The Many Faces of Peritoneal Carcinomatosis: Early and Challenging Presentations

Daisy Huang, MD, Victor Sai, MD, Katrina Beckett, MD
Objectives

1. Review peritoneal anatomy and pathways of peritoneal dissemination
2. Review spectrum of typical findings in peritoneal carcinomatosis
3. Understand early presentations of peritoneal carcinomatosis
Anatomy of Peritoneum

- Peritoneum: Thin serous membrane with 2 layers
  - Parietal peritoneum (lines abdominal wall)
  - Visceral peritoneum (covers organs)

- Peritoneal cavity: Potential space between parietal and visceral peritoneum
  - Closed in males
  - Open in females to extraperitoneal pelvis via uterus, vagina and fallopian tubes
  - 100 ml serous fluid normally in potential space
Anatomy of Peritoneum

Peritoneal ligaments, omentum, and mesentery:

- Double layers of peritoneum
- Divide peritoneum into greater sac and lesser sac
- Mesentery envelops organs and attaches to abdominal wall (hence intraperitoneal organs are enveloped by mesentery while retroperitoneal organs are not)

Parietal peritoneum (lines abdominal wall)
Visceral peritoneum (covers organs)
Right subphrenic/subdiaphragmatic space

Left subphrenic/subdiaphragmatic space

Subhepatic spaces (communicate via falciform ligament)

Inframesoscolic spaces

Right paracolic gutter

Left paracolic gutter
Peritoneal Fluid Circulation

- Peritoneal fluid flows SUPERIORLY, following negative intra-abdominal pressure gradient
  - Flows upward from pelvis through paracolic gutters to right subhepatic and subphrenic spaces
  - Preferentially right paracolic gutter as left paracolic gutter more shallow and limited superiorly by phrenicocolic ligament at splenic flexure
Peritoneal Fluid Circulation

- Common recesses for peritoneal fluid accumulation because of gravity:
  - Rectouterine/retrovesicular space
  - Ileocolic region
  - Sigmoid colon
  - Right paracolic gutter

These are also the common sites for peritoneal tumor seeding!
Imaging Modalities

- **US**: detect peritoneal collections/ascites but not sensitive for other manifestations of peritoneal carcinomatosis

- **CT**: most common method, ideal for complex peritoneal cavity anatomy

- **MR**: often used in oncologic surveillance but not ideal given artifacts from motion and respiration; also lower spatial resolution compared to CT; however, DWI can detect subtle peritoneal implants and lack of ionizing radiation better for repeated scans
Peritoneal Hotspots: Where to Look

Tumor seeding follows peritoneal fluid and often areas of fluid stasis are initial sites for tumor implants:

- Rectourtine/retrovesical space
- Ileocolic region
- Sigmoid colon
- Paracolic/subphrenic spaces (right more than left)
- Small bowel mesentery root

Two unusual but classic sites:

- Umbilicus (Sister Joseph Mary’s nodule)
- Ovaries (Krukenberg tumor)
84-year-old man with neuroendocrine tumor: axial (left) and sagittal (right) CT show peritoneal implants in hepatorenal pouch (orange arrow) and retrovesical pouch (pink arrow)
Peritoneal Hotspots

64-year-old man with hepatocellular carcinoma: axial (left, middle) and coronal (right) CT demonstrate ascites in right paracolic gutter (orange arrow) and right subdiaphragmatic space (pink arrow) with scattered nodules (circles)
Unusual sites: Ovaries (Krukenberg)

Mucin-secreting adenocarcinomas such as gastric and colon are most common malignancies that spread to ovaries, followed by breast and lung.

70-year-old woman with gastric cancer and biopsy-proven Krukenberg tumor

64-year-old woman with colon cancer and bilateral Krukenberg tumor
Unusual sites: Sister Mary Joseph node

Sister Mary Joseph tumor
- Classically seen in gastric, ovarian and pancreatic adenocarcinoma
- Rarely described in renal cell carcinoma and prostate cancer

Umbilicus:
- Point of convergence for multiple peritoneal folds such as ligamentum teres and median umbilical ligament
- As such direct peritoneal spread is the proposed mechanism of spread
Patterns of Peritoneal Carcinomatosis

- **Intraperitoneal seeding**: tumor growth through peritoneal lining of organs and subsequent tumor seeding following peritoneal circulation
  - GI and ovarian malignancies

- **Direct invasion**: contiguous growth of GI malignancies or tumor growth via peritoneal ligaments and mesenteries

- **Hematogenous spread**: melanoma, breast and lung malignancies often to antimesenteric border of GI tract

- **Lymphatic spread**
Imaging Findings of Peritoneal Carcinomatosis

- Peritoneal reflection thickening and enhancement
- Peritoneal nodules
- Mesenteric stranding/thickening, distortion
- Omentum thickening/caking
- Bowel wall thickening/nodularity
- Ascites
53-year-old man presents to the ED with right lower quadrant pain

What is the diagnosis?
53-year-old man presents to the ED with right lower quadrant pain

Peritoneal thickening and enhancement, small free fluid

Axial CT on soft tissue windows (left) show free fluid and subtle peritoneal thickening in right lower abdomen which becomes more conspicuous with narrowed window level (right)
53-year-old man presents to the ED with right lower quadrant pain

Careful observation demonstrates nodular thickening at the posterior aspect of gastric antrum on axial (left) and coronal CT (right)

Biopsy = Primary gastric adenocarcinoma
Early Peritoneal Carcinomatosis

Mesenteric stranding/thickening
Increased attenuation of mesenteric fat

43-year-old woman with pancreatic adenocarcinoma
Axial (left) and coronal (right) CT show subtle hazy attenuation of the mesenteric fat, suspicious for early peritoneal carcinomatosis
Early peritoneal carcinomatosis in gastric adenocarcinoma
CT at baseline (left) shows very subtle increased attenuation of mesenteric fat which becomes confluent one month later (right) with a sheetlike appearance also called “omental caking”
Same patient: CT at baseline (left) shows a small 5 mm nodule anterior to the gastric antrum, which increases in size one month later (right); there is also increase in ascites.
A 72-year-old man presents for screening CT colonography. Axial CT shows multiple hypervascular nodules scattered throughout the abdomen, most adjacent to bowel loops and one in the retrovesical space.
Early Peritoneal Carcinomatosis

**Peritoneal Nodules**

*Can be small!*

Same patient: Axial CT six months later shows increase in size of hypervascular nodules

Resection = Primary peritoneal mesothelioma
Early Peritoneal Carcinomatosis

Serosal Implants

Easy to miss!

92-year-old woman with colon cancer
Axial (left) and coronal (right) CT with narrow windows shows nodular thickening at small bowel loops adjacent to calcifications, compatible with serosal implants.
Early Peritoneal Carcinomatosis

Serosal Implants

PET/CT increases conspicuity

49-year-old woman with serous ovarian carcinoma
Axial CT (left) shows discrete nodular thickening along sigmoid colon
PET-CT (right) confirms FDG uptake with these tumor implants
77-year-old woman with ovarian carcinoma
Axial (left) and coronal (right) CT shows serosal implants along the hepatic capsule

Distinguishing serosal implants (stage III) from parenchymal liver lesions (stage IV) is important for surgical planning as the latter precludes tumor debulking.
Early Peritoneal Carcinomatosis

**Serosal Implants**

Can cause bowel obstruction

70-year-old woman with breast cancer
Axial (left) and sagittal (middle) CT show serosal implant (circles) resulting in colonic obstruction (right)
Diagnosis?

62-year-old woman with incidentally discovered bilateral adnexal masses
Not Peritoneal Carcinomatosis

62-year-old woman with incidentally discovered bilateral adnexal masses

Serous cystadenofibromas

Benign inclusion cysts

Although pathologic diagnosis may be required, not all peritoneal nodules are malignant
Summary

• Gastrointestinal and gynecologic malignancies frequently spread to the peritoneum; primary peritoneal malignancies also occur but are less common

• Signs of peritoneal carcinomatosis include peritoneal thickening, nodules, mesenteric stranding, and ascites, which can often be subtle in early disease and easily missed

• Not all suspicious peritoneal nodules are malignant