Intraluminal Duodenal Diverticulum: A Pictorial Review of X-ray, US, CT, MRI, and Endoscopic Findings

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Learning Objectives

1. To review the embryology and pathology of intraluminal duodenal diverticulum (IDD).
2. To illustrate UGI, US, CT, MRI and endoscopic findings of IDD.
3. To discuss potential complications resulting from IDD.

Background

An IDD is a sac of duodenal mucosa originating in the second portion of the duodenum near the papilla of Vater. The diverticulum forms from a congenital duodenal web or diaphragm that gradually elongates intraluminally over time as a result of mechanical factors such as forward pressure by food and duodenal peristalsis [1].

The symptoms are vague consisted of postprandial epigastric pain and fullness. These rarely appear until the third decade of life [2, 3]

Reported complications include upper gastrointestinal bleeding, obstruction secondary to the accumulation of food, acute and recurrent pancreatitis, cholangitis, and intussusception [4, 5, 6].

Imaging Findings OR Procedure Details

Embryology of IDD

During the fifth and sixth weeks of the human development, the lumen of the duodenum becomes progressively smaller and is temporarily obliterated due to the proliferation of its epithelial cells (Fig. 1 A) [7]. Normally, because of vacuolation due to degeneration of the epithelial cells, the duodenum becomes recanalized by the end of the embryonic period (Fig. 1 B and C) [7].

Complete occlusion of the lumen of the duodenum is not common (Fig. 2). If reformation of the lumen fails to occur, a short segment of the duodenum is occluded (Fig. 2C). Most atresias involve the descending (second) and horizontal (third) parts of the duodenum and are located distal to the opening of the bile duct.
Partial occlusion of the duodenal lumen usually results from incomplete recanalization of the duodenum due to defective vacuolation (Fig. 3). Duodenal stenosis may also be caused by pressure from an annular pancreas. Most stenoses involve the horizontal (third) and/or ascending (fourth) parts of the duodenum.

If there is a small aperture in the duodenum to allow distal passage of duodenal contents (Fig. 4A), then it may elongate caudally under the pressure of duodenal peristalsis and duodenal contents to form a pulsion-type diverticulum (Fig. 4B and C) [2, 3, 8]. It occurs with the same frequency in both sexes, usually during the third to fifth decades of life [9]. Associated congenital anomalies are present in up to 40% of patients with IDD. These include Down's syndrome, annular pancreas, intestinal malrotation, hernias, imperforate anus, and situs inversus [2, 8].

Pathology of IDD

Histologically, IDD is typically composed of a double layer of mucosa with an incomplete layer of muscularis mucosa. It suggests that these lesions are diverticula which are differentiated from duplication by the absence of all tissue layers of the intestine [10].

Imaging findings of IDD

Upper gastrointestinal series show duodenal windsock sign (Fig. 5), a pathognomonic finding, first described radiologically by Nelson [11]. When filled with barium, an intraluminal duodenal diverticulum appears on barium studies as a finger-like sac separated from barium in the adjacent duodenal lumen by a radiolucent band representing the wall of the diverticulum (the "halo" sign) (Fig. 6) [12]. This finding can help differentiating IDD from duodenal duplications. In duodenal duplications, the appearance of upper GI series is that of mass lesion which does not collect food or barium.

To detect the cause of epigastric pain or acute pancreatitis, upper abdominal ultrasound is mainly performed to scan the liver, pancreas, and the bile duct. Usually, the duodenum could be poorly evaluated because it is not the main focus of scan but also poor sonic window by bowel gas. However, focused ultrasound shows similar to CT findings of IDD. Ultrasound shows segmental circumferential wall thickening of the duodenum (Fig. 7) when IDD is collapsed or filled by food materials. If the findings of acute pancreatitis are accompanied, this finding would be regarded as secondary change due to pancreatitis. IDD looks like cystic mass in the lumen of the duodenum when it is filled by fluid and then it mimics duodenal duplication cyst or cystic tumor.
The usefulness of CT in the diagnosis of IDD has recently been reported [5, 13, 14, 15]. In axial planar CT imaging, Fidler et al. [14] reported that positive oral contrast is required within the lumen to define the IDD wall. Conversely, Lawler et al. [15] stated that the contrast likely had difficulty in entering the IDD because of its distorted periampullary orifice and the fact that the IDD was already greatly distended and filled with debris, and so concluded that three-dimensional images of multidetector CT with volume rendering would be effective to reproduce the classic features of barium study of IDD.

Various CT findings of IDD are possible depending on whether it is distended or not and level of CT scanning.

1. Circumferential wall thickening (Fig. 8A)
2. Intraluminal cystic mass looks like duodenal duplication (Fig. 8B)
3. Web lesion with small opening (Fig. 8C)
4. Bowel in bowel appearance mimicking intussusception (Fig. 8D)

MDCT combined with postprocessing techniques such as minimum intensity projection (Fig. 9 A and B) and curved planar reconstruction (Fig. 9 C and D) can clearly reveal the attachment of the diverticulum to the duodenal wall, the channel for passage of enteric contents, and the extent of duodenal obstruction [13].

For IDD patients, MRCP is usually performed to evaluate the cause of acute pancreatitis. On MRI (T2WI, MRCP) studies, a small intraluminal cystic lesion surrounded by a hypointense rim in the second portion of the duodenum was identified (Fig. 10) [9]. Often IDD leads to acute pancreatitis, so patients with IDD may first undergo abdominal MRI for the diagnosis of a CBD stone or pancreas tumor before CT or upper gastrointestinal series. So, the radiologist should consider not only tumors or stones but also IDD on MRI, especially for children or young adults with recurrent pancreatitis.

Endoscopy increasingly plays a major role in the diagnosis and treatment of IDD. On endoscopy, the diverticulum appears as a blind sac with orifice, which looks like a polyp when inverted (Fig. 11). However, in some instances, endoscopy alone may not distinguish between extra and intra-luminal diverticulum.

**Complications of IDD**
Patients may describe chronic symptoms such as epigastric pain, nausea, vomiting, and abdominal fullness alone or in combination with acute symptoms secondary to obstruction (Fig. 12), hemorrhage, pancreatitis (Fig. 13), or other complications.

The symptoms are depending on the size of the opening of the IDD. If the fenestration is enough big to pass enteric contents, the symptom would be vague. If the opening is too small to pass enteric contents, IDD would be formed by chronic incomplete duodenal obstruction and then would lead to other complications.

Acute pancreatitis is associated with IDD in approximately 20% of the reported cases [5, 6]. The pathogenesis of pancreatitis in patients with IDD is unclear. Nance et al [16] has suggested two potential etiologies for pancreatitis in association with IDD. One is partial obstruction of the duodenum by the distended diverticulum, resulting in duodenal contents spillage into the pancreatic duct. The second is dysfunction of the sphincter of Oddi, which results from deformity of the ampulla of Vater due to the pressure of the distended diverticulum during duodenal peristalsis.

Gastrointestinal bleeding is reported in 25% of the patients which might result from trauma induced by passage of food and ulceration of diverticulum [4].

**Treatment of IDD**

Duodenotomy and excision of the diverticulum have been the treatment of choice. Endoscopic treatment offers a potentially equal effectiveness. If diverticulum is not circumferentially attached to the duodenal wall and can be inverted with the endoscopy, it can be resected endoscopically with a snare or needle-knife (Fig. 14).

**Images for this section:**
Figure 1. Recanalization of the duodenum

Fig. 1: Recanalization of the duodenum
Fig. 2: Duodenal atresia
Fig. 3: Duodenal stenosis
Fig. 4: Development of IDD
**Figure 5. Duodenal windsock sign**

A. UGI shows barium-filled sac (*) with a radiolucent rim (arrowheads) in the duodenum. B. Windsock image is from www.wikipedia.org.

**Fig. 5:** Duodenal windsock sign A. UGI shows barium-filled sac (*) with a radiolucent rim (arrowheads) in the duodenum. B. Windsock image is from www.wikipedia.org.
**Figure 6. UGI finding of IDD**

**Fig. 6**: UGI findings of IDD A. Barium-filled sac (*) is noted with a radiolucent rim (arrowheads) in the duodenum. B. Two radiolucent webs (arrows) are noted in the second and third parts of the duodenum. Mild distention of the duodenum (*) above each web is noted.
**Figure 7. US finding of IDD**

![Ultrasound Image]

**Fig. 7:** Ultrasound finding of IDD The duodenum shows segmental circumferential wall thickening with luminal narrowing (arrows). Swelling of the pancreatic head (*) suggests acute pancreatitis.
**Figure 8. Axial CT finding of IDD**

A. Concentric wall thickening of the second portion of the duodenum is noted (arrow).
B. Intraluminal cystic mass (arrow) mimicking duplication cyst.
C. Web lesion with small opening (arrow).
D. Bowel in the bowel appearance (arrow) mimicking intussusception.

*Fig. 8:* Axial CT findings of IDD A. Concentric wall thickening of the second portion of the duodenum is noted (arrow). B. Intraluminal cystic mass (arrow) mimicking duplication cyst. C. Web lesion with small opening (arrow). D. Bowel in the bowel appearance (arrow) mimicking intussusception.
Fig. 9: Reformatted MDCT findings of IDD A. Coronal reformatted minimum-intensity-projection image shows dilated blind-ending saccular structure (*) with thin wall (arrowheads). B. Reformatted image shows eccentric small opening (arrow) at the anterior medial wall of the IDD. C and D. Curved planar reformatted images show fluid-filled saccular structures(*), CBD (arrow) and main pancreatic duct (arrowhead).
Fig. 10: MRI finding of IDD A and B. Coronal and axial T2 weighted images show fluid-filled saccular structure (*) with hypointense rim in the second part of the duodenum. C. MRCP shows a small intraluminal cystic lesion (*) with hypointense rim in the duodenum second part, CBD (arrow) and pancreatic duct (arrowhead).
Figure 11: Endoscopic findings of IDD

Fig. 11: Endoscopic finding of IDD A. Polyp-like intraluminal lesion B. Collapsed blind sac C. Web with eccentric opening
**Figure 12. Duodenal obstruction by IDD**

![Image](image.png)

**Fig. 12:** Duodenal obstruction by IDD A. Fluid-filled dilatation of the stomach and the duodenum are noted. B. Web lesion (arrow) with small opening (arrowhead) is noted at the transition zone of the duodenum.
Fig. 13: Acute pancreatitis results from IDD. An 11 year-old girl had two attacks of pancreatitis. A. Initial acute necrotizing pancreatitis with necrosis (arrow) in the pancreatic body and large amount of fluid collection (*). B. Second recurrent pancreatitis with parenchymal atrophy of the body and small amount of fluid collection (*)
Fig. 14: Endoscopic treatment of IDD A. IDD is resected with a snare technique. B. The web is resected with endoscopic needle-knife.
Conclusion

Intraluminal duodenal diverticulum can present as duodenal obstruction, duodenal bleeding, and acute pancreatitis. Awareness of the imaging findings will give the correct diagnosis and the optimal treatment.

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References