Small Bowel Volvulus
Agenda

1. Our Patient
2. Differential Diagnosis
3. Choice of Imaging
4. Intestinal Embryology
5. Midgut Volvulus
6. Classic Imaging Findings
87 years old Caucasian female
PMH: Breast cancer, hypothyroidism, osteoporosis
HPI: Colicky diffuse abdominal pain for two weeks. The pain is relieved when she lies in the left lateral decubitus position. Persistent bloating. “Belly feels firm.” + constipation. + Weight loss. Occasional mild nausea.
Exam: Distended abdomen. +BS, No guarding/tenderness.
Labs: Ucx -, Normal CBC, Normal Chem 7
Diffuse colicky abdominal pain (most likely causes in bold):

- **Vascular:** Ischemic Colitis, Mesenteric Ischemia, AAA (+/-rupture), myocardial ischemia
- **Infectious:** C. Diff. Pancreatitis. Pneumonia. Less likely PID, intraperitoneal abscess, appendicitis, cholecystitis, pyelonephritis, peritonitis and diverticulitis.
- **Trauma/Toxin:** Bowel wall hematoma, organ laceration (esp liver, spleen)
- **Autoimmune/Anatomic:** Mechanical/functional obstruction, renal calculus, uterine fibroid, incarcerated hiatal hernia. Less likely ruptured ovarian cyst, ovarian torsion.
- **Metabolic:** Hypercalcemia, hypoglycemia, hyponatremia, porphyria
- **Inflammatory:** Inflammatory bowel disease
- **Neoplastic:** Metastatic lesions (eg peritoneal carcinomatosis), primary malignancy (gastric, colonic, liver, pancreatic), benign tumors (leiomyoma, adenoma)
Proceed to the next slide to review the ACR Appropriateness Criteria for imaging tests to order when evaluating small bowel obstruction
ACR Appropriateness Criteria for High-Grade SBO

For Complete or High-Grade Partial SBO:

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT abdomen and pelvis with contrast (routine)</td>
<td>8</td>
<td>Oral contrast should not be used. Positive enteric contrast may prevent detection of diminished bowel wall enhancement in ischemia and obscure abnormal mucosal enhancement in inflammatory and neoplastic conditions. Additional fluid from oral contrast is not well tolerated with bowel obstruction.</td>
<td>☀☀☀☀</td>
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<tr>
<td>X-ray abdomen and pelvis</td>
<td>7</td>
<td></td>
<td>☀☀☀</td>
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<tr>
<td>CT abdomen and pelvis with contrast (CT enteroclysis)</td>
<td>4</td>
<td>A limited role if high-grade obstruction has been confirmed.</td>
<td>☀☀☀☀</td>
</tr>
<tr>
<td>X-ray small bowel follow-through</td>
<td>4</td>
<td></td>
<td>☀☀☀</td>
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<tr>
<td>X-ray small bowel enteroclysis</td>
<td>4</td>
<td></td>
<td>☀☀☀</td>
</tr>
<tr>
<td>MRI abdomen and pelvis with or without contrast</td>
<td>4</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>US abdomen and pelvis</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
</tbody>
</table>

*Rating Scale: 1, 2, 3 Usually not appropriate; 4, 5, 6 May be appropriate; 7, 8, 9 Usually appropriate*

For Low-Grade or Intermittent SBO:

<table>
<thead>
<tr>
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<th>Comments</th>
<th>RRI*</th>
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</thead>
<tbody>
<tr>
<td>CT abdomen and pelvis with contrast (CT enteroclysis)</td>
<td>8</td>
<td>Other less invasive techniques may be considered first to avoid placing an enteric tube.</td>
<td>☠ ☠ ☠ ☠</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with contrast (MR enteroclysis)</td>
<td>8</td>
<td>MR enteroclysis may have sensitivity and specificity similar to those of CT enteroclysis and it avoids radiation risks. However, the choice of examination depends on institutional preferences and resources. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast (CT enterography)</td>
<td>8</td>
<td></td>
<td>☠ ☠ ☠ ☠</td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with contrast (MR enterography)</td>
<td>7</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>O</td>
</tr>
<tr>
<td>X-ray small bowel enteroclysis</td>
<td>7</td>
<td>☠ ☠ ☠ ☠</td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast (routine)</td>
<td>5</td>
<td>☠ ☠ ☠ ☠</td>
<td></td>
</tr>
<tr>
<td>X-ray small bowel follow-through</td>
<td>5</td>
<td>☠ ☠ ☠ ☠</td>
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<td>MRI abdomen and pelvis with or without contrast (routine)</td>
<td>5</td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level*
Pause to evaluate the slide, then continue to read findings…
Major Findings:
1. SMV midline with SMA. The SMV **should** be to the anatomic right of the SMA, but appears to have rotated around the SMA.
2. Twisting of mesentery and bowel around SMA.
These findings collectively are known as the **“Whirl Sign”**
Major Findings:
1. Mild narrowing of jejunum as it wraps around SMA
2. No sign of dilation, bowel thickening or ascites
3. Benign left renal cysts

Source: BIDMC, PACS

Axial C+ Abd CT
Major Findings:
1. Compressed SMV dilated distal to twisting plane where it rotates around SMA (mag view)
2. Small bowel in right hemiabdomen and underneath right hemidiaphragm
3. Hypoattenuating lesion in uncinate process of pancreas consistent with IPMN (mag view)

Source: BIDMC, PACS
Major Findings:
1. Colon medial to small bowel and posterior to anterior liver edge
Our Patient: Image #4

Major Findings:
1. Right lobe of liver pulled toward left lower quadrant
2. Duodenum/jejunum twisting around mesentery
Our Patient: Image #5

Our patient has no previous abdominal imaging, but she does have a Chest X-Ray from 4 years ago.....

Loop of bowel beneath right hemi-diaphragm

....this suggests that she had a pre-existing anatomical abnormality
Major Findings:
1. Intra-thoracic stomach suggesting large hiatal hernia

Source: BIDMC, PACS
Our Patient: Incidental Finding #2

Major Findings:
1. Cholelithiasis
2. Indeterminate adrenal nodule

Coronal C+ Abd CT

Faceted calcifications in gallbladder
Nodule in left adrenal gland

Source: BIDMC, PACS
Midgut Volvulus

This patient has the two characteristic findings of Midgut Volvulus:

1. Rotation of SMA and SMV with surrounding mesentery and bowel
2. Ectopic location of small bowel, suggesting intestinal malrotation
Intestinal Embryology

- **Stage 1 (6-10 weeks):** Expanding bowel herniates into yolk stalk. **DJ** and **CC** undergo partial rotation.

- **Stage 2: (10 weeks)** Bowel returns to peritoneum. **DJ** and **CC** complete rotation.

- **Stage 3:** Cecum descent to RLQ and fixes to the lateral abdominal wall.

Spectrum of Malrotation

- **Nonrotation (Stage 1 Failure)**

- **Incomplete Rotation (Stage 2 Failure)**
  - Both the CC and DJ limb each rotate approximately 90 degrees. The Cecum ends up in the RUQ.

Features of Incomplete Rotation

1. Small bowel in **right** hemiabdomen; large bowel in **left** hemiabdomen.

2. Cecum fixed to mesentry by **Ladd’s Bands** which can obstruct the **third** portion of the duodenum.

3. Small bowel suspended along a **narrowed mesentry**

3. Midgut Volvulus

Source: Dr. Brandt, www.UptoDate.com
Midgut Volvulus—Epidemiology

- Some extent of malrotation occurs in \( \frac{1}{200} \) to \( \frac{1}{500} \) live births
- 30-62% of patients have an associated anomaly\(^5\)
- Most patients present before as surgical emergencies before the age of one\(^6\)
- Patient series from MGH: 48% of cases present as adults (>18). \(^7\)
Midgut Volvulus—Presentation and Treatment

- Children present with **bilious emesis** (93%) and less often malabsorption, failure to thrive, biliary obstruction, GERD
- In adults common symptoms are **intermittent abdominal pain** (87%) and less often nausea (31%)
- Complications: a) Ischemia and necrosis of SMA territory b) Obstruction of duodenum
- Treatment: **Ladd’s Procedure**
Ladd’s Procedure: Steps 1 & 2

1. **Reduce** the volvulus—turn counterclockwise
2. **Divide** Ladd’s bands between cecum and abdominal wall
Ladd’s Procedure: Step 3

3. Divide mesentry between duodenum and terminal ileum

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Ladd’s Procedure: Step 4

4. **Remove** appendix to prevent later diagnostic uncertainty


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Imaging of Small Bowel Volvulus—Plain Film

Small bowel volvulus has non-specific findings on plain film.....

Abdominal Plain Film, Upright

Major Findings:

1. Dilated stomach  
2. Distal paucity of gas


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Upper GI study will show **two** classic findings.

The first is **cork-screw appearance** of the small bowel, from twisting of the mesentery and bowel around the SMA.

Source: Dr. Brandt, UptoDate.com/contents/intestinal-malrotation
The second classic finding is the position of small bowel on the right side of the abdomen that does not cross midline.
Imaging of Small Bowel Volvulus—Ultrasound Finding #1

On ultrasound, you can see the “Whirlpool Sign”......

SMV and mesentry wrap around SMA (white arrowhead) in clockwise direction. Both are anterior to the aorta (white arrow)

Transverse abdominal ultrasound

Imaging of Small Bowel Volvulus—Ultrasound Finding #2

With Doppler, you should see close apposition of SMA and SMV with opposing flow directions.

Transverse abdominal ultrasound

Usefulness of the Whirl Sign

- Originally specific for intestinal malrotation, now thought to be associated with any closed-loop obstruction of the small bowel
- Thought to be predictive for severity of obstruction
  - Study examining 194 patients with SBO\(^{[12]}\)
    - Whirl Sign had 80% PPV for SBO requiring surgery
Usefulness of the Whirl Sign (II)

- Australian series of 6 patients with “Whirl Sign”: only 2 of those patients had volvulus discovered during surgery\(^\text{[10]}\)
- Retrospective review of 33 positive “Whirl Sign”\(^\text{[11]}\)
  - 64% sensitivity
  - PPV of 21%
  - For maximum specificity and sensitivity, the sign required:
    a) involvement of the bowel in mesentery swirling
    b) minimum 90 degree turn of bowel
We discussed:

- the **ACR criteria** for imaging suspected small bowel obstruction
- The **differential** for diffuse abdominal pain
- The **embryology** and **anatomy** of intestinal rotation
- The spectrum of **malrotation** and the use of the **Ladd procedure**
- The specificity and sensitivity of the **whirl sign**
Acknowledgments

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- Claire Odom
Sources