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ORIGINAL ARTICLE

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The duodenal fossae: anatomic study and clinical correlations

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Abstract The aim of this study was to present anatomic macroscopic aspects and the relationship between the duodenum and the posterior abdominal wall. The authors describe anatomic types of peritoneal duodenal fossae and stress some points of surgical importance. Twenty-four cadavers, fixed in formalin, were dissected. Ten peritoneal fossae were given prominence and the authors show the anatomical structures topographically, from a superficial plane to a deep viscerae level. There is usually a complete fusion of the duodenal loop with the posterior parietal peritoneum except the duodenojejunal flexure. The study reveals three right retroduodenal fossae, three left retroduodenal fossae, two inferior duodenal fossae, one left paraduodenal fossa and one superior duodenal fossa. These peritoneal recesses mostly result from an incomplete adhesion of the Treitz's fascia. This work provides some explanation of paraduodenal hernias that represent a rare case of intestinal obstruction. Two cases of these internal hernias are illustrated and their pathophysiology and embryologic basis are discussed.

Keywords Peritoneal fossae · Abdominal hernias · Duodenum · Peritoneum · Peritoneal cavity · Abdomen anatomy

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Introduction

The duodenum loop belongs to the peritoneal cavity. It extends from the first to the fourth lumbar vertebra and lies on the ventral face of the column "like a bag on a miller's back". However, if the duodenum does not adhere to the posterior parietal peritoneum, it adheres to the peritoneal fossae sometimes. We also studied the relationship between the duodenum and the posterior abdominal wall and highlighted its clinical and surgical implications.

Materials and methods

The peritoneal cavities of 24 cadavers were dissected. The cadavers had previously been embalmed in a formalin solution (a mixture of 10% formalin and ethanol). The anterior abdominal wall was incised with a vertical opening resembling a laparatomy. The greater omentum was suspended and the small intestine loops isolated. The liver was removed. A macroscopic analysis of the duodenal area was then performed. An anterior or anterolateral position was chosen.

Results

The dissection revealed three right retroduodenal fossae, three left retroduodenal fossae, two inferior duodenal fossae, one left paraduodenal fossa and one superior duodenal fossa. These fossae extend as far as the second and the third lumbar vertebra. Their height is about 7 cm and their depth in a sagittal plane is about 1–2 cm.

The duodenojejunal flexure appears movable and a semilunar avascular inferior duodenal fold delimits the entrance to these fossae: left paraduodenal fossa under the bridge formed by vessels; left retroduodenal fossae behind the fourth (ascending) portion of the duodenum, inferior duodenal fossa under that fold in the vicinity of

the ascending branch of the left colic artery; and superior duodenal fossa under the Treitz's vascular arch (Fig. 1).

If the second (descending) part of the duodenum does not lean against the posterior parietal peritoneum, we can discover a right retroduodenal fossa between the head of pancreas ventrally and the inferior vena cava dorsally and the psoas major muscle overlayed with parietal peritoneum. Above and below the recess, the superior genu and the inferior genu are bent across by two right folds, which are very thin on a frontal plane. These avascular folds are involved in the duodenal loop anchorage (Fig. 2).

The abdominal aorta and the inferior vena cava can be visible through the transparent parietal peritoneum. In that dissection, we can view a right inferior fold more widespread and thickened with a sagittal orientation (Fig. 3).

The right inferior fossa continues below the third (horizontal) portion of the duodenum. The hepatoduodenal ligament arises at the flexure between the duodenal bulb and the descending part and reaches the gallbladder. It can clearly participate in the existence of an inferior recess because of its traction. This ligament can extend towards the visceral peritoneum causing a new gutter under the inferior genu (Fig. 4).

Sometimes the left retroduodenal fossa consists of a bridge formed caudally by the inferior duodenal fold and cranially by the superior duodenal fold. That recess is enhanced by a lumbar overlordosis (Fig. 5).

Discussion

Peritoneal fossae are usually caused by a non-adhesion between the posterior parietal peritoneum and the abdominal posterior wall between the 5th and the 11th week of gestation. These various recesses have been reported to occur in 68 and 48% cases of inferior and superior duodenal fossae, respectively, and coexist in 30%, with a 1% incidence of paraduodenal and retroduodenal fossae [19].

The retroduodenal fossae are related to partial failure of coalescence of the mesoduodenum to the posterior parietal peritoneum. Viscerae can also be dissimulated between either the posterior face of the fourth duodenum and the descending colon with Toldt's fascia on the left side or the posterior face of the second duodenum and the ascending colon with Toldt's fascia on the right

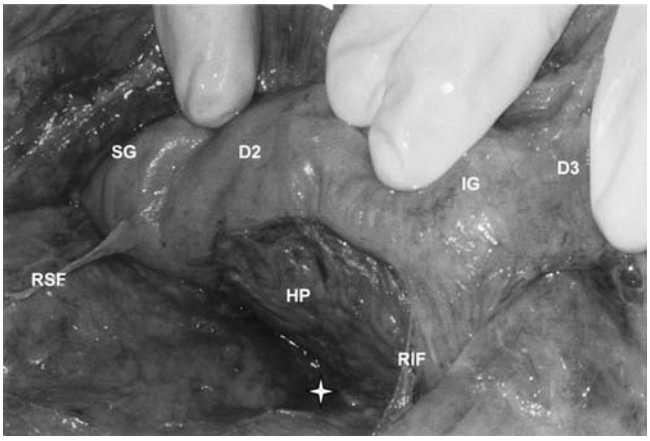

Fig. 2 Right anterolateral view. *SG* superior genu, *RSF*: right superior fold, *D2* second (descending) portion of the duodenum, *HP* head of the pancreas, *IG* inferior genu, *RIF* right inferior fold, *D3* third (horizontal) portion of the duodenum, right retroduodenal fossa (✧)

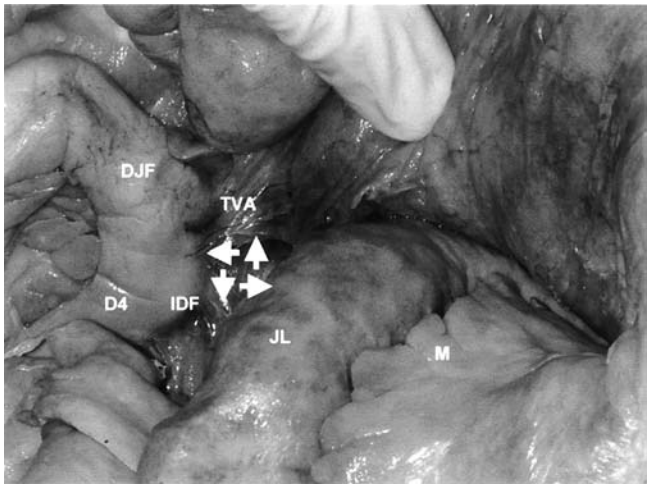

Fig. 1 Anterior view of the duodenojejunal flexure. *JL* jejunal loop, *DJF* duodenojejunal flexure, *D4* fourth (ascending) portion of the duodenum, *IDF* inferior duodenal fold, *TVA* Treitz's vascular arch, *M* mesentery, paraduodenal fossa (→), left retroduodenal fossa (←), inferior duodenal fossa (↓), superior duodenal fossa (↑)

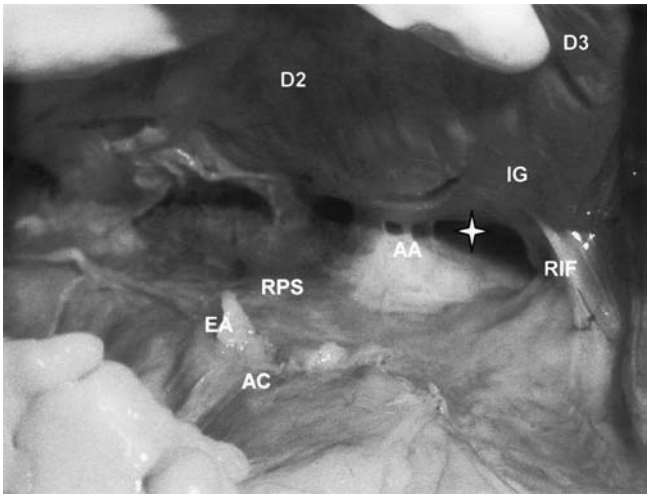

Fig. 3 Right anterolateral view. *D2* second (descending) portion of the duodenum, *AA* abdominal aorta, *RPS* right paracolic gutter, *AC* ascending colon, *EA* epiploic appendices, *IG* inferior genu, *RIF* right inferior fold, *D3* third portion of the duodenum, *D1* first portion of the duodenum, *D2* second (descending) portion of the duodenum, *SG* superior genu, right retroduodenal fossa (✧)

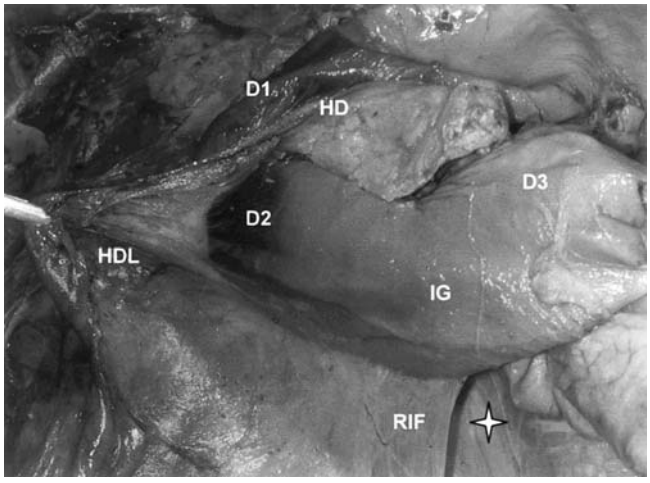

Fig. 4 Right anterolateral view. *D1* first portion of the duodenum, *D2* second (descending) portion of the duodenum, *SG* superior genu, *HDL* hepatoduodenal ligament, *IG* inferior genu, *RIF* right inferior fold, *D3* third (horizontal) portion of the duodenum, right inferior fossa

side. We can note a thinning of Treitz's fascia behind the duodenal loop (Fig. 6).

The mesenterico-parietal fossa or inferior duodenojejunal is located under the superior mesenteric artery that runs in the superior pole of the mesentery between the duodenum on the ventral side and the posterior parietal peritoneum on the dorsal side. (Fig. 7) [1, 6, 8, 16, 25].

The paraduodenal fossa of Landzert is located lateral to the fourth segment of the duodenum and posterior to the inferior mesenteric vein and ascending branch of the left colic artery just beneath the posterior parietal peritoneum. These vessels raise serosal folds leading to venous and arterial paraduodenal fossae [11–13]. This fossa of Landzert is a fold seen in 1–2% of autopsies [10, 19, 20]. In addition the left superior duodenal fossa can

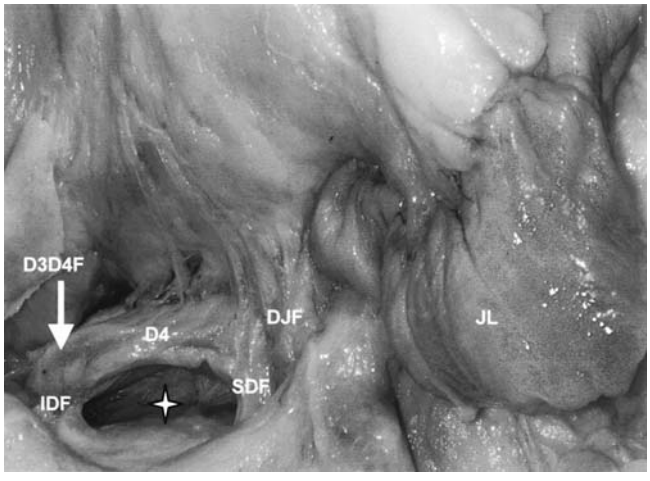

Fig. 5 Left anterolateral view. *JL* jejunal loop, *DJF* duodenojejunal flexure, *D4* fourth (ascending) portion of the duodenum, *IDF* inferior duodenal fold, *SDF* superior duodenal fold, *D3D4F* flexure between D3 and D4, left retroduodenal fossa (✧)

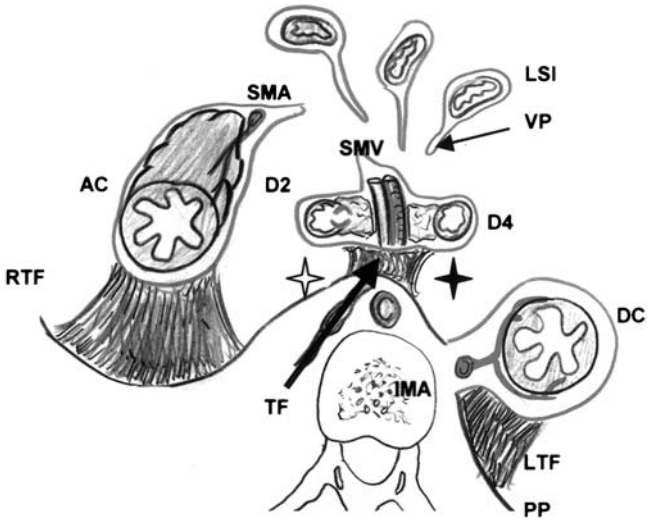

Fig. 6 Horizontal section at L2. *RTF* right Toldt's fascia, *AC* ascending colon, *SMA* superior mesenteric, *D2* second (descending) portion of the duodenum, *D4* fourth (ascending) portion of the duodenum, *SMV* superior mesenteric vessels, *LSI* loops of small intestine, *TF* Treitz's fascia, *IMA* inferior mesenteric artery, *LTF* left Toldt's fascia, *DC* descending colon, *PP* parietal peritoneum, *VP* visceral peritoneum, right retroduodenal fossa (✧), left retroduodenal fossa (✦)

be divided into two parts; the first horizontal segment interposed in the place below the root of the transverse mesocolon and the superior face of the duodenojejunal flexure; the second vertical part is located between the posterior face of the duodenojejunal flexure and the

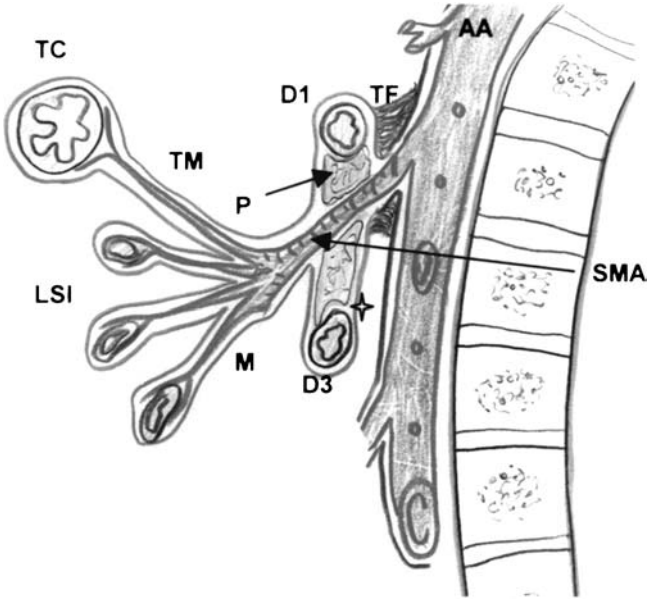

Fig. 7 Midsagittal section. *AA* abdominal aorta, *TF* Treitz's fascia, *SMA* superior mesenteric artery, *P* pancreas, *PP* parietal peritoneum, *VP* visceral peritoneum, *LSI* loops of small intestine, *D1* first portion of the duodenum, *D3* third (horizontal) portion of the duodenum, *TC* transverse colon, *M* mesentery, *TM* transverse mesocolon, inferior duodenal fossa (✧)

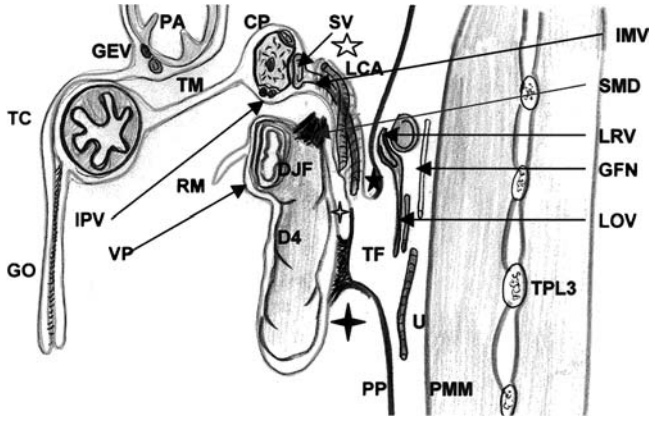

Fig. 8 Parasagittal section through the left fossae. *LCA* left colic artery (ascending branch), *SV* splenic vein, *IMV* inferior mesenteric vein, *TF* Treitz's fascia, *D4* fourth (ascending) portion of the duodenum, *TM* transverse mesocolon, *TC* transverse colon, *GO* greater omentum, *GEV* gastroepiploic vessels, *RM* root of mesentery, *CP* corpus of pancreas, *IPV* inferior pancreatic vessels, *DJF* duodenojejunal flexure, *PP* parietal peritoneum, *VP* visceral peritoneum, *SMD* suspensory muscle of duodenum (Treitz's muscle), *LRV* left renal vessels, *LOV* left ovarian vessels, *GFN* genitofemoral nerve, *U* ureter, *PMM* psoas major muscle, *TPL3* transverse process of L3, *PA* pyloric antrum, left inferior fossa (✦), left superior fossa (✧), arterial fossa (☆), venous fossa (★)

posterior parietal peritoneum raised by the vessels with a curve with ventral concavity (Fig. 8).

These peritoneal fossae can be joined due to a scoliosis of the lumbar column. Thus they give rise to an abnormal "duodeno-aorto-spinal" fossa with unusual left lateroduodenal aortic position leading to a trapezoid space bordered by the fourth portion of the duodenum on the right and the abdominal aorta on the left [3].

The etiology of herniation into duodenal fossae is not well known and remains controversial and debatable. There are two main theories about the etiology of paraduodenal hernia. The first theory suggests that hernia was acquired by the gradual enlargement of an existing fossa. That mechanical theory states that increased intra-abdominal pressure (caused by peristaltismal undulations) forces loops of small intestine into pouches where fusion has not been completed [11, 12, 16, 23]. The second theory is related to anomalous rotation of the midgut between the 5th and 11th week of gestation and is a rare congenital anomaly. The midgut gets trapped in the mesentery of the proximal segment of the hindgut and as this descends to the right lower quadrant, a sac of peritoneum is formed to contain the small bowel to the right of the duodenum. There is, therefore, no possibility for the fusion of the ascending mesocolon to the posterior parietal peritoneum. A small hiatus, however, may admit a few loops of small bowel to the true peritoneal cavity and thereby constitutes a right paraduodenal hernia. On the other side, left paraduodenal hernias result on patients with paraduodenal hernia is progressive abdominal pain with epigastric cramps, bloating after meals. They often reduce spontaneously, leading to diagnostic difficulties [2, 4, 7, 9, 10, 14, 17, 19, 20, 24]. Paraduodenal hernias account for 0.2–0.9% of small bowel obstructions [10]. Males are affected twice as much as females [9, 20]. The average age at the time of occurrence is 38.5 years. The incidence of hernia on the left side is much more common than the right side, with the former accounting for 75% of the hernia cases [10]. To make from rotation of the midgut to the colic branches of the inferior mesenteric artery dorsally instead of ventrally, thereby allowing invagination into the mesocolon [2, 7, 15, 20].

The clinical manifestations at diagnosis, radiological studies (with barium) and CT scan are essential. The upper gastrointestinal series show a characteristic pattern of bunched-up small bowel, as if it were contained in a bag [22, 26]. The CT scan reveals a cluster of dilated loops behind the pancreas, contrasted against the psoas muscles [18, 21]. Once diagnosed, these hernias should

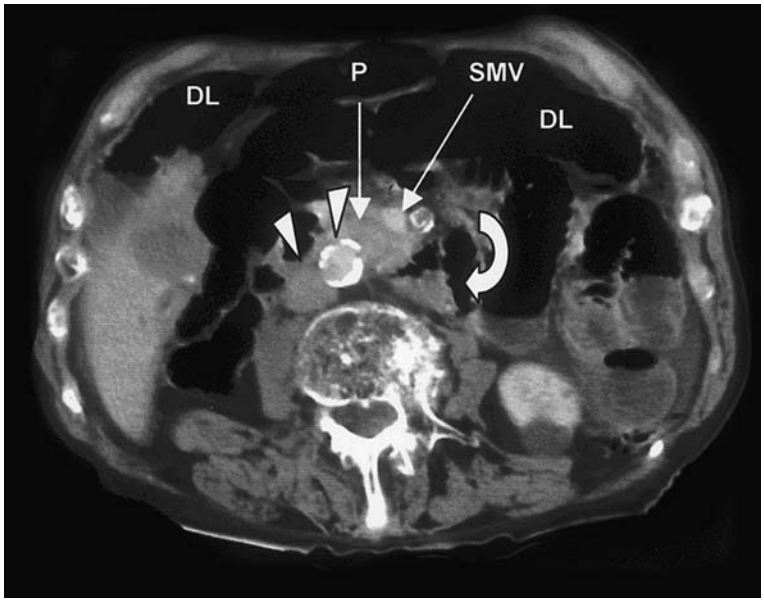

Fig. 9 Horizontal CT scan at level L2 showing a left paraduodenal hernia. Note that the abdominal aorta and the inferior vena cava (*arrowheads*) are displaced on the right side, forming in this case a new space. Then, a small bowel loop gets trapped (*curved arrow*). *SMV* superior mesenteric vessels, *P* pancreas, *DL* dilated loops

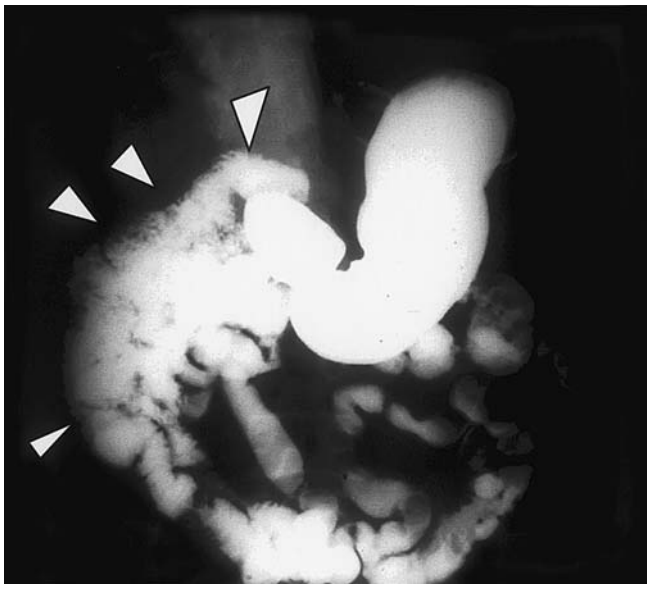

Fig. 10 Barium study demonstrating a right paraduodenal hernia. Note the abnormal stasis of barium in slightly dilated loops of jejunum (*arrowheads*). Small intestine appears to be enclosed within a sac

be treated. The operation should aim at a reduction of the incarcerated loops and an obliteration of the sac by conventional laparatomy [4, 5, 14] or by laparoscopic repair [24]. Care must be taken to preserve vessels during the surgical correction.

To illustrate this anatomic study, we reported two cases of paraduodenal hernias. The first was a left paraduodenal hernia of a 66-year-old man who complained of abdominal pain and vomiting. The CT scan was consistent with this diagnosis (Fig. 9). The patient underwent a laparotomy. Postoperative course was uneventful. The second patient was a 39-year-old man with the same symptomatology. The diagnosis of a right paraduodenal hernia was confirmed by the Roentgenogram after barium meal (Fig. 10). The treatment was a surgical reduction. Postoperative course went smoothly.

Conclusion

These anatomic data enable a better understanding of the intestinal pathology in this area. These hernias have a paranormal orifice and lack their sac; hence they are named ''internal prolapses or procidentia'' [9]. These unusual internal hernias must be known and recognized by an uninitiated surgeon, as transmesenteric hernia, paracaecal hernias, transomental hernias, etc., [9, 17]. This diagnosis should be born in mind, particularly in the case of intestinal obstruction, especially in young patients who have not had previous abdominal surgery or external herniae.

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