Imaging of the stomach with endoscopic correlation: a case-based approach

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Learning objectives

1. Review gastric anatomy.

2. Describe different pathologies affecting the stomach.

3. Illustrate imaging features of bariatric surgeries focusing on post operative complications.

4. Correlate radiological features associated with gastric pathologies to their endoscopic counterparts.
Background

Gastric pathologies constitute a considerable portion of the spectrum of our practice in radiology. Cases displayed in this poster can roughly divided into five main categories: neoplastic, inflammatory, structural, post-bariatric surgery and miscellaneous conditions.

Key players of gastric imaging include: upper GI studies, CT scan, MR imaging and nuclear medicine studies. Imaging can be of substantial value narrowing the differential diagnosis of these pathologies. Endoscopy, on the other hand, compliments medical imaging and guides clinical decision making.

In this abstract, we will review the major radiological appearances of diseased stomach. In addition, we will correlate these appearances to their endoscopic counterparts. This shall help us understand the relative weaknesses and strengths of medical imaging in comparison with endoscopy in gastric assessment.
Findings and procedure details

**Gastric Anatomy:**

The stomach is an alimentary reservoir that mixes and partially digests food. It lies between the esophagus and the duodenum and is traditionally divided into cardia, fundus, body, antrum and pylorus. Anteriorly, it is related to the left lobe of the liver and the left hemidiaphragm, while posteriorly it is related to the stomach bed and lesser sac. These are better illustrated in figure 1.

The gastric mucosa is thrown into folds called "rugae". In a well-distended stomach, gastric wall thickness should be less than 5 mm. On the other hand, a thickness more than 10 mm is suspicious and warrants further investigation. It is important to remember that antral wall thickness commonly exceeds 5 mm and may normally measure up to 12 mm.

**Gastric Imaging:**

A wide variety of tools can be used to investigate gastric pathologies including upper GI studies, multi-detector CT (MDCT), MRI, EUS, PET-CT. In this poster, we are going to focus on upper GI studies and MDCT.

Generally speaking, upper GI studies can be done using single contrast or double contrast techniques. However, their role is increasingly being replaced by cross-sectional imaging. When an upper GI study is requested in our institute, we only perform a single contrast upper GI study.

On the other hand, in a well-distended stomach, MDCT can accurately assess for subtle luminal and mural lesions with higher accuracy, especially if intravenous contrast media is injected. However, as patient presentation is usually not very specific, tailored CT exam for the stomach is rarely done. In our institute, we generally acquire post contrast images using both oral contrast and intravenous contrast in porto-venous phase using 64 channel helical scanner at 1.5 & 5 mm collimation for patients with abdominal complaints.

For patients presenting with non-specific abdominal pain, MDCT might be the first study that can suggest a gastric pathology. On the other hand, patients presenting with post bariatric surgery complaints are usually assessed first using an upper GI study. Finally, for patients with very acute presentation e.g. hematemesis, endoscopy might be used first because of its diagnostic and therapeutic value.

**Gastric Pathologies:**
1) Neoplastic Conditions:

a. Adenocarcinoma (Figure 2):

This is by far the most common gastric malignancy, representing over 95% of malignant tumors of the stomach. CT appearance of this tumor is variable. It might be seen as a focal wall thickening with mucosal irregularity, a polypoid mass with/without ulceration, an ulcer or wall thickening with loss of normal rugal pattern.

Endoscopy plays a pivotal role in this context. It better characterizes the luminal surface of a CT detected lesion and more importantly obtains biopsies for definite histopathological assessment of any suspicious lesion.

b. Lymphoma (Figure 3):

The stomach is the most frequent site of gastrointestinal tract non-Hodgkin lymphoma. In comparison to gastric adenocarcinoma, lymphoma typically involves more than one region of the stomach with greater degree of wall thickness. Also, lymphoma is known to be a soft tumor, therefore gastric outlet obstruction is less common than adenocarcinoma. Finally, adenopathy that extends below the renal hila favors gastric lymphoma over adenocarcinoma as a diagnosis. These CT features makes lymphoma a more favorable diagnosis. CT is also useful in detecting tumor complications such as perforation, extra-gastric extension, or fistulization.

One variant, Mucosa-associated lymphoid tissue (MALT) lymphoma, is important to be considered here. It is a low-grade lymphoma that is being recognized with increasing frequency. It is thought to be associated with Helicobacter pylori. Its CT picture differs from high-grade non-Hodgkin gastric lymphoma as gastric wall thickening is usually minimal and associated adenopathy or extra-gastric distention is uncommon.

c. Gastrointestinal Stromal Tumors (GIST) (Figure 4):

This group of tumors typically arises in adults from mesenchymal cells in the wall of the gastrointestinal tract and account for only 1% of gastric tumors.

CT appearance of GIST is variable. It usually arises in the fundus or body of the stomach. Small tumors appear as intramural masses. As the tumors grow, they cause the overlying mucosa to stretch and ulcerate. Larger tumors, on the other hand, appear exophytic and may contain areas of central necrosis or calcification. It is uncommon to see associated adenopathy.
Malignant stromal tumors can invade adjacent organs and can metastasize hematogenously, usually to the lung or liver. Metastatic lesions may also appear low in attenuation due to necrosis.

CT usually cannot distinguish between malignant and benign gastric stromal tumors unless obvious local invasion or metastatic disease is seen. Thus, endoscopy and histopathological assessment of a suspicious lesion is essential.

d. **Gastric metastasis (Figure 5):**

These reach the stomach either through hematogenous, lymphatic or direct spread.

Some metastatic tumors have characteristic imaging appearance e.g. malignant melanoma metastasis characteristically appear as Bull's-eye or "target" lesions, while breast cancer metastasis manifest as markedly thickened gastric wall with enhancement and persevered folds mimicking primary scirrhous carcinoma of stomach "*Linitis plastica*".

Metastatic tumors directly spreading to the stomach are typically seen as tumors arising from an adjacent structure e.g. transverse colon or pancreas and invading the gastric wall. These might not be evident on endoscopy if gastric mucosa remained intact.

e. **Other less common gastric intramural tumors (Figure 6):**

Other less common gastric intramural neoplasms include lipomas, neuroendocrine tumors, glomus tumors, hemangiomas and schwannomas. Some of these might have characteristic CT appearance e.g. lipoma appears as pure fat density lesion. In other circumstances, a biopsy is necessary to reach an accurate histopathological diagnosis.

2) **Inflammatory Conditions:**

a. **Gastitis (Figure 7):**

This is an entity where endoscopy has the upper hand. Except for wall thickening, gastritis typically doesn't have a specific CT picture. Thus, without clinical suspicion, this entity might be missed.

b. **Gastric ulcer (Figure 8):**

CT can see only deep ulcers or ulcers that have penetrated or perforated the gastric wall mainly due to associated gastric wall thickening, soft tissue inflammatory changes
or extraluminal air. On the other hand, most gastric ulcers are not visible at CT as they affect only the superficial layers of the gastric wall.

c. Emphysematous Gastritis (Figure 9):

This is an uncommon life-threatening condition that usually results from gastric wall invasion by an organism, most commonly E.coli. It must be differentiated from gastric emphysema. The distinction between both conditions is usually clinical. Gastric emphysema is a more common benign condition that is usually an incidental finding in an asymptomatic individual.

3) Structural Conditions:

a. Gastric volvulus:

This refers to gastric rotation in relation to adjacent structures. It occurs in two forms.

I. Organo-axial volvulus (Figure 10):

- More common.

- The stomach is rotated along its long axis i.e. lesser curve to the left side and greater curve to the right side.

- Strangulation and necrosis are common.

II. Mesentero-axial volvulus (Figure 11):

- Less common.

- The stomach is rotated along its short axis i.e. GEJ is lower in position than the pyloro-duodenal junction.

- Usually, rotation is incomplete and might be intermittent.

b. Hiatus hernia:

This refers to herniation of part of the abdominal contents (most commonly stomach) through the esophageal hiatus of the diaphragm. This can be divided into two main categories:

I. Sliding hiatus hernia (Figure 12):

- Most common (around 90%).
- The gastro-esophageal junction is 2 cm above the esophageal hiatus. In addition, the esophageal hiatus is widened reaching up to 4 cm.

- Endoscopically, a sliding hiatus hernia is diagnosed when the distance between the squamocolumnar junction and the diaphragmatic impression exceeds 2 cm using the hash marks on the endoscope relative to the incisors. One technique to improve accuracy is to retroflex the instrument and viewing from below. The lumen becomes narrow where the diaphragm presses against the stomach.

II. Para-esophageal hernia (Figure 13):

- Less common.

- Gastroesophageal junction remains in its location while part of the stomach herniates through the esophageal hiatus.

- Again, best seen by endoscope retroflexion.

4) Post-bariatric Surgery Complications:

The most common bariatric procedures performed include laparoscopic Roux-en-Y gastric bypass, laparoscopic adjustable gastric banding, laparoscopic sleeve gastrectomy and intragastric balloons. Fluoroscopic upper GI studies examinations and MDCT are the major imaging tests used to evaluate patients after these surgeries. On the other hand, endoscopy might be a part of treatment plan rather than a diagnostic tool.

A number of complications occur which varies according to the bariatric surgery. Figures (14-22) display some of these complications with a hint of the clinical background of these cases.

5) Miscellaneous Gastric Disorders:

a. Gastric varices (Figure 23):

These usually occurs in conjunction with esophageal varices secondary to portal hypertension. Isolated gastric varices might be seen also in the setting of splenic vein thrombosis. Most gastric varices appear as a continuation of esophageal varices and extend 2 to 5 cm below the gastroesophageal junction, along the lesser curvature of the stomach.

b. Gastric bezoar (Figure 24):

This refers to accumulation of foreign material within the stomach, most commonly undigested food or hair. This appears on CT as a non-enhancing intra-luminal mass.
with characteristic mottled appearance secondary to air bubbles retained within the mass. Endoscopy both confirms the diagnosis and allows for endoscopic lavage and fragmentation as well.

c. Dieulafoy Lesion (Figure 25):

Dieulafoy’s lesion "caliber persistent artery" is a relatively rare, but potentially life-threatening condition. It accounts for 1-2% of acute gastrointestinal (GI) bleeding but arguably is under-recognized rather than rare. Its serious nature makes it necessary to include it in the differential diagnosis of obscure GI bleeding.

A normal artery of the GI tract will narrow progressively as it traverses the wall of its end organ. This is not the case in Dieulafoy’s lesion where a vessel maintains a constant width of 1-3 mm. This diseased vessel appears tortuous and typically protrudes through a small mucosal defect varying from 2-5 mm as well.
Fig. 1: Schematic presentation of the gastric anatomy.

**Fig. 2:** Gastric Antral Adenocarcinoma; CT scan shows an irregular area of circumferential antral wall thickening in addition to omental caking & ascites. Endoscopy confirms the imaging findings and shows an ulceroinfiltrative gastric antral lesion.

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**Fig. 3:** Diffuse Large B-Cell Lymphoma; CT scan shows marked antral wall thickening and peri-antral stranding suggesting an infiltrative lesion. The lesion is hypermetabolic in PET-CT with associated supra& infra-diaphragmatic lymphadenopathy. Endoscopy confirms an antral ulcerative mass which extends into the serosa on complimentary endoscopic US.

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Fig. 4: Gastrointestinal Stromal Tumor; CT scan shows a gastric exophytic soft tissue mass related to the lesser curvature of the stomach with central low density areas. It shows heterogeneous mainly peripheral enhancement. Endoscopy shows mucosal bulge with no evidence of mucosal lesion.

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**Fig. 5:** Colonic poorly differentiated adenocarcinoma invading the gastric submucosa; CT scan shows a heterogeneous mass with central low density areas arising from the transverse colon and abutting the greater curvature of the stomach. Endoscopy shows mucosal bulge with no mucosal lesions.

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Fig. 6: Gastric Antral Glomus Tumor; MRI shows a gastric submucosal lesion along the distal greater curvature of the stomach. The lesion is of low signal on T1WI, high signal on T2WI and shows no diffusion restriction. Endoscopy with complementary EUS shows a well defined submucosal gastric lesion of heterogeneous echogenicity. No invasion of muscle layer is seen.

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Fig. 7: Gastritis; CT scan shows mild non-specific thickening and enhancement along the greater curvature of the stomach. Endoscopy later confirmed the presence of gastritis.

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Fig. 8: Healing gastric ulcer; unremarkable contrast enhanced CT scan of the abdomen. On endoscopy, a small healing gastric ulcer is seen.

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**Fig. 9:** Emphysematous Gastritis; CT scan shows a distended stomach with linear lucencies within its wall, perigastric stranding and traces of perigastric fluid.

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**Fig. 10:** Organo-axial volvulus; upper GI study shows rotation of the stomach along its long axis with greater curvature lying superior to the lesser curvature. However, contrast passage was unobstructed. Following surgical intervention, endoscopy was repeated and was unremarkable.

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**Fig. 11:** Gastric outlet obstruction secondary to mesentero-axial volvulus; CT scan shows a grossly distended stomach filled with oral contrast. It also appears rotated along its short axis with the gastro-duodenal junction (A) higher in position than the gastro-esophageal junction (B). The patient was transferred to OR for surgery.

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Fig. 12: Sliding Hiatus Hernia; scout view of upper GI study shows a retrocardiac shadow. Following oral contrast ingestion, the fundus of the stomach is seen herniating into the thoracic cavity. Endoscopy confirmed the presence of the hiatus hernia in addition to mild esophagitis.

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Fig. 13: Para-esophageal Hiatus Hernia; upper GI study and contrast-enhanced CT scan show herniation of the gastric fundus through the esophageal hiatus while the gastro-esophageal junction is still in place. Endoscopy in retroflexion display this finding again.

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Fig. 14: Complicated Sleeve Gastrectomy; patient presented with abdominal pain and vomiting following sleeve gastrectomy. First upper GI study shows a trace of oral contrast tracking to the left sub-diaphragmatic region. Further evaluation by contrast enhanced CT shows left sub-diaphragmatic collection. Endoscopy was used to inserted a stent which migrated and was then removed. Follow-up upper GI study shows again the contrast leak with delayed filling of the bronchial tree suggestive of gastro-bronchial fistula.

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**Fig. 15:** Complicated Sleeve Gastrectomy; patient presented one year following sleeve gastrectomy with severe reflux symptoms. Endoscopy revealed hiatus hernia in addition to antral gastritis. Further evaluation by upper GI study confirms the presence of hiatus hernia in addition to severe reflux along with prominent esophagus showing tertiary contractions.

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Fig. 16: Complicated Sleeve gastrectomy; patient presented one year following sleeve gastrectomy with abdominal pain. Endoscopy shows a fundal diverticulum and an antral polypoid lesion which was resected. Upper GI study confirms the presence of a fundal diverticulum with no evidence of oral contrast leakage.

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Fig. 17: Complicated Sleeve Gastrectomy; patient presented 1 month following sleeve gastrectomy with persistent vomiting. Upper GI study revealed significant contrast hold-up in the middle part of the gastric remnant. Endoscopy confirmed the presence of stricture at this region which was managed using balloon dilatation.

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Fig. 18: Gastric Bypass Complicated by Gastro-gastric Fistula; patient presented few weeks following gastric bypass with abdominal pain, vomiting and cough. Upper GI study shows opacification of the excluded part of the stomach and duodenal limb by contrast material. Endoscopic assessment of the same patient visualized the opening of the fistula but failed to explore it.

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**Fig. 19:** Gastric Bypass Complicated by Obstruction; patient presented 3 month after gastric bypass with persistent vomiting. Scout view of the upper GI study shows a suspected lamillated filling defect at the site of the gastric remnant. In addition, oral contrast didn’t pass beyond the gastric remnant. Endoscopy revealed an obstructing food bolus in the gastric fundus which was fragmented and pushed through the jejunal limb.
**Fig. 20:** Slipped Gastric Band; patient presented following gastric band insertion with vomiting and abdominal pain. Upper GI study shows slipped band with secondary contrast hold up. Upper GI endoscopy was done and confirmed no band erosion. The band was deflated under fluoroscopy guidance and removed.

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**Fig. 21:** Gastric Band Erosion; patient presented with abdominal pain. Endoscopy revealed band erosion through the gastric wall. Further assessment by upper GI study showed free flow of contrast with no contrast hold-up or leak.

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Fig. 22: Impacted intragastric Balloon; patient presented with persistent vomiting. Non-enhanced CT scan shows impacted intact intragastric balloon with proximal gross gastric dilatation. Endoscopy confirmed an intact intragastric balloon that was deflated and removed.

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Fig. 23: Gastroesophageal Varices; patient presented with hematemesis which was first evaluated by endoscopy. Endoscopy revealed bleeding varices which was managed endoscopically, but failed. Further evaluation by CT revealed gastro-renal shunt in addition to the already known varices. The patient was managed by BRTO procedure which successfully controlled the bleeding.

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Fig. 24: Gastric Outlet Obstruction Secondary to Bezoar; CT scan shows gastric outlet obstruction secondary to a duodenal mixed density structure with intra-luminal air within. Endoscopy shows a dilated stomach secondary to distal gastric and duodenal phytobezoar.

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Fig. 25: Dieulafoy Lesion; patient presented with severe hematemesis. Upper GI endoscopy shows a Dieulafoy Lesion which was treated by adrenaline injection and clipping. Further evaluation by CTA revealed no active contrast extravasation or gastric wall lesions.

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Conclusion

It is clear from the previous discussion the relative strengths and weakness of medical imaging relative to endoscopy. While medical imaging might provide a better overview of the gastric pathologies relative to its surroundings, endoscopy better characterizes the luminal surface of gastric lesions, provides means to biopsy such lesions for histopathological assessment and might be used for therapy as well. Thus, optimum use of each diagnostic test is necessary for sound patient management.
Personal information

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References


