

## Upper gastrointestinal barium evaluation of duodenal pathology: A pictorial review

Pankaj Gupta, Uma Debi, Saroj Kant Sinha, Kaushal Kishor Prasad

Pankaj Gupta, Department of Radiodiagnosis, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India

Uma Debi, Division of GE Radiology, Department of Superspeciality of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India

Saroj Kant Sinha, Department of Superspeciality of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India

Kaushal Kishor Prasad, Division of GE Histopathology, Department of Superspeciality of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India

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**Correspondence to:** Kaushal Kishor Prasad, MD, PDC, CFN, MAMS, FICPath, Additional Professor, Chief, Division of GE Histopathology, Department of Superspeciality of Gastroenterology, Postgraduate Institute of Medical Education and Research, Sector-12, Chandigarh 160012, India. [kaushalkp10@hotmail.com](mailto:kaushalkp10@hotmail.com)  
Telephone: +91-172-2756604 Fax: +91-172-2744401

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a thorough acquaintance with the morphology of various duodenal lesions on upper gastrointestinal barium examination is essential in guiding further evaluation. We reviewed our experience with various common and uncommon barium findings in duodenal abnormalities.

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**Key words:** Barium study; Duodenum; Upper gastrointestinal tract; Small bowel; Pathology

**Core tip:** Barium evaluation of duodenal pathologies is technically more challenging than rest of gastrointestinal tract. Barium study still forms an initial and integral part of evaluation as it provide useful clues to the diagnosis and guide further evaluation. This article should alert the radiologist to consider various common and uncommon duodenal pathologies in the correct clinical setting to guide the clinician for further investigations to ensure correct diagnosis and enable appropriate treatment.

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### Abstract

Like other parts of the gastrointestinal tract (GIT), duodenum is subject to a variety of lesions both congenital and acquired. However, unlike other parts of the GIT viz. esophagus, rest of the small intestine and large intestine, barium evaluation of duodenal lesions is technically more challenging and hence not frequently reported. With significant advances in computed tomography technology, a thorough evaluation including intraluminal, mural and extramural is feasible in a single non-invasive examination. Notwithstanding, barium evaluation still remains the initial and sometimes the only imaging study in several parts of the world. Hence,

### INTRODUCTION

Duodenum is often an overlooked segment of the gastrointestinal tract (GIT) as much of the GIT Radiology literature has focused on the esophagus, stomach, distal small bowel and colon. Duodenum like other parts of the GIT is affected by a variety of pathologic conditions including congenital, inflammatory and neoplastic diseases. While some of the congenital abnormalities like duplications and diverticulae are usually asymptomatic, others



**Figure 1** Upper gastrointestinal barium study reveals that the duodenojejunal flexure does not cross the left of the midline suggestive of malrotation.



**Figure 2** Widening of the duodenal C-loop is noted. Ultrasonography (not shown) showed a well-defined cystic lesion suggestive of duplication. This is a non-specific barium finding.

like annular pancreas and malrotation may manifest in the first decade of life. Inflammatory involvement of the duodenum results from peptic ulcer disease, Crohn's disease (CD) and adjacent inflammatory conditions. Duodenal neoplasms are rare and malignant tumors are much more common than benign tumors. Although, there are no specific signs of the various duodenal pathologies on upper GIT barium series, barium evaluation still forms an integral part of evaluation of patients in several parts of the world due to easy availability and relatively less cost. However, computed tomography (CT) and endoscopy have a greater sensitivity and specificity in detecting duodenal pathologies. CT, in particular provides information about both intramural and extramural disease processes. When used as an initial imaging tool, barium examination does provide useful clues to the underlying pathophysiological processes and as such guide the choice of further tests. Barium examination of duodenum may be contraindicated in suspected leak, history of recent surgery or acute trauma. In these situations, water soluble contrast study replaces barium study. Correct diagnosis requires a thorough knowledge of the appearance of disease processes of duodenum on barium studies. We present a brief barium pictorial review of common and uncommon duodenal lesions.

## ANATOMY

Except for the bulb, duodenum is a retroperitoneal structure. It lies within the anterior pararenal space. Forming a C-loop segment around the pancreatic head, this 30 cm tube extends from pylorus to the ligament of Treitz. It is arbitrarily divided into four parts based on their anatomic orientation. The relationship of the proximal and distal end to the spine is important. The pyloric end of the duodenum lies to the right of the spine and the duodenojejunal (DJ) flexure to the left of the pedicle of the spine.

## CONGENITAL ANOMALIES

### Midgut malrotation

The embryological basis is inadequate rotation of the intestinal loop around the axis of the superior mesenteric artery (SMA) during fetal life, around 10<sup>th</sup> week of development. Malrotation may occur as an isolated congenital anomaly or as a part of visceral situs anomalies<sup>[1]</sup>. In practical terms, malrotation can be classified into three types: non-rotation, malrotation and reverse rotation<sup>[2]</sup>. Former, the most common type is usually asymptomatic and incidentally detected and is imprecisely labeled as non-rotation. Reverse rotation is rare.

Upper gastrointestinal (UGI) barium study is accurate for detection of malrotation. The DJ junction does not cross the midline and is below the duodenal bulb (Figure 1). Delayed evaluation usually shows abnormal location of the right colon. Though abnormal position of caecum is suggestive, normal position does not exclude the diagnosis as it can be normally located in 20% cases<sup>[3]</sup>.

### Duplication

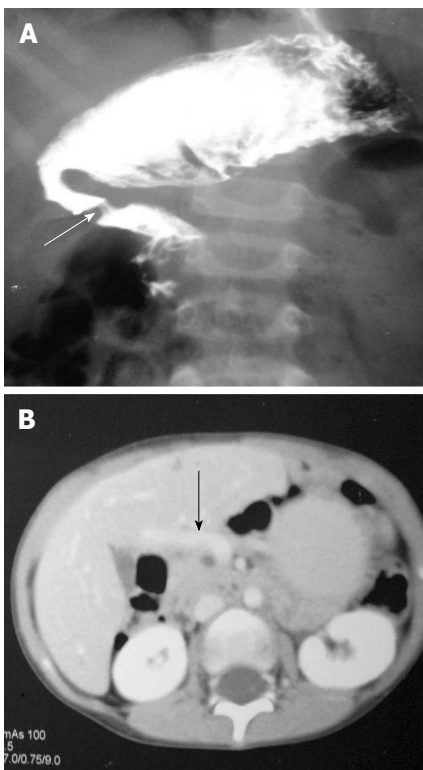
Most common site for duplication in the GIT is ileocecal region. Duodenal duplication is relatively uncommon congenital anomaly, accounting for less than 10% of all GIT duplications<sup>[4]</sup>. It is typically located along the mesenteric aspect of the first and second parts of the duodenum. On barium evaluation, extrinsic mass effect is noted on the duodenum and greater curvature of the stomach (Figure 2). Though rare, communication with the duodenum can be found. The barium findings are non-specific. Differential diagnosis include choledochal cyst, pancreatic lesions including pancreatic masses, pseudocyst, *etc.* and large duodenal diverticulum. A specific diagnosis can be made on high resolution ultrasonography if classical multi-layered appearance (gut signature) is seen<sup>[5]</sup>.

### Diverticulum

Duodenal diverticulum can be congenital or acquired. It is a frequent incidental finding detected in about 5% of upper GIT barium studies<sup>[6]</sup>. The most common site is along mesenteric border of second part of duodenum near the ampulla of Vater. It is seen as barium filled out pouching along the medial aspect of the second part of duodenum, although other locations are not uncommon (Figure 3).



**Figure 3** Barium filled out pouching is noted along the medial aspect of the second part of the duodenum (arrow) suggestive of a duodenal diverticulum.



**Figure 4** Upper gastrointestinal barium study (A) shows a band like extrinsic narrowing of the first part of the duodenum (arrow), axial computed tomography image (B) reveals the anomalous position of the portal vein anterior to the duodenum (arrow) suggestive of preduodenal portal vein.

#### **PREDUODENAL PORTAL VEIN**

It usually occurs in association with other congenital malformation, most commonly malrotation, pancreatic, splenic and cardiac anomalies. The portal vein passes anterior to the duodenum and pancreatic head<sup>[7]</sup>. On barium study, it appears as an extrinsic linear impression on the proximal duodenum or obstruction of the proximal duodenum (Figure 4A). The correct diagnosis is made by contrast enhanced CT that shows the abnormal location of portal vein (Figure 4B).

#### **Annular pancreas**

The embryologic basis of the annular pancreas is a defect



**Figure 5** Upper gastrointestinal barium study (A) demonstrates smooth circumferential extrinsic narrowing of the second part of the duodenum (arrow), axial computed tomography image (B) shows pancreatic parenchyma incompletely surrounding the duodenum (arrow), features suggestive of partial annular pancreas.

in the normal rotation of the ventral pancreatic anlage. The result of this aberration is encircling of the second part of duodenum by pancreatic tissue. The annulus encircles the duodenum partially or completely<sup>[8]</sup>. Pathologically, it is usually loosely applied to the serosa of the duodenum. In extreme cases, the pancreatic tissue is interdigitated with the wall of the duodenum. On barium study, it produces a smooth or tapered narrowing of the second part of the duodenum (Figure 5A). The diagnosis is confirmed by cross-sectional imaging, usually a CT scan (Figure 5B).

#### **Duodenal web**

There are several varieties of webs: complete duodenal atresias (imperforate webs), wind sock webs and webs with central or eccentric apertures. The most common sites of web are in vicinity of the ampulla either preampullary or postampullary location<sup>[8]</sup> (Figure 6). Upper GIT barium study shows the abnormality as a short segment transverse filling defect in the descending duodenum.

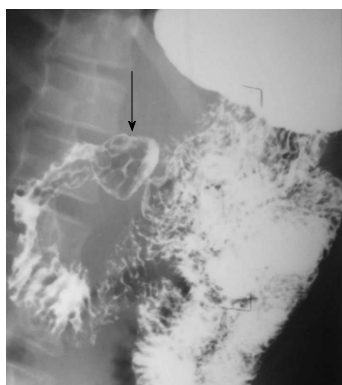
#### **Brunner gland hyperplasia**

Brunner's gland hyperplasia is a frequent asymptomatic finding on upper GIT barium evaluation. It is seen as solitary or multiple nodular filling defects that are typically less than 5 mm in diameter in the proximal duodenum<sup>[9]</sup>. When extensive, the nodules lead to a cobblestone or Swiss-cheese pattern (Figure 7). The differential diagnoses for such filling defects in the duodenum include heterotopia,





**Figure 6** A short segment narrowing (arrow) suggestive of a web is noted at the junction of first and second part of duodenum. In addition, multiple diverticula are seen at the medial aspect of the second part of the duodenum (arrowheads).



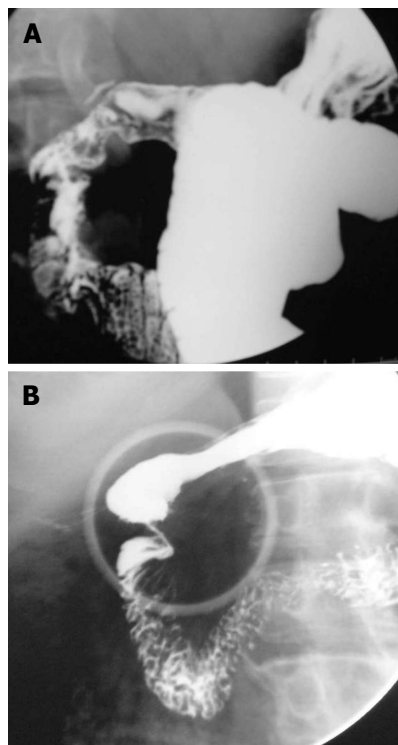
**Figure 7** Multiple nodular filling defects are noted in the duodenal cap (arrow) along with fold thickening in the second part of the duodenum. These findings suggest a diagnosis of Brunner gland hyperplasia.

nodular lymphoid hyperplasia, multiple adenomas in familial adenomatous polyposis, hamartomas in Peutz-Jeghers syndrome, carcinoid tumors and metastatic deposits.

## ACQUIRED DISEASES

### Inflammatory diseases

**Peptic ulcer disease:** Duodenal ulcers (DUs) are common and affect nearly one-tenth of the adult population. DUs are almost always benign. This is unlike gastric ulcers where 5% of the ulcers can be malignant. Though endoscopy is the most sensitive and specific method for diagnosis of suspected DUs, it is invasive and costly. Double-contrast UGI barium study still remains a useful alternative to endoscopy<sup>[10]</sup>. More than 90% of DUs occur in the duodenal bulb and nearly 50% of these occur on the anterior wall. Ulcer craters are seen as well-defined round or ovoid pools of barium, surrounded by a symmetrical mound of edematous mucosa. Adjacent radiating mucosal folds converge to the edge of the crater. Healed ulcer leads to deformity of the bulb (Figure 8A). The uncommon variety of DUs, postbulbar ulcers are usually located along the medial aspect of the second part of duodenum above the ampulla of Vater (Figure



**Figure 8** Upper gastrointestinal barium study shows deformity of the duodenal cap (A), stricture is noted at the junction of first and second part of the duodenum (B). These findings are secondary to healed bulbar (A) and post bulbar duodenal ulcers (B).

8B). Diagnosis on barium study is hampered by location; however indentation of the lateral wall of the duodenum opposite the ulcer due to spasm offers a clue<sup>[10]</sup>.

**Tuberculosis:** Duodenal tuberculosis (TB) comprises 2% of gastrointestinal TB. Clinically, the patients are divided into two groups: those having dyspeptic symptoms and those with obstructive symptoms. In the former group, barium findings include: luminal narrowing, ulcerations and extrinsic compression. These changes typically spare the proximal duodenum. Less frequently, scarring of duodenal cap, widening of the C-loop are noted. In the group with obstructive symptoms, findings include luminal narrowing of varying degrees (Figure 9) or cut off at junction of second and third part of duodenum resembling the SMA syndrome.

Concomitant tuberculous involvement of rest of the GIT is fairly common. Associated involvement of biliary tract can be noted (Figure 9). This takes the form of air in the common bile duct or reflux of barium into the biliary tree.

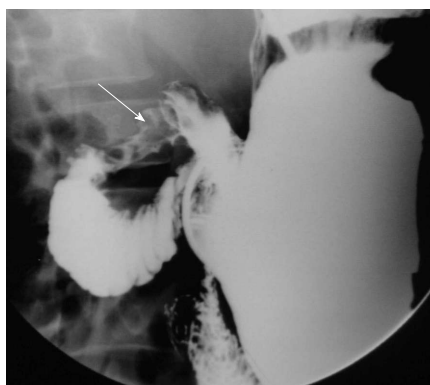
**CD:** CD affects the upper GIT mucosa in 20%-40% of patients. Early disease leads to irregular thickening, edema and cobblestone appearance. With disease progression, there is fibrosis and stenosis of the involved segment. Finally a string sign may develop. There are three patterns of involvement in advanced disease. The first and the most common pattern is the contiguous involvement of stomach and duodenum<sup>[11]</sup>. Other two patterns are isolat-



**Figure 9** There is narrowing of the distal second part of the duodenum with reflux of barium into the common bile ducts. This patient had concomitant involvement of the ileocecal junction (not shown). Histopathology revealed a diagnosis of gastrointestinal tuberculosis.

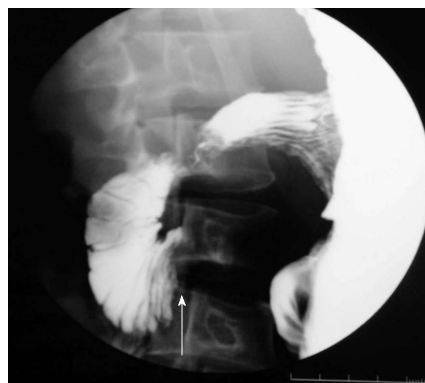


**Figure 10** A long segment narrowing with irregular outline and proximal dilatation is noted in the fourth part of duodenum. In addition few strictures are also noted in proximal jejunum. Detailed evaluation in this patient revealed a diagnosis of Crohn's disease.



**Figure 11** Mild luminal narrowing with ulceration is noted in the proximal duodenum. Computed tomography of this patient (not shown) revealed mural thickening of the duodenum with cystic changes suggestive of cystic dystrophy.

ed involvement of proximal and distal duodenum (Figure 10). Less common findings are development of fissures, pseudodiverticulae and reflux of contrast into the biliary tree. Advanced gastroduodenal involvement may lead to pseudo-Billroth I appearance.



**Figure 12** Upper gastrointestinal barium study shows cut off of the duodenum at the junction of second and third part with collapsed distal duodenum suggestive of superior mesenteric artery syndrome.

**Extrinsic inflammatory or neoplastic diseases affecting the duodenum:** Nonspecific duodenal wall thickening may occur in inflammatory conditions of pancreas or gall bladder. In addition, adjacent neoplastic processes can involve duodenum, *e.g.*, pancreatic adenocarcinoma.

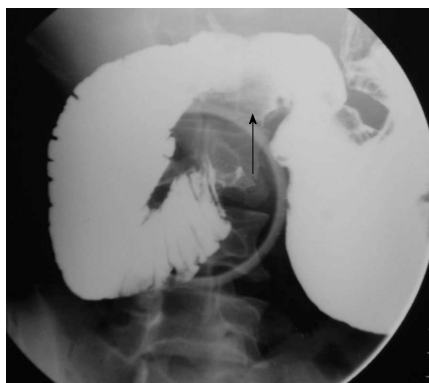
**Duodenal dystrophy:** This entity is associated with groove pancreatitis, a variant of chronic pancreatitis. It is characterised by the presence of multiple cystic lesions in the duodenal wall that is thickened because of chronic inflammation<sup>[12]</sup>. Barium findings are non-specific and demonstrate only stenosis of the involvement segment with or without irregularity of outline (Figure 11). Endoscopic ultrasound is the modality of choice. CT shows thickened duodenal wall between the duodenal lumen and pancreas. Cystic lesions are noted within the thickened wall.

### SMA syndrome

SMA syndrome is a rare condition characterised by acute angulation of SMA leading to compression of the third part of the duodenum between the SMA and the aorta<sup>[13]</sup>. The basic etiological factor is loss of abdominal fat due to a variety of debilitating conditions. Upper GIT barium study shows extrinsic compression of the third part, dilatation of the proximal duodenum and a collapsed small bowel distal to the impression of SMA (Figure 12).

### Neoplasms

Duodenal tumors account for about one-third of small bowel neoplasm. Overall small bowel tumors comprise only 5% of the gastrointestinal tumors. Benign tumors are rare. These include adenomatous polyp, lipoma and leiomyoma. Primary adenocarcinoma is the most common malignant lesion of the duodenum and is usually found in the periampullary region<sup>[14]</sup> (Figure 13). It presents as either a polypoidal mass causing filling defect or an irregular, annular constricting lesion with deformity of the lumen and mucosal irregularity. Rare malignant lesions include lymphoma (Figure 14) and malignant gastrointestinal stromal tumors.



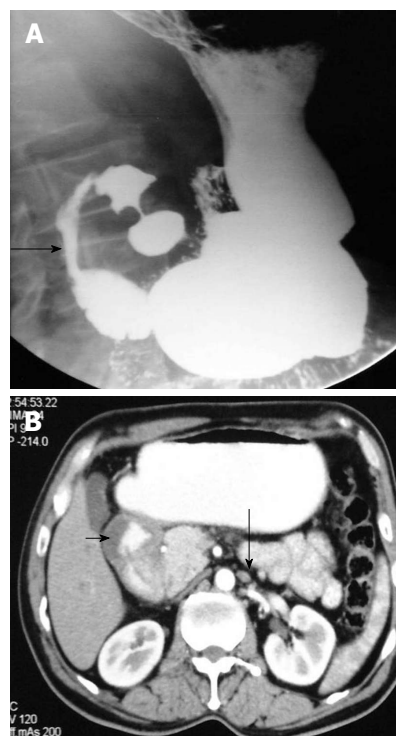
**Figure 13** A mass is noted in relation to the medial aspect of the first and second part of the duodenum with ulceration (arrow). In addition stricture with mucosal irregularity is seen in distal third part of duodenum. Endoscopic biopsy revealed adenocarcinoma.

## CONCLUSION

Duodenal pathologies are distinct from those in rest of the GIT. Upper gastrointestinal barium study comprises one of the initial methods of evaluation of duodenal pathologies. Though, not entirely specific for a particular pathological entity, barium studies do provide a fairly good idea about the underlying disease pattern and guide further management.

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**Figure 14** A long segment narrowing of the second part (arrow) of the duodenum is noted (A), axial computed tomography image (B) shows circumferential mural thickening of the duodenum (short arrow) with few para-aortic lymph nodes (long arrow). Endoscopic biopsy revealed a diagnosis of non-Hodgkin lymphoma.

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