreatic branches** as it courses along the superior border of the pancreas, supplying the neck, body, and tail. The pancreas also receives unnamed branches from the superior mesenteric artery, retroperitoneal vessels and the inferior and superior pancreatico-duodenal arteries (Howard *et al.*, 2014).

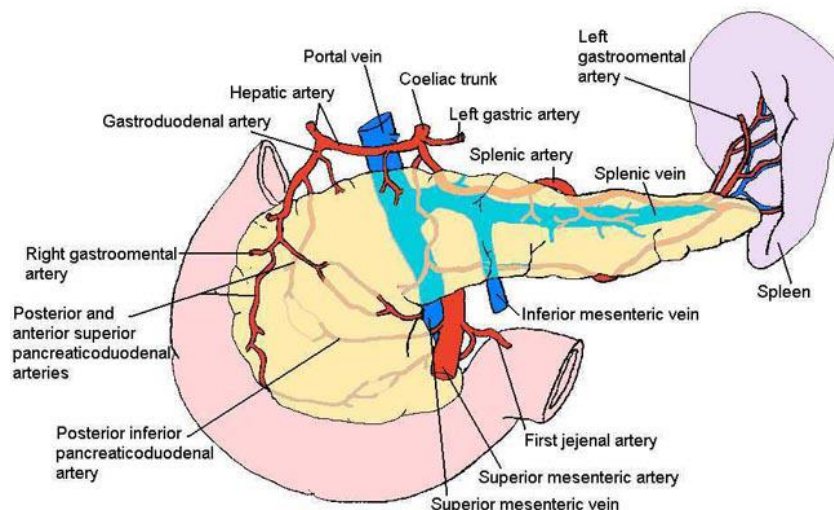


Figure 5: the arterial supply and venous vessels of the pancreas. (Lewis *et al.*, 2014)

The veins of the pancreas and duodenum correspond with the arteries and are usually superficial to them. The **pancreatic veins** ultimately drain into the **portal vein** (Graham *et al.*, 2015).

The pancreas contains a network of **lymphatic vessels**. Most of the lymphatic vessels of the pancreas lie within the interlobular septa of connective tissue that separates the pancreas into lobes and lobules. Peripheral extensions of these interlobular lymphatics can be found

within the lobules, however, they are few. For the most part, the pancreatic lymphatic vessels follow the blood vessels. There are a few scattered areas in which the intra- and interlobular lymphatic vessels come in close contact with the acini. However, rarely are these lymphatics associated with the islets of Langerhans (**Watson *et al.*, 2013**).

The lymphatic drainage of the head of the pancreas follow the blood vessels and drain first into the pancreaticoduodenal nodes, ultimately draining into the pyloric nodes of the gastroduodenal artery above or the superior mesenteric nodes below. The lymphatic drainage of the neck, body and tail follow the blood vessels, ending in the pancreaticolineal nodes along the splenic vessels and in the superior mesenteric nodes. (**Graham *et al.*, 2013**).

The **nerve innervation** of the pancreas is divided into the exocrine and endocrine portions. The **exocrine lobules** of the pancreas are innervated by **sympathetic** and **parasympathetic fibers**. The **sympathetic fibers** arises from the sixth to tenth thoracic spinal segments with their **preganglionic fibers** forming synapsis in the celiac ganglia. The **parasympathetic supply** is from the posterior vagus nerve and the **parasympathetic** component of the celiac plexus. The supply to the gland is both vasomotor, i.e., arterial (sympathetic) and to the cells forming the acini (sympathetic and parasympathetic) (**Mattox *et al.*, 2013**).

Sensory fibers leave the pancreas through both the sympathetic and parasympathetic nerves. The sensory fibers convey the sensation of pain arising from the pancreas.

The majority of pain arising from the pancreas is referred to the epigastrium. If the pancreas is involved with an inflammatory process or cancer, which spreads to the retroperitoneum, that pain is conveyed

through somatic nerves to the posterior paravertebral region around the lower thoracic spine (Kirks *et al.*, 2014).

B. Kidney

The kidneys lie embedded in fat and fibrous connective tissue in a deep retroperitoneal paravertebral gutter formed by the anteriorly projecting lumbar vertebrae and the psoas muscles. This gutter is bounded medially by the psoas muscles (figure 6). Behind the kidney lies the quadratus lumborum muscle and, at its lateral border, the transversus abdominis muscle (Barba *et al.*, 2012).

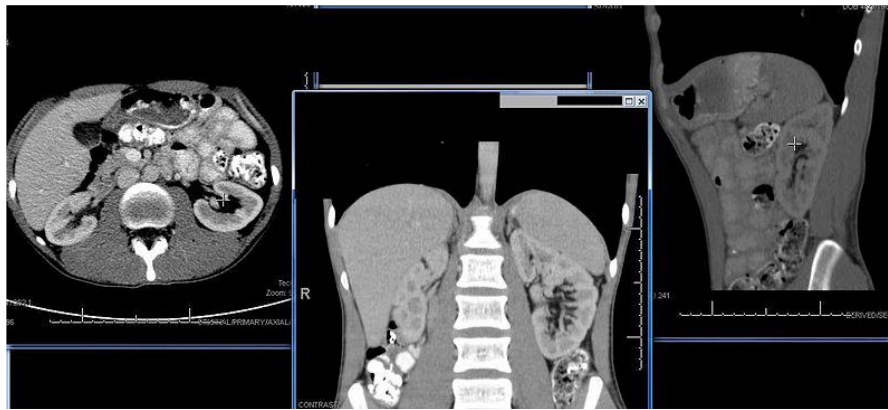


Figure 6: This is a CT scan showing the location of the kidneys in the paravertebral gutter formed by the anteriorly projecting lumbar vertebrae with the psoas muscles (James *et al.*, 2014).

The superior aspect of each kidney lies on the twelfth rib next to the upper border of the twelfth thoracic vertebra; their inferior aspect lie at the level of the third lumbar vertebra and are further from the median plane than are the superior aspect (poles) Anterior to the right kidney is the liver above and the colon below. The second part of the duodenum passes in front of its medial border (Petrone *et al.*, 2013).

The middle of the left kidney is behind the body of the pancreas, above are the spleen and stomach and below is the beginning of the jejunum. (Figure 7) (Picard *et al.*, 2013).

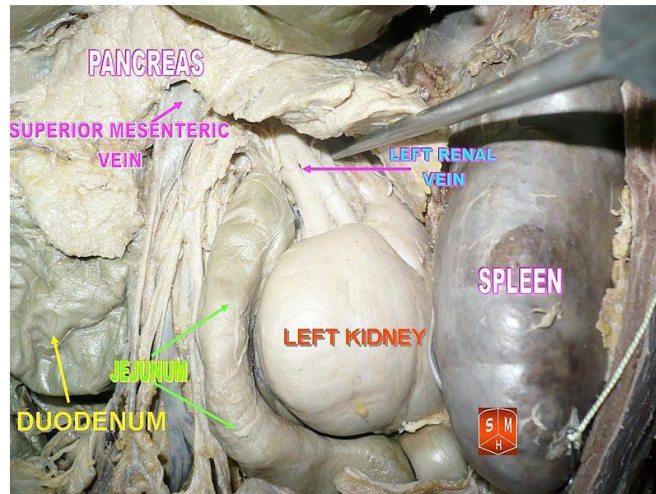


Figure 7: the relationships of the left kidney as seen in a cadaver (James *et al.*, 2014)

The perirenal fat is enclosed between two layers of perirenal fascia, which unite into the transversalis fascia laterally, immediately beneath the peritoneum.

The left kidney is usually somewhat longer than the right kidney, and the right kidney is usually slightly lower than the left kidney due to the mass of the liver above it. The kidneys are from 10 to 12 cm long, from 5 to 6 cm wide, and about 3 cm thick. The left kidney may be 1.5 cm longer than the right. In the adult male each organ varies in weight from 120 to 170 grams, average 150 grams, while in women the range is 110 to 150 grams, average 135 grams (Casillas *et al.*, 2014).

The center of the medial border of each kidney has a concavity, that contains the hilum, which is a deep vertical fissure for the entrance of the renal blood vessels, lymphatics, nerve supply, as well as accommodating the renal pelvis, which continues as the ureter. The ureter is a large excretory duct, which emerges from the hilum and courses downward to the urinary bladder, which is situated in the pelvis behind the pubis (Craig *et al.*, 2013).