Multimodality Evaluation of Gastric Pathology with Endoscopic Correlation: Part 2, 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 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

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**A**

**B**

**C**

**D**

**E**
UGI Evaluation

Normal UGI:

(A) rugal folds, (B) mucosa with areae gastricae pattern and GE junction, (C) distensibility and posterior duodenal sweep.

Abnormal UGI:

(A) Thickened rugal folds, (B) polyps, (C) persistent indistensibility, (D) hiatal hernia with esophageal reflux and (E) ulcerations.

Gastric Evaluation (radiologically or endoscopically):
- Rugal folds
- Mucosa
- Distensibility
- Anatomy/position
- Presence and degree of reflux
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
Gastric Adenocarcinoma

Background

- Most common gastric malignancy, > 95% of all malignant tumors of the stomach
- Overall 5-year survival rates < 20%
- Prognosis correlated to stage: CT is the staging modality of choice
- Peak incidence: 50 and 70 years
- Early stage gastric cancers are curable lesions, with 5-year survival rates of more than 90%
- Predisposing conditions: atrophic gastritis, pernicious anemia, gastric polyps, partial gastrectomy, and Ménétrier disease
- 30% of cancers are located in the antrum, 30% in the body, and 30% in the fundus or cardia region. The remaining 10% are diffusely infiltrating lesions that involve the entire stomach

Pathology

- Most gastric cancers are adenocarcinomas of mucinous cell origin
- Signet-ring cell carcinomas account for 5%–15% → scirrhous infiltration of the gastric wall. Scirrhous carcinomas frequently involve the distal half of the stomach, arise near the pylorus, and gradually extend upward from the antrum into the body and fundus.

Imaging features

- Focal area of mural thickening with or without
- Polypoid lesion
- Generalized mural thickening
- In early gastric cancers, malignant invasion is limited to the mucosa or submucosa. Advanced gastric cancer invades the muscularis propria.
- Signet-ring cell cancer usually manifests as a scirrhous tumor of the stomach that leads to obliteration of gastric folds and diffuse thickening of the gastric wall (linitis plastica)
CT Evaluation Gastric Adenocarcinoma

• CT is the staging modality of choice because it can identify the primary tumor and assess for extragastric disease, which is vital to determine treatment, palliative versus curative gastric surgery.

• EUS (endoscopic ultrasound) is the diagnostic modality of choice for the preoperative staging of early gastric cancer.

• Extragastric disease:
  • Direct extension:
    • Pancreas via lesser sac.
    • Transverse colon via gastrocolic ligament.
    • Liver via gastrohepatic ligament.
  • Longitudinally, ie esophagus
  • Lymph nodes: Local, regional or distant
  • Distant Metastases

(A) Axial and (B) coronal CECT of a patient with gastric cancer demonstrates extensive extragastric spread with regional lymphadenopathy (yellow arrows) and periportal extension of tumor (blue arrow) to the liver with narrowing of the portal vein.
Ulceration

(A-C) Abnormal persistent area of ulceration (yellow arrows) in the gastric antrum on UGI. (D) CECT demonstrates antral mural edema and thickening (blue arrow).

(E-G) Corresponding EGD demonstrates prominent gastric folds (green arrows) in the antrum which did not distend easily.
Infiltration: Focal Indistensibility

Scirrhous adenocarcinoma: (A-B) UGI demonstrates a rigid mid-distal gastric body (yellow arrows) with distorted rugal pattern, but no gastric obstruction. (C-E) Corresponding CT demonstrates irregular thickening (green arrows) of the gastric body and antrum.
Linitis Plastica- Diffuse Indistensibility

(A-B) UGI demonstrates persistent gastric indistensibility (yellow arrows).

(C-D) CECT demonstrates corresponding diffuse gastric wall thickening (green arrows).

(E-G) EGD confirms diffuse irregular thickening with infiltration of the folds (blue arrows) extending from the cardia to the peri-pyloric region in the antrum. Irregular and minimally stenotic lumen (magenta arrows).

Pathology confirmed signet ring cell cancer, with a background of chronic gastritis.

Linitis Plastica Differential:
- Scirrhous Adenocarcinoma
- Metastatic disease (breast)
- Lymphoma
- Granulomatous disease
Patient with a history of H. pylori gastritis presents with early satiety and abdominal pain. (A-B) Axial MRI and (C) axial and (D) coronal CECT demonstrates prior gastrojejunostomy (yellow arrow) with irregular circumferential thickening (blue arrows), loss of normal rugal fold pattern (green arrow) and luminal narrowing (magenta arrows) of the gastric antrum as well as multiple prominent lymph nodes (red arrow). (E-G) EGD demonstrates an indurated (orange arrows) circumferential mass (blue arrows) involving the antrum with narrowing of the gastric lumen.
Focal wall thickening

(A) Coronal CECT demonstrates more focal thickening (green arrow) and hyperenhancement (yellow arrow) of the greater curvature. (B - C) Corresponding EGD demonstrates an erythematous ulcerating mass (orange arrows).

(A) axial and (B) coronal CECT demonstrates marked irregular thickening (blue arrows) of the gastric antrum. (C) Corresponding EGD demonstrated a mass (magenta arrows) extending from the pre-pyloric antrum to the duodenal bulb with diffuse ulceration and friable appearing mucosa.
Diffuse wall thickening

(A) Axial and (B) coronal CECT demonstrates thickening of the stomach (yellow arrows), particularly the greater curvature. (C-D) Corresponding EGD demonstrates a deep friable gastric ulcer (blue arrows) with irregular borders at the angularis, worrisome for malignancy. Pathology confirmed poorly-differentiated adenocarcinoma, diffuse type with signet ring cell features. - H. pylori.

(A-B) Axial CECT demonstrates irregular marked gastric wall thickening (green arrows). (C-D) Corresponding EGD with erosive, friable, edematous and nodular gastric mucosa (red arrow). Pathology confirmed signet ring cell cancer, ulcer and H. pylori.
(A) Coronal and (B) axial CECT demonstrates an enhancing polypoid mass (green arrows) in the stomach. (C) UGI confirms a polypoid filling defect (blue arrow) in the stomach. (D) Corresponding EGD demonstrates an approximately 3 cm ulcerated fundal mass (yellow arrows). Pathology confirmed gastric adenocarcinoma.
Gastric Adenocarcinoma: (A-B) Circumferential thickening (yellow arrows) and hypoenhancement of the gastric antrum on CECT. (C) Gastric outlet obstruction with irregular narrowing of the antrum (blue arrows) on UGI and (E-G) EGD.
Virchow Nodes

(A) Axial and (B) coronal CECT demonstrates gastric outlet obstruction (yellow arrow) due to an antral mass (blue arrow).

(C) Corresponding EGD demonstrated a friable malignant appearing antral mass.

(D-E) Staging CT Chest demonstrates left supraclavicular (orange arrows) and left axillary adenopathy (green arrows) which has corresponding (F) abnormal FDG activity on PET.

Lymph Node Evaluation:

Greater than 6 mm is suspicious

**Local (N1):** prepyloric, gastrocolic ligament and gastrohepatic ligament. Usually removed with gastrectomy.

**Regional (N2):** portahepatic, hepatoduodenal ligament, peripancreatic and celiac.

**Distant (N3):** left axillary and left supraclavicular (Virchow nodes).
Omental Carcinomatosis

Gastric Adenocarcinoma. (A) Coronal and (B) axial CECT demonstrates omental nodules (blue arrows), ascites and focal gastric enhancement with thickening of the gastric folds (yellow arrow). (C and D) EGD with thickened gastric folds (magenta arrow) and mild erythema (green arrow).

Intraperitoneal and omental metastases are common in advanced gastric cancer and may manifest as nodules, ascites, irregular thickening of the mesentery and omentum.
25 yo female presents to ED with pelvic pain and hard abdomen. (A) CECT demonstrates ascites, large pelvic mass (yellow arrow) and (B) a small focal area of gastric thickening (blue arrow). Given the degree of pelvic disease findings were felt to represent an ovarian primary with metastatic disease. Frozen section during oophorectomy and exploratory laparoscopy confirmed bilateral Krukenberg tumors with gastric adenocarcinoma as the primary. (C) Status post partial gastrectomy (green arrow) and oophorectomy.

Gastric Cancer is the most common primary to metastasize to the ovaries. Usually bilateral and are known as Krukenberg tumors.
Osseous and dural metastases

(A) CECT in a patient with known gastric cancer (blue arrows) develops (B-C) multiple enhancing vertebral bodies compatible with thoracolumbar osseous (yellow arrow) metastases with epidural drop metastases (green arrow) and paravertebral extension.

- Liver is the most common site for hematogenous metastases because the portal vein drains the stomach.
- Lungs, adrenals and kidneys are less common.
- Bone and cerebral metastases are uncommon in gastric cancer.
Gastric Lymphoma

- 1-5% of gastric malignancies
- Stomach is the most common location of extranodal lymphoma
  - B Cell type non-Hodgkin lymphoma - aggressive
    - May cause Linitis plastica
  - Low grade mucosa-associated lymphoid tissue (MALT) - indolent clinical course, better prognosis than gastric carcinoma
    - Associated with Helicobacter pylori
    - Gastric wall thickening, usually minimal
    - Adenopathy or extragastric extension is uncommon
- Transpyloric spread of tumor into the duodenum occurs in 30% of patients; more common than with adenocarcinoma. Since the stomach remains pliable and does not obstruct, patients may present with perforation.

Gastric MALT: (A) Axial CECT demonstrates a homogeneously enhancing solid gastric fundal mass (blue arrow). Further evaluation with EGD demonstrates (B - C) a smooth-walled firm mass without overlying mucosal abnormalities. (D) Follow up CT after treatment demonstrates interval improvement without a discrete residual mass identified.
Gastric Lymphoma

- Imaging Findings:
  - Segmental or diffuse bulky gastric wall thickening due to submucosal spread, >1 cm. Nodular, disorganized wall thickening. Less commonly may be a polypoid mass or ulcerative.
  - Less likely to cause gastric outlet obstruction than gastric adenocarcinoma.
  - Infiltration of the stomach with preservation of the perigastric fat planes.
  - Perigastric adenopathy
    - Adenopathy that extends below the renal hila favor lymphoma over adenocarcinoma
  - Sandwich sign: presence of lymph nodes on either side of the mesenteric vessels.

(A) Coronal and (B-C) axial CECT demonstrates circumferential gastric thickening (yellow arrows) with more focal prominence in the distal body with regional lymphadenopathy (blue arrow).
(D) Corresponding hypermetabolic activity of the gastric wall and lymphadenopathy is noted on FDG-PET.
Metastases to the Stomach

- Hematogenous metastases to the stomach: melanoma, breast, lung, ovarian, esophageal, hepatic
- Contiguous tumor invasion into stomach from neighboring organs: pancreas, esophagus, gallbladder, liver, colon, and kidney

Ovarian metastases to the stomach: (A) Coronal CECT demonstrates nodular gastric wall thickening (green arrow) and a large abdominal wall mass (orange arrow). (B-C) Diffuse, polypoid, ulcerated and friable gastric mass involving the proximal stomach to the antrum is demonstrated on corresponding EGD.
Gastrointestinal Stromal Tumor (GIST)

- Most common mesenchymal neoplasm of the GI tract and most common submucosal gastric tumor.
- Most frequently found in the stomach (60-70%)
- 1% of all gastric tumors
- 10-30% of GISTs are malignant and the risk of malignancy increases with diameter > 5 cm, and extension into adjacent organs
  - Malignant GIST features: Large, heterogeneous, central necrosis, ulceration, calcifications and metastases
- Most common in gastric antrum and body
- CT features: solid smooth bordered mass without areas of necrosis, submucosal lesion with preserved mucosal lining, mucosal ulceration in central portions of the tumor
- Adenopathy is uncommon
- Defining feature: c-KIT (tyrosine kinase growth factor expression
- Extent of the GIST may be underestimated on endoscopy

(A-B) CECT coronal and axial images demonstrate a homogeneous submucosa (blue arrows) gastric mass
(C) Axial CECT images demonstrate a larger, heterogeneous submucosal GIST
(D) EGD appearance of a submucosal mass (yellow arrow).
GIST

Malignant GIST

Metastatic GIST: large, submucosal gastric lesion with areas of necrosis and calcifications and metastatic disease to the liver.

(A-B) EGD of a GIST underestimates the size of the mass; better delineated on (C-D) corresponding CECT.
Carcinoid

- Rare
- Prevalence: ~0.3%

3 subtypes

- Type 1
  - Associations: enterochromaffin-like cell hyperplasia, hypergastrinemia, and chronic atrophic gastritis, with or without pernicious anemia
  - Generally benign

- Type 2: least common, MEN type 1 association
  - Hypergastrinemic states of Zollinger-Ellison syndrome in association with MEN type 1
  - 30% of patients with MEN 1 have gastric carcinoid tumors
  - Imaging features: Multiple masses in the setting of diffuse gastric wall thickening
  - Tumor-related death and carcinoid syndrome are rare

- Type 3: sporadic tumors
  - Not associated with hypergastrinemic state
  - Imaging features: Large, solitary tumors that may show ulceration and are more likely to be invasive with distant metastases
  - Carcinoid syndrome may be seen in patients with hepatic metastases.
  - Poor prognosis; 5 year survival rates of 20%

- Pearls: In a patient with chronic atrophic gastritis with polyps, possibility of type 1 gastric carcinoid tumor is raised.

(A and B) large gastric cardia mass
(C and D) ulcerated friable gastric cardia mass on EGD
(E and F) Follow up CECT in 6 months demonstrates metastatic lymphadenopathy and hepatic lesions
Uncommon Gastric Tumors

Leiomyoma

Lipoma

Plasmacytoma

Sarcoma

Lipoma may be indistinguishable from GIST on UGI. Solitary intraluminal mass within the antrum. CT is diagnostic.
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


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