Compendium of Intestinal and Extraintestinal Manifestations of Crohn’s Disease

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Outline

• Our patient
• Crohn’s Disease
  – Background
  – Menu of radiologic tests
  – Imaging of intestinal and extra-intestinal complications
• Summary
Our Patient: History I

- 32 year old male with chronic abdominal pain and diarrhea since childhood presents with 2 weeks of worsening crampy lower abdominal pain. He reports poor appetite with weight loss, as well as fever to 100.8°F.

- A CT scan is ordered in the ED.
Out patient: ileal wall thickening on CT

Ileum with wall thickening and narrowed lumen

Coronal c(+) CT, abdomen/pelvis
PACS, BIDMC
Bowel wall thickening: wide differential

1. Infectious enterocolitis
2. Ulcerative colitis (UC)
3. Crohn’s disease
4. Radiation injury
5. Ischemia
6. Bowel wall edema in cirrhosis
7. Submucosal hemorrhage
8. Adenocarcinoma, gastrointestinal stromal tumor, metastases, lymphoma
9. Systemic lupus erythematosus
10. Tuberculosis, histoplasmosis, cytomegalovirus

How can we narrow our differential radiologically?

Radiologic approach to bowel wall thickening on CT: Overview

Assess:
1. Degree of thickening: mild vs. marked?
   - <2cm
   - >2cm

2. Symmetry: symmetric or asymmetric thickening?

3. Length of bowel involved: focal, segmental, or diffuse?
   - <10cm
   - 10-30cm
   - most of small bowel or colon

4. Attenuation pattern of bowel wall: homogeneous or heterogeneous?

5. General appearance and surroundings:
   - Adenopathy?
   - Fat stranding?
   - Abscesses, sinus tracts, fistulas?

Step 1: Assess degree of thickening

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
   <2cm       >2cm
Step 1 (cont’d): Our patient has mild bowel wall thickening

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: **mild** vs. marked?
   - <2cm
   - >2cm

Ileal wall thickness = 0.9 cm
(normal <0.3cm)

Our patient: axial c(+) CT, abdomen PACS, BIDMC
Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?

**Common:**
1. Infectious enterocolitis
2. UC
3. Crohn’s
4. Radiation
5. Ischemia
6. Cirrhosis
7. Submucosal hemorrhage

**Uncommon:**
1. Adenocarcinoma
2. Lymphoma

**Common:**
1. Adenocarcinoma, GIST, metastases, lymphoma
2. Severe colitis
3. SLE

**Uncommon:**
1. Crohn’s, TB, histoplasmosis, CMV
2. Submucosal hemorrhage

This is the differential for mild bowel wall thickening on CT. It is our patient’s new working differential.

Step 1 (cont’d): Let’s narrow our differential based on degree of thickening

This is the differential for marked bowel wall thickening on CT. It does not apply to our patient.
Step 2: Assess bowel wall symmetry

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: **mild** vs. **marked**?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: <10cm, 10-30cm, diffuse?
3. Attenuation pattern of bowel wall:
   - Homogenous or heterogeneous?
   - Enhances with IV contrast?
4. Surroundings:
   - Adenopathy?
   - Fat stranding?
   - Abscesses, sinus tracts, fistulas?
Step 2 (cont’d): Our patient has symmetric bowel wall thickening

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?

Companion patient #1:
Example of asymmetric bowel thickening on CT (rectal adenocarcinoma)*

Our patient: axial c(+) CT, abdomen
PACS, BIDMC

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?

Our patient’s differential:

**Common:**
1. Infectious enterocolitis
2. UC
3. Crohn’s
4. Radiation
5. Ischemia
6. Cirrhosis
7. Submucosal hemorrhage

**Uncommon:**
1. Adenocarcinoma
2. Lymphoma

Most neoplasms such as adenocarcinomas typically cause asymmetric bowel wall thickening. Recall the rectal adenocarcinoma we just saw.

Lymphoma, unlike other cancers, often causes symmetric bowel wall thickening. Therefore, it stays on our differential.

Step 3: Assess length of bowel involved

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
   
   - <10cm
   - 10-30cm
   - most of small bowel or colon
Step 3 (cont’d): Our patient has segmental bowel involvement

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
   - <10cm
   - 10-30cm
   - most of small bowel or colon

Segmental involvement of distal ileum

Our patient: coronal c(+) CT, abdomen/pelvis
PACS, BIDMC
Step 3 (cont’d): Let’s further narrow our differential based on length of bowel involved

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?

Our patient’s differential:

Common:
1. Infectious enterocolitis
2. UC
3. Crohn’s
4. Radiation
5. Ischemia
6. Cirrhosis
7. Submucosal hemorrhage

Uncommon:
1. Lymphoma

Ulcerative colitis and cirrhosis usually cause diffuse, not segmental, bowel wall thickening.

Additionally, our patient has selective involvement of the distal ileum, with sparing of the rectum and most of the colon. This pattern would be highly unusual for UC.

Our patient also has normal LFTs and albumin, further ruling out cirrhosis.

Step 4: Assess bowel wall attenuation

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
4. Attenuation pattern of bowel wall: homogenous or heterogeneous?
3. Length of bowel involved: focal, segmental, or diffuse?

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
4. Attenuation pattern of bowel wall: homogenous or heterogeneous?

- Heterogeneous, stratified enhancement of the ileal wall with IV contrast.
- This specific attenuation pattern is called a “target sign.” It typically indicates acute inflammation or ischemia.
- Continue to the next slide to learn more about the target sign.

Step 4 (cont’d): Our patient has heterogeneous attenuation of the bowel wall with “target sign” on CT
What is the target sign?

- The “target sign,” when seen in a thickened bowel wall on contrast-enhanced CT, indicates inflammation or ischemia of the bowel.

- Though commonly associated with Crohn’s, the target sign is not specific for this disease.

**TARGET SIGN**:

- **Muscularis mucosa**: High attenuation due to inflammatory hyperemia
- **Submucosa**: Low attenuation due to edema
- **Mucosa**: High attenuation due to hyperemia

Oral contrast in bowel lumen

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Our patient: target sign of thickened ileal wall.
Axial c(+) CT, abdomen. PACS, BIDMC.

Companion patient #2: target sign of thickened small bowel wall in Crohn’s disease.
Axial c(+) CT, abdomen. No oral contrast. PACS, BIDMC.

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Using the target sign to rule out cancer

- The “target sign,” when seen in a thickened bowel wall on contrast-enhanced CT, indicates inflammation or ischemia of the bowel.

- Though commonly associated with Crohn’s, the target sign is not specific for this disease.

**TARGET SIGN**:

- **Muscularis mucosa**: High attenuation due to inflammatory hyperemia
- **Submucosa**: Low attenuation due to edema
- **Mucosa**: High attenuation due to hyperemia

Oral contrast in bowel lumen

- Since the target sign is rarely seen with malignancies, it is useful for excluding cancer as the cause of bowel wall thickening.

**Our patient**: target sign of thickened ileal wall.

Axial c(+) CT, abdomen. PACS, BIDMC.

**Companion patient #2**: target sign of thickened small bowel wall in Crohn’s disease.

Axial c(+) CT, abdomen. No oral contrast. PACS, BIDMC.

**Companion patient #3**: The thickened bowel wall in this patient, due to lymphoma, homogeneously enhances with IV contrast.

Axial c(+) CT, abdomen.²

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Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
4. Attenuation pattern of bowel wall: homogenous or heterogeneous?

Submucosal hemorrhage is unlikely, since this usually causes homogeneous high attenuation of the bowel wall. (Additionally, our patient had normal coagulation studies, making this diagnosis clinically unlikely.)

Lymphoma is excluded due to the low likelihood of malignancy associated with the target sign.

Our patient’s differential:

Common:
1. Infectious enterocolitis
2. Crohn’s
3. Radiation
4. Ischemia
5. Submucosal hemorrhage

Uncommon:
1. Lymphoma
Step 5: Assess general bowel appearance and surroundings

Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
4. Attenuation pattern of bowel wall: homogenous or heterogeneous?
5. General appearance and surroundings:
   • Adenopathy?
   • Fat stranding?
   • Abscesses, sinus tracts, fistulas?
Step 5 (cont’d): Our patient has alternating diseased and non-diseased segments of ileum on CT.

Segments of diseased ileum with thickened wall and narrowed lumen.

Segments of non-diseased ileum with aneurysmatic dilatation ("skip" lesions).

Our patient: Coronal c(+) CT, abdomen/pelvis
PACS, BIDMC
Step 5 (cont’d): Our patient has a mesenteric comb sign on CT

“Comb Sign”: Increased mesenteric vascularity with vasa recta prominence and increased vasa recta spacing

Our patient: Coronal c(+) CT, abdomen/pelvis. PACS, BIDMC
Step 5 (cont’d): Our patient has a pelvic abscess with communication to adjacent ileum on CT.

Pelvic abscess

High-density material within abscess, most likely oral contrast from communication with adjacent ileum.
Step 5 (cont’d): Our patient has perienteric fat stranding and mesenteric lymphadenopathy on CT

**Perienteric fat stranding suggests inflammatory process**

**Enlarged mesenteric lymph node**
Radiologic approach to bowel wall thickening – assess:
1. Degree of thickening: mild vs. marked?
2. Symmetry: symmetric or asymmetric thickening?
3. Length of bowel involved: focal, segmental, or diffuse?
4. Attenuation pattern of bowel wall: homogenous or heterogeneous?
5. General appearance and surroundings:

Our patient’s differential:

Common:
1. Infectious enterocolitis
2. Crohn’s
3. Radiation
4. Ischemia

- Alternating strictures and “skip lesions” of the mid and distal ileum
- Mesenteric comb sign indicating mesenteric hyperemia
- Pelvic abscess with communication to adjacent ileum
- Perienteric fat stranding
- Mesenteric lymphadenopathy

Together, these findings are most consistent with Crohn’s disease, which is on the differential we generated in steps 1-4.
Further history reveals that the patient was diagnosed with Crohn’s disease 10 years ago. His diagnosis was made based on colonoscopy, biopsy, and compatible clinical findings.

Our patient’s current clinical and radiologic presentation is consistent with a flair of Crohn’s disease complicated by abscess formation.
Crohn’s Disease: Background

- Chronic inflammatory disease that can involve any part of the GI tract
  - Noncontinuous, segmental involvement with “skip” lesions
  - Terminal ileum commonly involved
  - Bowel wall inflammation is transmural and granulomatous

- Peak incidence: 15-22 years of age

- Clinical presentation: abdominal pain, diarrhea (+/- blood), weight loss, fever

- Variety of intestinal and extraintestinal complications (continue to learn more)

Intestinal Complications of Crohn’s Disease: Overview

- Abscess formation
- Fistula formation
- Perforation
- Bowel obstruction
- Toxic megacolon
- Colorectal cancer
- Adenocarcinoma of small bowel

Highlighted items: radiographic imaging of these complications is included in this presentation.

### Extra-Intestinal Complications of Crohn’s Disease: Overview

<table>
<thead>
<tr>
<th>Arthritic</th>
<th>Ocular</th>
<th>Dermatologic</th>
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<tbody>
<tr>
<td><strong>Sacroiliitis</strong></td>
<td>Episcleritis</td>
<td>Erythema nodosum</td>
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<tr>
<td>Ankylosing spondylitis</td>
<td>Uveitis</td>
<td>Pyoderma gangrenosum</td>
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<td>Peripheral arthritis</td>
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<tr>
<th>Hepatobiliary</th>
<th>Vascular</th>
<th>Other</th>
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<tr>
<td>Cholelithiasis</td>
<td>Thromboembolism</td>
<td><strong>Nephrolithiasis</strong></td>
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<td>Sclerosing cholangitis</td>
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<tr>
<td>Cholangiocarcinoma</td>
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<td>Osteoporosis</td>
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**Highlighted items:** radiographic imaging of these complications is included in this presentation.

Diagnosis of Crohn’s Disease

- No single test is diagnostic

- Diagnosis usually made via endoscopy (colonoscopy with advancement to terminal ileum) in combination with clinical history

- Confirm diagnosis via biopsy
Role of Radiology in Crohn’s Disease

• Although radiologic imaging is not diagnostic in Crohn’s disease, it still plays important roles in the initial workup and subsequent follow-up of Crohn’s patients:

  1. Initial workup of suspected Crohn’s disease
     • Narrow the differential diagnosis (as seen earlier with our patient)
     • Assess location and severity of disease involvement

  2. Evaluation and management of acute exacerbations in patients with known Crohn’s disease
     • Assess for intestinal and extra-intestinal disease complications
     • Percutaneous abscess drainage via interventional radiology

Menu of radiologic tests in Crohn’s disease: initial workup

• Initial workup of suspected Crohn’s disease:
  1. **Endoscopy**: imaging modality of choice – however, not usually performed by radiologists
  2. **Traditional barium studies** (small bowel follow-through, enteroclysis) previously preferred for small bowel evaluation
  3. Now, **CT, MRI, capsule endoscopy** on the rise

• Evaluation and management of acute exacerbations in patients with known Crohn’s disease:
  1. **CT**: usually the imaging modality of choice
  2. **MRI**: perianal disease and MSK complications
  3. **Plain films**: emergent situations
  4. **Interventional radiology**: percutaneous abscess drainage

Initial workup of suspected Crohn’s disease: SBFT and enteroclysis

- Traditional barium studies (SBFT and enteroclysis) previously #1 choice for initial imaging of Crohn’s disease.

- Used to assess small bowel involvement, particularly in areas inaccessible to endoscopy.

- However, popularity waning with the rise of CT, MRI, and capsule endoscopy.

- Of the barium studies, SBFT usually preferred over enteroclysis due to benefits of lower radiation exposure, fewer side effects, and better patient tolerance.

Companion patient #4: two strictures in the terminal ileum (narrowed lumen demonstrates “string sign”) separated by a segment of spared bowel (“skip lesion”) on SBFT.

Frontal spot view, SBFT, abdomen/pelvis. PACS, BIDMC

CT is increasingly common in the initial workup of suspected Crohn’s disease.

**Benefits of CT over traditional barium studies:**
- Higher sensitivity for detecting Crohn’s (CT=83-95%, SBFT=65-90%)\(^1,2,3\)
- Better visualization of extra-luminal disease (e.g. abscesses)

**Signs of active Crohn’s disease on CT:**\(^4\)
- Bowel wall thickening
- Stratified enhancement of bowel wall with IV contrast
- Prominent, hyperemic vasa recta

Recall that our patient demonstrated these findings on CT. Scroll back to review these images if necessary.

Initial workup of suspected Crohn’s disease: MRI

- **CT** is increasingly common in the initial workup of suspected Crohn’s disease.

- **Benefits of CT** over traditional barium studies:
  - Higher sensitivity for detecting Crohn’s (CT=83-95%, SBFT=65-90%)\(^1,2,3\)
  - Better visualization of extra-luminal disease (e.g. abscesses)

- **Signs of active Crohn’s disease on CT:**\(^4\)
  - Bowel wall thickening
  - Stratified enhancement of bowel wall with IV contrast
  - Prominent, hyperemic vasa recta

- **MRI**: similar sensitivity, specificity, and bowel findings as CT.\(^4\)
  - Advantage: no radiation. Therefore, MRI is preferred in children.
  - Disadvantages: more expensive and time-consuming compared to CT.

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Recall that our patient demonstrated these findings on CT. Scroll back to review these images if necessary.
Menu of radiologic tests in Crohn’s disease: acute exacerbations

• Initial workup of suspected Crohn’s disease:
  1. Endoscopy: imaging modality of choice – however, not usually performed by radiologists
  2. Traditional barium studies (small bowel follow-through, enteroclysis) previously preferred for small bowel evaluation
  3. Now, CT, MRI, capsule endoscopy on the rise

• Evaluation and management of acute exacerbations in patients with known Crohn’s disease:
  1. CT: usually the imaging modality of choice
  2. MRI: perianal disease and MSK complications
  3. Plain films: emergent situations
  4. Interventional radiology: percutaneous abscess drainage

Assessing acute exacerbations in patients with known Crohn’s disease: CT

- Imaging modality of choice for detecting most complications of Crohn’s disease, including:
  - Intestinal complications
    - Abscesses
    - Fistulas
    - Bowel obstruction
  - Extra-intestinal complications
    - Nephrolithiasis

Let’s take a look at these complications on CT
Companion patient #5: Bowel obstruction on CT in a patient with acute Crohn’s flare

Transition point: narrowing of the terminal ileum is causing mechanical bowel obstruction in this patient.

Proximal small bowel loops are dilated (normal: <3cm diameter).

Many air-fluid levels are seen (normal: <3 air-fluid levels).
Companion patient #6: enteroenteric fistula on CT

At this level, oral contrast is seen tracking into the enteroenteric fistula connecting the two loops of small bowel.
Companion patient #6: enterocolonic fistula on CT

Oral contrast tracking into the enterocolonic fistula connecting the distal ileum and sigmoid colon.

Ileum

Sigmoid colon

Companion patient #6:
Axial c(+) CT, abdomen/pelvis
PACS, BIDMC

Companion patient #6:
Sagittal c(+) CT, abdomen/pelvis
PACS, BIDMC
Companion patient #7: nephrolithiasis on CT

Renal stone in right kidney

Companion patient #7: Axial c(+) CT, abdomen/pelvis
PACS, BIDMC

Companion patient #7: Coronal c(+) CT, abdomen/pelvis
PACS, BIDMC
Initial workup of suspected Crohn’s disease:

1. Endoscopy: imaging modality of choice – however, not usually performed by radiologists
2. Traditional barium studies (small bowel follow-through, enteroclysis) previously preferred for small bowel evaluation
3. Now, CT, MRI, capsule endoscopy on the rise

Evaluation and management of acute exacerbations in patients with known Crohn’s disease:

1. CT: usually the imaging modality of choice
2. MRI: perianal disease and MSK complications
3. Plain films: emergent situations
4. Interventional radiology: percutaneous abscess drainage

Assessing acute exacerbations in patients with known Crohn’s disease: MRI

- MRI is used in Crohn’s disease for:
  - Evaluation of perianal complications (imaging test of choice)
  - Detection of sacroilitis, especially in patients with high clinical suspicion but negative plain film imaging
    - MRI is most sensitive and specific imaging test for sacroilitis
  - Imaging of patients in whom radiation is contraindicated
Companion patient #8: perianal fistula on MRI

Perianal fistula (hypointense linear tract) with surrounding edema

Sacrum

Gluteus maximus muscle

Companion patient #8: Coronal c(+) T2-weighted MRI of pelvis
PACS, BIDMC
Companion patient #6: bilateral sacroiliitis on MRI

-Narrowed sacroiliac joint space-

Subchondral marrow edema (inflammation)

Compare to companion patient #8: no sacroiliitis on MRI

Normal sacroiliac joint space with no surrounding edema
Menu of radiologic tests in Crohn’s disease: acute exacerbations (cont’d)

• Initial workup of suspected Crohn’s disease:
  1. Endoscopy: imaging modality of choice – however, not usually performed by radiologists
  2. Traditional barium studies (small bowel follow-through, enteroclysis) previously preferred for small bowel evaluation
  3. Now, CT, MRI, capsule endoscopy on the rise

• Evaluation and management of acute exacerbations in patients with known Crohn’s disease:
  1. CT: usually the imaging modality of choice
  2. MRI: perianal disease and MSK complications
  3. Plain films: emergent situations
  4. Interventional radiology: percutaneous abscess drainage

Acute exacerbations in patients with known Crohn’s disease: plain films and interventional radiology

• Plain films not commonly used in Crohn’s except:
  − In emergent situations, e.g. detecting bowel perforation or toxic megacolon
  − For initial imaging of sacroiliitis (however, not as sensitive as MRI)

• Interventional radiology in Crohn’s:
  − Percutaneous drainage of abscesses

Recall that earlier, our patient had a pelvic abscess in the setting of a Crohn’s exacerbation. Continue to the next slide to find out how our patient was treated.
Our patient's pelvic abscess was percutaneously drained under CT fluoroscopic guidance by interventional radiology.

Our patient also received IV antibiotics, and his drainage catheter was removed after 3 weeks. At his last follow-up appointment, he denied abdominal pain or fever, though he continued to have loose stools as per his baseline.
Summary

• Our patient
  • Differential diagnosis via radiologic approach to bowel wall thickening
  • Illustrated classic CT findings in Crohn’s disease:
    • Segmental bowel involvement with “skip lesions”
    • Stratified hyperenhancement of bowel wall (“target sign”)
    • Mesenteric hyperemia (“comb sign”)
    • Abdominal/pelvic abscess

• Crohn’s disease
  • Background
  • Menu of radiologic tests
    • Initial workup: endoscopy, traditional barium studies, CT/MRI
    • Acute exacerbations: CT, MRI, plain films, interventional radiology
  • CT and MRI imaging of disease complications
    • Bowel obstruction, enteric fistulas, nephrolithiasis on CT
    • Perianal fistula, sacroiliitis on MRI
• Our patient: percutaneous abscess drainage via IR and follow-up


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