Multimodality Evaluation of Gastric Pathology with Endoscopic Correlation: Part 1, Non-Neoplastic Disease Entities

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Audience and Objectives

Target Audience: Practicing Radiologists, Gastroenterologists, Residents and Fellows in Training.

Objectives:

1. Review normal gastric anatomy and physiology as it relates to various pathological entities.

2. Illustrate the non-neoplastic spectrum of gastric pathology on abdominal CT and fluoroscopy with selected endoscopic correlation.

3. Describe differentiating features and findings relevant to further work-up and management.
**Stomach**

- **DISTENSIBILITY:** Easily distensible
- **WALL:** Homogeneous enhancement. Normal gastric wall thickness is **site specific**:
  - <10 mm in thickness for an under distended stomach.
  - <5 mm for a distended gastric body
  - The distal gastric antrum often exceeds the threshold of 5 mm. Some studies suggest that irregular or eccentric antral thickening >12 mm is abnormal.
  - Pseudo-thickening is also noted at the fundus.
  - Gastric wall thickening is a nonspecific finding. Wall thickness of >1 cm has a high sensitivity but low specificity in detecting malignant or potentially malignant lesions on CT, therefore further diagnostic evaluation may be required.
  - Assess enhancement pattern, if thickening is focal, eccentric or irregular.
- **Imaging Evaluation:**
  - Upper Gastrointestinal Fluoroscopy (UGI)
  - Contrast enhanced CT (CECT)

Normal stomach appearance on (A-B) **double contrast UGI**, (C-D) **contrast enhanced CT** (CECT), and (E-F) **Esophagogastroduodenoscopy** (EGD).
### Abnormalities of the Stomach

#### Wall
- Thickening
- Circumferential
- Gastritis (A) - i.e. NSAIDS, H. pylori, radiation, hypertrophic gastropathy
- Tumor
- Eccentric
- Tumor – Primary or metastatic
- Serpentine
- Varices

#### Lumen
- Foreign body
- Polyps (B)
- Leiomyoma
- Lipoma
- Gastrointestinal Stromal Tumor (GIST)
- Bezoar/Retained food
- Ectopic pancreatic rest
- Malignant Neoplasms

#### Distensibility
- Extrinsic mass effect
- Annular pancreas
- Regional adenopathy or other mass effect
  - Inherent mural indistensibility (C)
- Malignancy
- Peptic scarring
- Corrosive ingestion
- Granulomatous disease

#### Position
- Hiatal hernia (D)
- Volvulus

#### Integrity
- Ulcer (E)
- Perforation
- Emphysematous gastritis
- Gastric emphysema
UGI Evaluation

Normal UGI:

- Rugal folds
- Mucosa
- Distensibility
- Anatomy/position
- Presence and degree of reflux

Abnormal UGI:

- Thickened rugal folds
- Polyps
- Persistent indistensibility
- Hiatal hernia with esophageal reflux
- Ulcerations

Imaging of the Stomach: UGI
Imaging of the Stomach: EGD

Esophagogastroduodenoscopy (EGD)

- Normal esophagus
- Normal rugal folds
- Normal mucosa
- Normal duodenum
- Esophagitis
- Blood
- Erythema
- Ulceration
- Retained food
- Rugal fold thickening
- Luminal narrowing
- Polyps
CT Gastric Evaluation

- Gastric abnormalities can commonly be encountered on routine CT evaluation, although a contracted stomach may mask or mimic many gastric lesions.
- CT gastrography can prospectively optimize gastric distention in patients with suspected gastric disease.
  - Methods of distention:
    - Effervescent granules with a small amount of water to distend the stomach prior to CT.
    - 750 mL of water approximately 15 minutes prior to scanning and an additional 250 mL immediately prior to scanning.
    - May use a combination of supine and prone imaging to ensure adequate gastric distention.

Normal Stomach: (A) Axial CECT images of the decompressed stomach. (B) Axial images at the same level from CT Enterography in the same patient with gastric distention.
Gastritis

- Most common site of involvement: Antrum
- CT features: Thickened gastric folds, wall thickening with soft tissue attenuation
- Risk factor: *Helicobacter pylori* infection, alcohol, aspirin, nonsteroidal anti-inflammatory drugs, stress, viral or fungal infection, chemotherapy agents and radiation
  - *H. pylori* gastritis is identified in nearly 80% of patients with gastric ulcers and in nearly 100% of patients with chronic gastritis. It is a significant risk factor for developing adenocarcinoma and lymphoma. Diagnosed with serologic tests and endoscopic biopsies. Treatment: acid blocker and antibiotics.
  - Radiation gastritis may be seen 1 month to 2 years after therapy. Gastric thickening is demarcated by boundaries that correspond to radiation ports.
    - Often in patients with pancreatic cancer who undergo radiation therapy after a Whipple operation. Thickening is usually seen in the area of gastrojejunostomy which corresponds to the site receiving peak radiation dose.
- Biopsy is required in some cases, as polypoid and lobulated folds are difficult to distinguish from cancer

Imaging appearance of gastritis: (A - B) gastric wall thickening on axial CECT. EGD demonstrating (C) erythema (D) luminal narrowing and (E) nodular gastric wall thickening.
Localized gastric wall thickening

(A) Coronal and (B) axial CT and (C-D) UGI demonstrate localized wall thickening along the greater curvature. Pathology confirmed moderate to severe chronic gastritis and + H. pylori

Diffuse gastric wall thickening

(A-C) CT and (D) UGI demonstrate diffuse gastric wall thickening. Pathology confirmed chronic gastritis and + H. pylori
Gastritis- Non H. pylori

(A - B) Axial and coronal CECT images of a patient with viral gastritis.

(C- D) CECT and UGI of patient with gastritis caused by underlying pancreatitis and outlet obstruction. (E) follow up image with diffuse gastric thickening

(F) Axial CECT demonstrates a pancreatic pseudocyst.

(G) coronal CECT 2 weeks later with new focal intramural fluid collection in the greater curvature of the stomach.

(H) Note no intramural fluid present 2 weeks prior. Compatible with an intramural gastric pseudocyst.
Varices

Imaging features

- **CT:**
  - Gastric: Well-defined clusters of rounded or tubular enhancing structures within body and fundus of the stomach.
    - Antrum is typically spared.
  - Perigastric: Collateral vessels are commonly seen in the region of the gastrohepatic ligament, near the lesser omentum, along the course of the coronary vein.
  - Can be mistaken for gastric wall thickening, gastric cancer, or perigastric adenopathy on both endoscopy and CT, particularly if intravenous contrast material is not administered for the CT.

- **UGI:**
  - Multiple serpentine filling defects that change in size and shape during fluoroscopic observation.
  - “Downhill” varices: Upper 1/3 of esophagus, results from superior vena cava obstruction. Often asymptomatic.
  - “Uphill” varices: Lower aspect of esophagus, result from portal hypertension. May present with GI bleeding.

- Differential: Varicoid carcinoma appears fixed, often with shouldered margins and noncompliant wall.

**Images:**

- (A-D) UGI demonstrates serpentine filling defects that change in size and shape between images.
- (E) Corresponding CECT demonstrates esophageal mucosal varices.
Gastric Varices

- Commonly associated with splanchnic obstruction or portal hypertension
- Gastric varices in association with esophageal varices: underlying cirrhosis and portal hypertension
- Gastric varices without esophageal varices: Underlying splenic vein thrombosis or occlusion
  - Most commonly secondary to pancreatitis or pancreatic carcinoma

Portal hypertension: (A-D) Gastric and perigastric varices on CT.
Splenic vein thrombosis: (E) Isolated gastric cardia varices on CT with (F) corresponding appearance of the (F) gastric cardia varices on EGD.
Rare hypertrophic gastritis linked to TGF-A activation of the EGFR receptor

Middle aged, men > women

CT features: Giant gastric wall folds usually confined to the proximal stomach, especially the greater curvature. Folds are pliable and organized (follow the normal rugal distribution).

Typically spares the antrum

Differential diagnosis:

- Lymphoma - disorganized and enlarged folds
- Zollinger-Ellison syndrome - thick folds, ulcers in the stomach and duodenum, and enhancing mass in the gastrinoma triangle

Menetrier’s Disease with diffuse gastric fold thickening on CECT
Hypertrophic Gastropathy: Zollinger-Ellison Syndrome

- Hypersecretion of gastric acid secondary to a gastrinoma. 80-90% of gastrinomas are found in the gastrinoma triangle. At least half of the tumors are malignant.

- Elevated hormone gastrin (even after secretin injection) → gastric acid hypersecretion → recurrent peptic ulcer disease, diarrhea, reflux, pain, anemia.

- Imaging findings: hypersecretions, thickened rugal and duodenal folds, multiple ulcers, recurrent duodenal and jejunal ulcers.

- ~25% have MEN 1

- Differential: gastritis from other causes, gastric lymphoma

**Gastrinoma triangle:** Junction of the cystic and common bile duct, junction of the head/neck of the pancreas and junction of the 2nd/3rd portion of the duodenum

(A) Coronal enhanced T1W MRI demonstrates marked gastric wall thickening with hypervascular peripancreatic mass in the gastrinoma triangle. (B) Endoscopic ultrasound demonstrates corresponding solid mass. (C) EGD demonstrating rugal fold thickening. (D) In-111 Octreotide scan demonstrates corresponding abnormal tracer accumulation, consistent with a neuroendocrine tumor (gastrinoma).
Gastric Polyps

- Types: Hyperplastic, adenomatous, and hamartomatous polyps
- Most polyps are either hyperplastic or adenomatous.
- Gastric polyps in Peutz-Jeghers syndrome, juvenile polyposis, and Cronkhite-Canada syndrome are hamartomatous polyps.
- Gastric polyps in Lynch syndrome are adenomatous.
- May be difficult to see on CT, especially when exam is not tailored for gastric evaluation.
- Polyps are better visualized on EGD and UGI than on routine CECT.

(A) CECT demonstrates subtle polyps along the anterior gastric wall, indistinguishable from rugal folds. (B) Corresponding EGD clearly delineates innumerable polyps in the same patient. (C) Polyps and (D) familial adenomatous polyposis (FAP) syndrome visualized on UGI in additional patients.
Gastric Polyps

Hyperplastic polyps

- 75-90% of all gastric polyps
- Seen in the setting of chronic gastritis, atrophic gastritis, or bile reflux gastritis
- No malignant potential, but increased risk for coexisting gastric carcinomas.
- Smooth, sessile, round, or oval lesions, ranging from 5 to 10 mm in diameter
- Usually multiple lesions of similar size, clustered in the gastric body or fundus on the posterior gastric wall
- Innumerable hyperplastic polyps in the gastric polyposis syndrome (fundic gland polyposis).
- Gastric polyps in FAP are usually hyperplastic, whereas polyps in the remaining intestines are adenomatous.

Multiple gastric polyps noted on (A-C) UGI with corresponding (D - E) polyps on EGD.
Pathology confirmed hyperplastic polyps with underlying gastritis.
Gastric Polyps

Adenomatous polyps

- Rare
- Larger than hyperplastic polyps (>1 cm), more commonly pedunculated
- Often solitary
- Occur adjacent to antrum
- 40% of cases contain or will develop carcinoma, generally among the larger lesions (>2 cm)

(A) Noncontrast CT demonstrates a polypoid mass along the greater curvature. (B) Axial and (C) coronal contrast enhanced CT demonstrates avid enhancement of this polypoid mass.
Foreign Bodies in the stomach: (A-B) Scout and CT demonstrate a fork handle in the stomach. (C) Scout demonstrates ileus and a necklace in the stomach. (D-E) Axial and coronal CT demonstrate a bag of drugs in the stomach in a drug mule.
Incomplete Distensibility

- **Extrinsic pathology**
  - Lymphadenopathy
  - Annular pancreas
  - Bowel
- **Intrinsic pathology**
  - Linitis plastic (metastases or scirrhous adenocarcinoma)
  - Scarring or stricture
  - Granulomatous disease

(A) Indistensible gastric antrum on UGI due to adjacent dilated bowel loops better seen on (B) CT

(A) Coronal CECT demonstrates gastric distention and **gastric outlet obstruction**. (B) CECT demonstrating **annular pancreas** at the site extrinsic compression. (C) Corresponding EGD demonstrates **luminal narrowing** from extrinsic compression, no intraluminal mass. (D) UGI following **gastrojejunostomy** as definitive treatment.
Hiatal Hernia

- Sliding and Paraesophageal types
- May be seen on UGI and CT
- Identify supradiaphragmatic location of the gastroesophageal junction
- May be potential risk for volvulus

(A) Small hiatal hernia on an UGI.  (B -C) Larger paraesophageal hernia with (D) evidence of reflux on UGI.  (E) Retrocardiac density on chest radiograph corresponds to a large paraesophageal hernia as seen on (F) axial and (G) coronal CECT.
Gastric Volvulus

- Rare
- 180° torsion of the stomach with intrathoracic location of the stomach:
  - Organoaxial
    - Torsion along the longitudinal axis (upside down stomach). Greater curvature is located superiorly and the body is cranial to the fundus.
  - More common
    - Often associated with a long standing hiatal hernia, paraesophageal hernia or diaphragmatic eventration.
  - Mesenteroaxial – torsion about the gastric mesentery
    - Antrum and pylorus torse anteriorly and superiorly
    - Often causes obstruction in the region of the pylorus/antrum.
- Ischemia and gangrene may develop in either subtype.
- Treatment: surgical intervention

Organoaxial gastric volvulus: (A-C) Coronal CECT and (D) sagittal CECT images demonstrate intrathoracic location of the stomach with gastric distention and the greater curvature cranial to the lesser curvature.
## Gastric Ulcers

- Mucosal defect that extends to the muscularis mucosa and beyond
- Usually occur as a solitary lesion
- Important cause of acute abdomen: bleeding, perforation, obstruction or penetration
- Associations: Aspirin, nonsteroidal anti-inflammatory drugs, alcohol, coffee, corticosteroids, and stress
- Imaging findings may include:
  - Mucosal defect extending beyond the expected contour of the stomach
  - Regional edema
  - Gastric outlet obstruction
  - Perforation
- Average time to heal is 8 weeks.

### Integrity: Peptic Ulcer Disease

**Benign ulcer:** round or oval crater, smooth & symmetric ulcer collar (submucosal edema surrounding the ulcer cavity),

**Hampton line:** thin line of nonulcerated mucosa surrounding the ulcer. Folds cross the mound of surrounding edema and extend up to the ulcer crater. Most are along lesser curvature (posterior wall of the antrum or body of the stomach).

**Malignant ulcer:** nodular ulcer collar, abrupt transition between surrounding tissue and normal gastric wall. Crater does not project beyond the expected location of the gastric wall. Radiating folds do not extend to the ulcer crater. **Carman meniscus** ulcer straddling the lesser curvature looks like a crescent on compression views with nodular tumor surrounding the periphery of the ulcer.

### Giant gastric ulcer (>3 cm):

- (A) Axial and (B) coronal CECT demonstrates a large ulcer along the lesser curvature of the stomach in a patient presenting with melena.
- (C) A 4 x 3 cm clean based ulcer on corresponding EGD along the lesser curvature without active bleeding.
- (D) Follow up EGD following 8 weeks of proton pump inhibitor treatment demonstrates healing of the ulcer.
Peptic Ulcer Disease

Extensive Edema and Wall Thickening

Peptic Ulcer Disease: (A - B) coronal CECT demonstrates irregular edema and ulceration of the antrum with suspected microperforation. (C - D) UGI demonstrates multiple ulcers of the gastric antrum.

Gastric Outlet Obstruction

(A) Axial and (B) coronal CT demonstrates gastric outlet obstruction with edema and ulceration of the antrum and pylorus. Corresponding EGD demonstrates (C) retained food, (D) large deep ulceration at the pylorus with (E) narrowing of the pylorus channel. Pathology confirmed gastritis and ulceration with presence of H. pylori and fungi.
Emphysematous Gastritis

- Causes:
  - Infection by a gas-producing organism, typically *Escherichia coli*
  - Caustic ingestion
  - Alcohol abuse
  - Ischemia
  - Life-threatening condition with a high mortality rate
    - Acute sepsis
    - Gastric hemorrhage
  - Imaging features: Gastric wall thickening, air within layers of gastric wall
  - Endoscopic features: “cobblestone” appearance of the gastric mucosa from submucosal blebs of air

(A) Patient with lap band presents with acute abdominal pain. Axial CECT demonstrates a *malpositioned gastric band* and *air within the gastric wall* due to resulting ischemia.

(B) UGI demonstrates subsequent removal of the band.
Gastric Emphysema

- Benign condition
- More commonly seen than emphysematous gastritis
- CT appearances of gastric emphysema and emphysematous gastritis can be similar
- Patients with benign gastric emphysema are **asymptomatic** and condition resolves spontaneously
- Causes: Infection, ischemia, increased intraluminal pressure, severe vomiting, spontaneous or traumatic rupture of a pulmonary bulla, nasogastric tube placement
- Imaging features: Linear distribution of mural air without associated wall thickening and inflammation

(A) CT demonstrates air within the gastric wall noted incidentally in an asymptomatic patient with (B) large underlying bullae. Findings are most consistent with benign gastric emphysema. (C) Follow up NECT demonstrates spontaneous resolution of the gastric emphysema.
### Differential Diagnosis

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- Antrum spared: Varices and Menetrier’s disease
- Greater curvature predominantly: Menetrier’s disease; thickened organized folds.
- Lesser curvature: benign ulcers (Hampton line)
- Antrum predominantly: H. pylori gastritis, lipoma
- Stomach and duodenal ulcerations and rugal fold thickening: Zollinger- Ellison syndrome → look for tumor in gastrinoma triangle
- Lymphoma: thickened disorganized folds
Conclusion

- Gastric pathology is commonly encountered on abdominal CT and fluoroscopy, which are complimentary in evaluating the stomach mucosa and surrounding structures.

- The radiologist plays an essential role in characterizing the lesions and guiding further endoscopic work-up and management.
References

• Kim JH, Eun HW, Goo DE, Shim CS, Auh YH. Imaging of Various Gastric Lesions with 2D MPR and CT Gastrography Performed with Multidetector CT. Radiographics. 2006; 26: 1101-1118.

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