Etiologies, clinical manifestations, and diagnosis of mechanical small bowel obstruction in adults

AUTHORS: Liliana Bordeianou, MD, MPH, Daniel Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN
SECTION EDITORS: Krishnan Raghavendran, MD, FACS, Korilyn S Zachrison, MD, MSc
DEPUTY EDITOR: Wenliang Chen, MD, PhD

All topics are updated as new evidence becomes available and our peer review process is complete.

Literature review current through: **Feb 2024.**
This topic last updated: **Dec 04, 2023.**

INTRODUCTION

Bowel obstruction occurs when the normal flow of intraluminal contents is interrupted. The small bowel is involved in approximately 80 percent of cases of mechanical intestinal obstruction [1,2].

Mechanical small bowel obstruction is caused by intraluminal or extraluminal mechanical compression. In developed countries, adhesion is the most common cause, followed by hernias, malignancies, and various other infectious and inflammatory disorders. (See 'Etiologies' below.)

The etiologies, clinical manifestations, and diagnostic evaluation of mechanical small bowel obstruction will be reviewed here.

The treatment of small bowel obstruction is reviewed elsewhere. (See "Management of small bowel obstruction in adults" and "Palliative care of bowel obstruction in cancer patients".)

Functional small bowel disorders are reviewed elsewhere. (See 'Differential diagnosis' below and "Chronic intestinal pseudo-obstruction: Etiology, clinical manifestations, and diagnosis" and "Postoperative ileus".)

Colorectal obstruction is reviewed elsewhere. (See "Large bowel obstruction".)

EPIDEMIOLOGY

Acute mechanical small bowel obstruction is a common condition that warrants surgical evaluation [3-5]. It accounts for 2 to 4 percent of emergency department visits, approximately 15 percent of hospital admissions, and 20 percent of emergency surgical operations for abdominal pain [6,7]. As an example, in the 2005 United States National Inpatient Sample, 967,332 days of care were attributed to adhesiolysis-related procedures, many of which were for small bowel obstruction, with inpatient expenditures totaling $2.3 billion [8].

The incidence of small bowel obstruction is similar for males and females. The average age of patients hospitalized for their first episode of acute obstruction was 68.5 years [9], women comprised 55 percent of the group [9], and the small bowel was affected in 76 percent [1].

Between 20 and 30 percent of patients with small bowel obstruction undergo operative intervention [10]. Bowel ischemia as a complication of bowel obstruction is seen in 7 to 42 percent of bowel obstructions and significantly increases mortality associated with bowel obstruction [11].

PATHOPHYSIOLOGY

Mechanical obstruction is caused by either intrinsic luminal obstruction or extrinsic compression of the small bowel. Obstruction leads to progressive dilation of the intestine proximal to the blockage while, distal to the blockage, the bowel will decompress as luminal contents pass. Swallowed air and gas from bacterial fermentation can accumulate, adding to bowel distention. As the process continues, the bowel wall becomes edematous, normal absorptive function is lost, and fluid is sequestered into the bowel lumen [12]. There may also be transudative loss of fluid from the intestinal lumen into the peritoneal cavity.

Ischemic necrosis of the bowel is most commonly caused by twisting of the bowel and/or its mesentery around an adhesive band or intestinal attachments. The incidence of ischemia is significantly increased with a closed loop obstruction. Alternatively, if bowel dilation is excessive, the intramural vessels of the small intestine become compromised and perfusion to the wall of the intestine is reduced [13]. If perfusion to a segment of intestine is inadequate to meet the metabolic needs of the tissue, ischemia will occur, which will eventually lead to necrosis and perforation unless the process is interrupted [11]. However, bowel ischemia from progressive bowel dilation alone is rare.

With proximal bowel obstruction, ongoing emesis leads to additional loss of fluid containing Na, K, H, and Cl; metabolic alkalosis; and, if ignored, paradoxical aciduria. These fluid losses can result in hypovolemia. Bacterial overgrowth can also occur in the proximal small bowel, which is normally nearly sterile, and emesis can become feculent.

ETIOLOGIES

In the United States and Western Europe, the most common cause of mechanical small bowel obstruction is intraperitoneal adhesions, followed by tumors and complicated hernias [1,11]. In 90 percent of cases, small bowel obstruction is caused by adhesions, hernias, or neoplasms [5]. Less frequent causes of obstruction include Crohn disease (3 to 7 percent) [5,14], gallstones (2 percent), volvulus (4 to 15 percent) [15-17], and intussusception (4 to 8 percent) [15,18].

Causes of mechanical small bowel obstruction may be classified as external to the bowel (extrinsic), within the wall of the bowel (intrinsic), or due to a luminal defect that prevents the passage of gastrointestinal contents (table 1):

- Processes that are extrinsic to the wall of the small intestine (eg, adhesions, hernia, volvulus) can mechanically compress the bowel and obstruct the luminal flow.
- Diseases intrinsic to the wall of the small intestine (eg, tumor, stricture, intramural hematoma) can cause small bowel obstruction by encroaching upon the lumen of the bowel because of edema, infiltration of the bowel wall, or from progressive stricture formation.
- Processes that block an otherwise normal bowel lumen (eg, intussusception, gallstones, foreign body) can also cause mechanical bowel obstruction.

Specific etiologies are discussed in detail below. (See 'Specific etiologies' below.)

CLASSIFICATIONS

Small bowel obstructions can be acute or chronic, partial or complete [3,4].

Bowel ischemia leading to intestinal necrosis and perforation occurs more frequently in the setting of complete than partial obstruction. An exception is a Richter hernia, a condition in which only a portion of the intestinal wall protrudes through a hernia defect and that can lead to ischemia and perforation without complete obstruction of the lumen (figure 1). (See "Overview of abdominal wall hernias in adults", section on 'Richter hernia'.)

A closed-loop obstruction is a form of complete bowel obstruction that occurs when a segment of intestine, usually small bowel, is obstructed in two locations, creating a segment with no proximal or distal outlet. There could be minimal abdominal distention since only a short segment of intestine may be involved. Closed-loop obstruction can rapidly lead to complications (ischemia, necrosis, perforation); thus, early identification and treatment are important to restore perfusion to the affected segment of bowel. In many cases, abdominal exploration will be needed to make a definitive diagnosis [19]. (See 'Complete obstruction and closed-loop obstruction' below.)

Severity grading — The American Association for the Surgery of Trauma (AAST) has devised a grading system to standardize the severity of emergency general surgery diseases (table 2) [20,21]. The grading schema for acute small bowel obstruction has been validated in both single- and multi-institutional studies [22-24]. Specifically, a higher AAST grade for small bowel obstruction is predictive of longer hospital stay, increasing need for critical care, and increased rate of complications.

CLINICAL PRESENTATIONS

Most patients with small bowel obstruction will present acutely with an abrupt onset of colicky abdominal pain, nausea, vomiting, and abdominal distention. A minority of patients with chronic partial obstruction will have intermittent symptoms that resolve only to recur again (recurrent obstructions) [3,5,14,16,25-35].

The history should seek to identify risk factors for bowel obstruction, which will provide clues to the potential etiology of suspected bowel obstruction or suggest an alternative diagnosis [36,37]. In addition, prescription or nonprescription medications (including recreational drugs) that may impact bowel function should be noted (table 3).

The most important risk factors for small bowel obstruction include:

- Prior abdominal or pelvic surgery (risk for adhesion formation)
- Abdominal wall or groin hernia
- Intestinal inflammation (eg, Crohn disease)
- History of or increased risk for neoplasm
- Prior abdominopelvic irradiation
- History of foreign body ingestion

Acute small bowel obstruction

Symptoms — The symptoms most commonly associated with acute small bowel obstruction are:

- **Nausea, vomiting** – Proximal small bowel obstruction (duodenum, proximal jejunum) can cause severe nausea and vomiting; as a result, patients typically cease taking in food or liquids orally.

- **Cramping abdominal pain** – Abdominal pain associated with small bowel obstruction is frequently described as periumbilical and cramping with paroxysms of pain occurring every four or five minutes [32]. A progression from cramping to more focal and constant pain may indicate peritoneal irritation related to complications (ischemia, bowel necrosis). A sudden onset of severe pain may suggest acute intestinal perforation. (See "Overview of gastrointestinal tract perforation".)

- **Obstipation (ie, inability to pass flatus or stool)** – Cessation of passage of stool or flatus indicates a complete obstruction. However, passage of flatus or feces can continue for 12 to 24 hours after the onset of obstructive symptoms as there is evacuation of luminal contents from the more distal bowel. Hematochezia may be a sign of tumor, ischemia, inflammatory mucosal injury, or intussusception.

The frequency of these symptoms is variable and depends upon the etiology and location of obstruction (proximal versus distal) and the degree of obstruction (partial versus complete). A review of 300 patients reported abdominal pain in 92 percent of patients and vomiting in 82 percent [27]. In a prospective study of 150 patients, the absence of the passage of flatus (90 percent) or stool (81 percent) was the most common presenting symptom [11]. In a study of patients with adhesive small bowel obstruction, the presenting symptoms were vomiting in 77 percent, cramping abdominal pain in 68 percent, absence of passage of flatus and/or feces in 52 percent, and constant pain in 12 percent [30].

Physical examination — The physical examination should include evaluation for systemic signs of dehydration or sepsis, abdominal inspection, auscultation, percussion and palpation, as well as a digital rectal examination.

- **Systemic signs** – A hallmark of small bowel obstruction is dehydration, which manifests as tachycardia, orthostatic hypotension, reduced urine output, and, if severe, dry mucus membranes. Fever may be associated with infection (eg, abscess) or other complications of obstruction (bowel ischemia, necrosis), although its absence does not exclude infection or complication, particularly in older or immunocompromised patients.

- **Abdominal inspection** will identify a variable degree of abdominal distention in most patients with acute bowel obstruction. In multiple retrospective reviews, abdominal distension was the most frequent physical finding on clinical examination, occurring in 56 to 65 percent of patients [11,27,30]. Although nausea and vomiting may be less severe in patients with distal small bowel obstruction compared with proximal obstruction, abdominal distention is greater because the more proximal bowel acts as a reservoir. Swallowed air and gas from bacterial fermentation can also accumulate, adding to the abdominal distention. It is important to remember, however, that in patients with a closed-loop obstruction, abdominal distention can be minimal.

  Abdominal inspection should also examine for any surgical scars that would indicate prior abdominal surgery and associated hernia.

- **Abdominal auscultation** – Acute mechanical bowel obstruction is characterized by high-pitched "tinkling" sounds associated with the pain. With significant bowel distention, bowel sounds may become muffled, and as the bowel progressively distends, bowel sounds can become hypoactive.

- **Abdominal percussion** – Distention of the bowel results in hyperresonance or tympany to percussion throughout the abdomen. However, fluid-filled loops will result in dullness. If percussion over the liver is tympanitic rather than dull, it may be indicative of free intra-abdominal air. Tenderness to light percussion suggests peritonitis.

- **Abdominal palpation** may identify any abdominal wall or groin hernias, or abnormal masses, which, in the setting of small bowel obstruction, may indicate an abscess, volvulus, or tumor as the source of obstruction.

- **Digital rectal examination** should be performed to identify fecal impaction or rectal mass as the source of obstruction (see "Large bowel obstruction"). Gross or occult blood may be related to intestinal tumor, ischemia, inflammatory mucosal injury, or intussusception.

Laboratory studies — The typical laboratory evaluation for patients who present with significant abdominal pain includes:

- **Complete blood count with differential** – Leukocytosis with neutrophil predominance or leftward shift (ie, bandemia) may indicate the presence of bowel complications. Anemia may point to a specific etiology (eg, Crohn disease, tumor, or Meckel's diverticulum).

- **Electrolytes, including blood urea nitrogen and creatinine** – Although not specific for a diagnosis of small bowel obstruction, these studies help assess the presence and severity of hypovolemia and metabolic abnormalities such as hyponatremia and hypokalemia.

In patients who present with systemic signs of illness (eg, fever, tachycardia, hypotension, altered mental status), additional laboratory investigation may include:

- **Arterial blood gas (ABG)** – Metabolic alkalosis can result from severe vomiting, but metabolic (lactic) acidosis can also occur if the bowel becomes ischemic or if hypovolemia is severe enough to cause hypoperfusion of other organs [38].

- **Serum lactate** – Elevated serum lactate is sensitive but not specific for mesenteric ischemia, including in those with small bowel obstruction [33,34]. Thus, serum lactate level is often obtained to assess patients with small bowel obstruction [10]. In a retrospective study of 100 consecutive patients with small bowel obstruction, intestinal ischemia was associated with elevated serum lactate concentration (2.7±1.6 versus 1.3±0.6 mmol/liter) on univariate analysis [39].

- **Blood cultures** – Blood cultures can diagnose bacteremia and guide antibiotic de-escalation therapy in the context of bowel compromise and septicemia.

- **Procalcitonin** – There is emerging evidence that elevated serum procalcitonin levels may be sensitive for detecting intestinal strangulation [40] and predicting the need for operative intervention [41], though more studies are required before we can recommend routine utilization of this biomarker [42].

Chronic partial obstruction — Chronic small bowel obstruction occurs in a fixed segment of bowel, and the obstruction is, by definition, partial. The most common causes of chronic partial small bowel obstruction are chronic stricture from Crohn disease, adhesions from prior surgery, slowly growing tumors, and stricture related to prior bowel resection or irradiation.

Patients usually present with colicky postprandial abdominal discomfort and variable nausea intermittently over days to weeks. Although colicky abdominal pain and vomiting are common, it is uncommon for both to occur simultaneously, especially for over 24 hours [43]. For example, viral gastroenteritis causes vomiting, but rarely for over 24 hours, and typically without severe colicky abdominal pain [44]. Abdominal distention and tympany may be present, but usually without any fluid or electrolyte derangements.

When a patient with chronic partial small bowel obstruction becomes completely obstructed, the clinical presentation becomes indistinguishable from acute obstruction as described above,

and such patients should be treated as having acute obstruction.

Recurrent intermittent obstruction — The patient who presents with recurrent intermittent obstruction, typically due to adhesions or internal hernia, is distinguished from the patient with a chronic partial small bowel obstruction. During an episode of obstruction, symptoms are identical to those of patients with acute small bowel obstruction described above, but symptoms resolve and the patient may report postobstructive diarrhea. In the period between obstructive episodes, the patient is usually asymptomatic with a normal abdominal examination.

Recurrent obstruction due to adhesions can occur in a fixed segment of bowel or differing segments of bowel. Those that occur at the same site due to a focal band adhesion are more likely to respond to surgery compared with those that occur at varying locations within the abdomen due to diffuse adhesions, for which surgery is likely to increase the risk of future obstructions.

Approximately 20 percent of patients with adhesive small bowel obstruction will experience a recurrence, most occurring within five years of the initial episode [45]. For patients with a history of prior bowel obstruction, whether managed medically or surgically, the likelihood of recurrent obstruction increases with an increasing number of episodes, and the asymptomatic time period between episodes decreases [4,46,47]. After three prior episodes, the likelihood of recurrent obstruction is >80 percent [48].

In two retrospective, propensity-score-matched administrative database studies of over 27,000 patients with their first episode of adhesive small bowel obstruction, operative management was associated with a lower risk of recurrence (13 versus 21 percent, hazard ratio [HR] 0.62, 95% CI 0.56-0.68) [49] and a lower risk of death (HR 0.80, 95% CI 0.75-0.86) [50]. The five-year probability of recurrence increased with each episode until surgical intervention, at which point the rate of subsequent recurrence decreased by approximately 50 percent [49]. When adjusting for the risk of recurrence, operative intervention was not associated with improved survival, suggesting that the survival benefit is related to the lower risk of recurrence in patients with bowel obstruction [50]. However, conclusions from retrospective administrative database studies do not indicate the risk of surgical intervention for each individual patient.

DIAGNOSIS

Although mechanical small bowel obstruction may be suspected (or obvious) based upon risk factors, symptoms, and physical examination findings consistent with obstruction, abdominal

imaging is usually required to confirm the diagnosis, identify the location of obstruction, judge whether the obstruction is partial or complete, identify complications related to obstruction (ischemia, necrosis, perforation), and determine the potential etiology, all of which will help determine the urgency and nature of further treatment (surgery versus initial nonoperative management) [51,52]. (See "Management of small bowel obstruction in adults".)

DIAGNOSTIC EVALUATION

Preferred initial studies for most patients — For most patients suspected of having mechanical small bowel obstruction, we obtain plain radiographs to quickly confirm a diagnosis of bowel obstruction, and, provided the films do not have findings that indicate the need for immediate intervention, we then use computed tomography (CT) of the abdomen and pelvis to further characterize the nature, severity, and potential etiologies of the obstruction. If the abdomen is grossly dilated, a nasogastric tube decompression must be performed prior to imaging to reduce the incidence of gastric aspiration.

Although many imaging modalities are available to diagnose small bowel obstruction, plain radiography and abdominal CT are the most practical and useful. The typical protocols are:

- The basic plain radiographic examination should include an upright chest film and upright and supine abdominal films (image 1 and image 2). If the patient cannot be placed into an upright position, a lateral decubitus abdominal film may show free air and/or air-fluid levels.

- CT of the abdomen should be performed with intravenous contrast if not contraindicated [53], though it is possible to diagnose small bowel obstruction without contrast enhancement [54].

  - For patients with suspected complete small bowel obstruction based on clinical evaluation and/or plain radiographs, oral contrast should be omitted. In such patients, oral contrast will not add to diagnostic accuracy, since it will not reach the site of obstruction. Instead, it will only waste time, add expense, and can induce further patient discomfort or lead to complications (eg, vomiting and aspiration).

  - For patients with suspected partial or intermittent small bowel obstruction, CT can be performed with both intravenous and oral contrast [53]. The addition of oral contrast may help guide management strategy, especially if contrast is seen distal to the site of suspected obstruction.

Exclude bowel compromise — The presence of clinical signs of bowel compromise (ie, perforation (image 3), necrosis, or ischemia) such as generalized guarding and rebound tenderness in unstable patients may warrant immediate surgical intervention without any radiologic studies. In stable patients, radiographic diagnosis is preferred prior to surgical exploration.

A diagnosis of bowel perforation relies on the finding of extraluminal air on plain radiography or abdominal CT. Abdominal CT is more sensitive for detecting extraluminal air, particularly air in the retroperitoneum, and in some patients, free air demonstrated on CT scan is not apparent on plain radiographs.

- Pneumoperitoneum is a sign of perforation of the intra-abdominal gastrointestinal tract (small bowel, transverse colon, sigmoid colon) and may be detected as:
  - Free air under the diaphragm on upright chest or upright abdominal radiograph (image 4).
  - Free air over the spleen or liver on lateral abdominal film or abdominal CT.
  - Free air as a "football sign" on supine abdominal film or abdominal CT.
- Air in the retroperitoneum may indicate perforation of the duodenum or retroperitoneal portions of the colon.
  - Psoas sign on supine abdominal film.
  - Air adjacent to the second portion of the duodenum on plain abdominal film or abdominal CT.

Abdominal CT is superior to plain radiographs for detecting signs of bowel ischemia. Advanced bowel ischemia can generally be recognized on CT scan; however, lesser degrees of ischemia are more subtle [11]. Findings associated with small bowel ischemia on abdominal CT are listed below [55-59]. However, none of these signs taken individually are highly sensitive or specific [55,56]. The presence of a combination of these findings increases the reliability of diagnosing ischemia [60,61].

- Poor or absent segmental bowel wall enhancement
- Delayed hyperenhancement
- Bowel wall thickening
- Small bowel feces sign (image 5 and image 6)
- Air in the bowel wall (pneumatosis intestinalis)

- Edematous, thickened mesentery
- Engorgement of mesenteric vessels
- Hemorrhage in the mesentery
- Portal or mesenteric venous gas
- Increased free fluid

Complete obstruction and closed-loop obstruction — Bowel ischemia leading to intestinal necrosis and perforation is more common in the setting of complete obstruction. The absence of air or fluid in the distal small bowel or colon on plain abdominal radiograph or CT scan supports a diagnosis of complete obstruction.

A special type of complete obstruction, a closed-loop obstruction, may be more difficult to identify on radiologic studies [62]. On imaging studies, a closed-loop obstruction often appears as a distended, fluid-filled, sometimes C-shaped or U-shaped bowel segment (image 7) with prominent mesenteric vessels converging on a point of torsion (CT whirl sign [63]) or incarceration [64]. Other signs include a triangular loop, the beak sign, and the presence of two collapsed bowel loops adjacent to the obstruction site [65]. Unless perfusion is restored to the affected bowel segment, closed-loop obstruction can rapidly lead to complications.

Diagnose small bowel obstruction

Plain radiography — For most patients, we obtain plain radiographs first to quickly confirm a diagnosis of bowel obstruction. Plain radiographs are widely available, are inexpensive, expose the patient to little radiation, and may demonstrate findings that indicate the immediate need for urgent decompression (eg, sigmoid volvulus) or surgical intervention (eg, pneumoperitoneum, cecal or midgut volvulus) [10]. In patients with multiple prior episodes of small bowel obstruction managed nonoperatively, plain radiographs can confirm the diagnosis and obviate the need for abdominal CT. Plain radiography also assesses the lungs for evidence of aspiration in those who have been vomiting and can easily be repeated to follow the patient's progress. (See "Management of small bowel obstruction in adults", section on 'Serial monitoring'.)

Findings on plain radiography consistent with small bowel obstruction include the following:

- Dilated loops of bowel with air-fluid levels.
    - In the supine position, the air-fluid interface is parallel to the x-ray plate, and the entire width of air- and fluid-filled loops of bowel will be visible (image 8). This allows an estimation of the amount of distention.

- In an upright (or lateral) position, the air-fluid interface is perpendicular to the film and is evident as an air-fluid level (image 9). Multiple air-fluid levels with distended loops of small bowel are seen in small bowel obstruction.

- The presence of air-fluid levels of differential height in the same loop of bowel and the presence of a mean air-fluid level width ≥25 mm on upright plain film has been reported to strongly correlate with a complete or high-grade obstruction [66].

- Proximal bowel dilation with distal bowel collapse – Small bowel obstruction can be diagnosed if the more proximal small bowel is dilated more than 2.5 cm (outer wall to outer wall) and the more distal small bowel is not dilated [11,67]. The stomach may also be dilated. The presence of air-fluid levels differing more than 5 mm from each other within the same loop of small bowel on upright films supports a diagnosis of mechanical small bowel obstruction [68].

- Gasless abdomen – A gasless abdomen may be due to complete filling of loops of bowel with sequestered fluid. The severity of the bowel obstruction may be underestimated. A "string of beads (or pearls)" sign may be seen in predominantly fluid-filled small bowel loops on upright or lateral films as small amounts of intraluminal gas collect along the superior bowel wall separated by the valvulae conniventes [67].

For a diagnosis of small bowel obstruction using plain radiographs, the sensitivity, specificity, and accuracy are 79 to 83 percent, 67 to 83 percent, and 64 to 82 percent, respectively [68-70]. Although plain abdominal films have a reasonable sensitivity for the detection of high-grade small bowel obstruction, they are less useful in the differentiation of small from large bowel obstruction and partial obstruction from ileus [69,71].

Plain films can be equivocal in 20 to 30 percent of patients and are "normal, nonspecific, or misleading" in 10 to 20 percent of patients [11,72]. Furthermore, even when bowel obstruction is confirmed, the site or cause of obstruction is usually not apparent on plain films, since a transition point between the dilated proximal and nondilated distal small bowel often cannot be established with certainty. Thus, follow-up abdominal CT is generally recommended in most stable patients suspected or diagnosed with mechanical small bowel obstruction.

Abdominal CT — Multidetector computed tomography (CT) of the abdomen is more useful than plain radiographs for identifying the specific site (ie, transition point) and severity of obstruction (partial versus complete) [10]; determining the etiology by identifying hernias, masses [73,74], or inflammatory changes; and for identifying complications such as ischemia, necrosis, or perforation [67]. This modality has been reported to have high sensitivity (83 percent) and specificity (92 percent) for identifying bowel ischemia when compared with

operative findings as the gold standard [75,76]. Some investigators have also tried to use CT findings to create scoring systems to predict the need for operation [57].

The administration of oral and intravenous contrast optimizes the information provided by abdominal CT scanning (image 10A-B). However, for those who cannot tolerate oral contrast, retained intraluminal fluid within dilated bowel loops usually provides adequate enhancement when evaluating patients for ischemic complications. A lack of bowel wall enhancement, an early sign of ischemia, may be easier to identify in the absence of oral contrast agents. (See 'Exclude bowel compromise' above.)

Similar to the findings on plain abdominal radiography, a diagnosis of bowel obstruction on abdominal CT can be made by the findings of dilated proximal bowel with distal collapsed bowel and air-fluid levels (image 11 and image 12) [11]. However, the presence of a radiographic transition zone has not been shown to be predictive of the need for operative intervention [77]. Additional findings on abdominal CT scan consistent with a diagnosis of bowel obstruction include [63-65,75]:

- Bowel wall thickening >3 mm (nonspecific)
- Submucosal edema/hemorrhage
- Mesenteric edema
- Ascites

Intraperitoneal free fluid is present on abdominal CT in over one-third of patients with acute small bowel obstruction. Although free fluid, per se, is not necessarily predictive of the need for operative intervention, fluid with a Hounsfield unit (HU) density >10 has a positive predictive value and negative predictive value of >75 percent for requiring an operation [78].

Beyond diagnosing small bowel obstruction, CT shows high accuracy in locating the site of the transition point [79]. Identifying the transition point between dilated and nondilated bowel, although not required to make the diagnosis of obstruction, may establish the site and cause of small bowel obstruction [67]. Reconstruction in multiple planes can delineate a sharply defined point, as with band adhesions, or a longer segment, as seen with matted adhesions or radiation enteritis. However, the location of obstruction as identified on CT only correlates with the intraoperative locations in approximately 60 to 70 percent of patients [77,79]. In addition, the presence of a transition point on abdominal CT does not appear to accurately predict the need for immediate or delayed operative intervention and thus should not be used as a major initial criterion influencing a decision to operate [77,80,81].

Additionally, CT can identify nonadhesive causes of a small obstruction, which may require surgical correction (see "Management of small bowel obstruction in adults", section on 'Surgical

causes of small bowel obstruction'):

- Incarcerated abdominal wall or groin hernia (see 'Complicated hernia' below)
- Mass lesion (see 'Tumor' below)
- "Target sign" – Alternating hypo/hyperdense layers, indicative of intussusception (see 'Intussusception' below)
- "Whirl sign" – Rotation of small bowel mesentery, suggesting an internal hernia or volvulus (see 'Volvulus' below)
- "Venous cut-off sign" – Venous flow to a loop of small bowel that is "cut off" suggests thrombosis [64]

For high-grade small bowel obstruction, the sensitivity, specificity, and accuracy of CT scan are reported to be 90 to 94 percent, 96 percent, and 95 percent, respectively [76,82-86]. For low-grade obstruction, the accuracy of CT is reduced [87].

Alternative studies for special patient groups — Since most patients suspected of having small bowel obstruction undergo plain radiography and abdominal CT, the use of other imaging studies is usually limited and should be dictated by clinical situations (ie, acute versus chronic obstruction) and patient characteristics (eg, critically ill, young, pregnant, known Crohn disease).

Acute small bowel obstruction — For most patients with a clinically suspected acute small bowel obstruction, plain radiography followed by abdominal CT is the preferred imaging study [53]. Other studies, such as ultrasound and magnetic resonance imaging (MRI), may be useful in patients who cannot tolerate CT.

Bedside imaging study — Abdominal ultrasonography may be useful for the diagnosis of small bowel obstruction in patients who cannot undergo CT scanning due to contrast allergies [10], pregnant patients, and critically ill patients for whom ultrasonography can be performed at the bedside [88]. Ultrasound is also increasingly used in the emergency department to evaluate abdominal pain [25] and to assess for occult hernias, which may be the site of incarcerated small bowel.

Ultrasound is limited by poor visualization of gas-filled structures [70]. It is more sensitive and specific than plain films for the diagnosis of small bowel obstruction [25,89-91] but not as helpful as CT for determining the location, cause, and potential complications of bowel obstruction. In a study that compared the efficacy of plain radiography, ultrasound, and CT scan in 32 patients presenting with clinical suspicion of intestinal obstruction [70], the sensitivity and

specificity of ultrasound were 83 and 100 percent, compared with CT scanning at 93 and 100 percent, respectively. The level of obstruction was correctly predicted in 70 percent of patients using ultrasound but in 93 percent of patients on CT scan. Ultrasound was also inferior to CT for determining the cause of the obstruction (23 versus 87 percent). In another study, the positive predictive value of an akinetic dilated loop on ultrasound for strangulation was 73 percent [92].

Pregnant or young patients — MRI is an increasingly attractive option for the assessment of small bowel obstruction in pregnant women and in children and younger adult patients who have had multiple prior CT examinations [53,67].

Multiplanar MRI can be used in the same way as multidetector CT to look for evidence of a transition point and features indicative of complications. However, the increased time for image acquisition and the need for repeated breath-holds to obtain high-quality images limit the general applicability of MRI in patients with acute small bowel obstruction.

When used for diagnosing small bowel obstruction, MRI of the abdomen should be performed with and without intravenous contrast in nonpregnant patients and without intravenous contrast in pregnant women [53].

Chronic or intermittent obstruction — For most patients with a clinically suspected chronic or intermittent small bowel obstruction, abdominal CT is also the preferred imaging study. Enteroclysis is the second-best study after abdominal CT, but it may not be readily available at most facilities [53]. Other studies, such as ultrasound, abdominal MRI, and contrast studies, may be useful in certain patient populations.

Enteroclysis — Enteroclysis is a procedure in which the duodenum is intubated with a nasojejunal tube and a large volume of air, and contrast (barium and methylcellulose) is instilled directly into the small intestine while repeatedly imaging over time using fluoroscopy, CT, or MRI. The volume challenge caused by methylcellulose administration accentuates the effect of low-grade obstruction. For patients with chronic or recurrent small bowel obstruction, enteroclysis distends the small bowel sufficiently to identify areas of stenosis [67,93]. However, enteroclysis is not appropriate for patients with acute small bowel obstruction. The prolonged transit time of contrast material through obstructed bowel requires several hours to complete and can delay the diagnosis. In addition, patients with acute small bowel obstruction tolerate oral contrast material poorly, and it is preferable not to have large quantities of barium in the small bowel lumen if surgery is a possibility.

Both conventional fluoroscopic and CT enteroclysis offer improved sensitivity and specificity over standard barium small-bowel follow-through and abdominal CT in evaluating suspected intermittent or low-grade small bowel obstruction [94]. Enteroclysis is highly reliable in

revealing sites of bowel obstruction and distinguishing adhesions from alternative etiologies (eg, malignancy) [95]. However, enteroclysis has low patient acceptance (due to the need for small bowel intubation), depends on the skill of the performing radiologist, and is not widely available in all facilities.

CT or MRI enterography — CT or MRI enterography is an alternative to enteroclysis that does not require placement of a nasogastric tube for contrast administration; it is better tolerated by patients [96]. Patients ingest a large volume of an attenuation-neutral enteric contrast material (often low-concentration barium or water). This results in distension of the small bowel lumen with a contrast agent that does not interfere with the ability to visualize the lumen and the bowel wall with imaging.

CT or MRI enterography is most useful in the setting of diagnosing low-grade bowel obstruction associated with chronic small bowel conditions such as Crohn disease [67,97]. The procedure's role in diagnosing other causes of small bowel obstruction has not been established [53].

Functional study — Fluoroscopic small bowel follow-through studies may offer functional information about the small bowel obstruction but should not be used as a primary imaging modality in diagnosing acute small bowel obstruction [53]. In contemporary practice, abdominal CT has largely replaced fluoroscopic studies for diagnosing and characterizing small bowel obstruction.

Fluoroscopic findings consistent with small bowel obstruction are dilated loops of proximal small bowel opacified with contrast material and a change in the diameter of the small bowel at the transition zone. Minimal or no contrast material opacifying the small bowel loops distal to the transition zone indicates high-grade obstruction.

The transition zone at the site of small bowel obstruction can be missed using small bowel follow-through (or abdominal CT) because water-soluble contrast agents become diluted as they pass through dilated fluid-filled bowel loops. Consequently, the degree of opacification may not be sufficient to identify the transition point at the site of obstruction. The transition zone is, however, readily identified with enteroclysis.

Although small bowel follow-through series and enteroclysis can confirm the diagnosis of bowel obstruction and can determine if an obstruction is partial or complete, they are inferior to abdominal CT for detecting closed-loop obstruction or ischemia and only rarely point to the etiology of the obstruction. Thus, these studies have a limited role in the initial diagnosis of small bowel obstruction [67,98]. Small bowel follow-through is contraindicated if there are any signs of strangulation.

In the appropriate setting, a challenge of water-soluble contrast agent can help determine whether nonoperative management or operative management is appropriate. The selection criteria for administering water-soluble contrast agent for this (therapeutic) purpose are discussed in detail elsewhere. (See "Gastrografin for adhesive small bowel obstruction".)

DIFFERENTIAL DIAGNOSIS

Nonobstructive medical conditions — Nausea and vomiting may be a manifestation of a myriad of disorders, most of which are nonobstructive (table 4). For many medical conditions, vomiting is more likely to precede the onset of significant abdominal pain, whereas pain often precedes vomiting when associated with an acute surgical etiology.

The nonobstructive causes of nausea, vomiting, and abdominal pain are discussed elsewhere. (See "Approach to the adult with nausea and vomiting" and "Evaluation of the adult with abdominal pain".)

Functional bowel obstruction — Bowel dilation due to mechanical obstruction must be differentiated from functional, intestinal motility disorders such as adynamic (paralytic) ileus and intestinal pseudo-obstruction; the distinguishing features are presented in this table (table 5).

Adynamic (paralytic) ileus — Paralytic ileus occurs to some degree after almost all open abdominal operations and can also be caused by peritonitis, trauma, intestinal ischemia, and medications (eg, opiates, anticholinergics). It is exacerbated by electrolyte disorders, particularly hypokalemia. As the intestine becomes distended, the patient experiences many of the same symptoms as mechanical obstruction. However, on radiologic examination, there is air in the colon and rectum, and on abdominal computed tomography (CT) or small bowel series, there is no demonstrable mechanical obstruction [99,100].

In differentiating early postoperative ileus from postoperative adhesive disease, it is useful to note that nearly all patients with early postoperative bowel obstruction have an initial return of bowel function and oral intake, which is then followed by nausea, vomiting, abdominal pain, and distention, whereas patients with adynamic ileus do not experience return of bowel function [101]. (See "Postoperative ileus" and 'Early postoperative small bowel obstruction' below.)

Pseudo-obstruction — Intestinal pseudo-obstruction is a chronic condition characterized by symptoms of recurrent abdominal distention that may be associated with nausea, vomiting, and diarrhea. No mechanical cause can be demonstrated, and the patient frequently has a

history of several previous operations for bowel obstruction during which no cause for obstruction could be found.

Intestinal pseudo-obstruction can be acute (acute intestinal pseudo-obstruction [AIPO]; acute colonic pseudo-obstruction [ACPO or Ogilvie syndrome]) or chronic (chronic intestinal pseudo-obstruction [CIPO]); the colon is generally affected more than the small intestine. (See "Chronic intestinal pseudo-obstruction: Etiology, clinical manifestations, and diagnosis" and "Acute colonic pseudo-obstruction (Ogilvie's syndrome)".)

Large bowel obstruction — Large bowel obstruction can cause small bowel dilation, as well as symptoms such as nausea, vomiting, and abdominal pain/distension. Diseases affecting the proximal colon, such as cecal volvulus or adhesions, are more likely to be confused with acute small bowel obstruction compared with distal disease. The interval at which cramping pain occurs is typically longer with colonic obstruction compared with small bowel obstruction and occurs lower in the abdomen between the umbilicus and pubic tubercle. Large bowel obstruction can usually be distinguished from small bowel obstruction by the identification of a transition point in the colon, rather than small intestine, on imaging studies. (See "Large bowel obstruction".)

The clinical presentation of large bowel obstruction depends upon the location and etiology of the obstruction. Tumor is the most common cause of large bowel obstruction, followed by adhesive disease and volvulus.

- In the large bowel, adenocarcinoma of the colon and rectum is the predominant malignancy causing obstruction. Colonic obstruction complicates 10 to 20 percent of colon cancers. Because tumors are slow growing and often located more distally in the colon, symptoms are chronic, progressive, and rarely confused with those of acute small bowel obstruction. Tumors that cause colon obstruction commonly cause "apple-core" lesions, which are readily demonstrated on CT scan. (See "Clinical presentation, diagnosis, and staging of colorectal cancer".)

- Typical findings on plain abdominal films or abdominal CT scan of a grossly dilated cecum (image 13A-B) or sigmoid colon (image 14) quickly distinguish volvulus from small bowel obstruction and indicate the need for treatment, which is surgical (right colectomy) for cecal volvulus and, for sigmoid volvulus, involves endoscopic decompression and derotation, followed by surgery in selected patients. (See "Cecal volvulus" and "Sigmoid volvulus".)

Regardless of the etiology, large bowel obstruction presenting as a small bowel obstruction portends a higher mortality rate than primary small bowel obstruction.

SPECIFIC ETIOLOGIES

Once a diagnosis of small bowel obstruction has been established, it is important to try to determine the specific etiology responsible for the obstruction (table 1). The patient's age or medical history often suggests the possible etiology. (See 'Etiologies' above.)

Unique clinical and diagnostic features associated with the more common etiologies of small bowel obstruction are briefly reviewed below and discussed more fully in the linked topic reviews.

Adhesive bowel disease — Adhesions are the most common etiology for small bowel obstruction, with 55 to 80 percent of cases of bowel obstruction in developed countries attributable to adhesions within the abdomen or pelvis [67,102]. Approximately 80 percent of patients with adhesive small bowel obstruction have a history of prior intra-abdominal surgery; the remainder have prior peritonitis or no obvious precipitating cause for their adhesions [67].

Peritoneal adhesive bands are the most frequent etiology of bowel obstruction following abdominal or pelvic surgery. Patients with a history of prior abdominal or pelvic surgery, and particularly colorectal surgery, appendectomy, gynecologic surgery, prior adhesiolysis, and resection of malignancy, are prone to adhesive small bowel obstruction [13,102-104]. In a random 5 percent sample of all Medicare patients undergoing open colorectal and general surgery in a single year, 14 percent of patients had small bowel obstructions and 3 percent required adhesiolysis [105]. The type of operation performed was associated with the risk of postoperative adhesions causing small bowel obstruction, with ileo-anal pouch anastomosis having the highest incidence (19 percent), followed by open colectomy (10 percent). Gynecologic procedures were associated with an 11 percent incidence of postoperative adhesion-related small bowel obstruction. Although intra-abdominal adhesions form in more than 90 percent of patients after open abdominal surgery [106], few patients require surgery to manage adhesive bowel obstruction [107]. In general, the laparoscopic approach is associated with a lower incidence of adhesive small bowel obstruction compared with the open approach [107]. Indeed, the increasing utilization of laparoscopic surgery over the past few decades has been associated with a decrease in the population-based rate of adhesive SBO [9].

A specific preoperative diagnosis of adhesions as a cause of bowel obstruction is difficult to confirm [65]. However, because adhesions commonly involve the omentum or mesenteric fat, signs that indicate abnormalities of the normal architecture may indicate that adhesions are responsible for bowel obstruction. Signs include a "fat-bridging sign," which is a cord-like structure containing mesenteric fat that can bridge across the peritoneum; twisting of the

mesentery (whirl signs); and tethering of the omentum. Adhesions are a frequent cause of closed-loop obstruction [108], which, in addition to the identification of abnormal bands on imaging, may appear as a sac-like clustering of intestine, indicating that the intestine has herniated into an enclosed space [108]. (See 'Complete obstruction and closed-loop obstruction' above.)

There are data to indicate that even in patients with no prior surgical intervention (ie, "virgin abdomen"), adhesions are still the most common cause of small bowel obstruction [109,110]. Adhesive small bowel obstruction occurs in the absence of prior abdominal surgery in 3 to 9 percent of patients [109,111]. The underlying etiology is malignant in only approximately 10 percent and is equivalent to the prevalence in patients with previous surgery [109]. In a meta-analysis of six studies involving over 400 patients with small bowel obstruction without any prior surgery, adhesions were the cause in the majority (54 percent) of cases, and malignant etiology was discovered in 7 to 13 percent [112]. Adhesions may have developed in these patients as a result of prior episodes of intra-abdominal inflammation (eg, diverticulitis, Crohn disease). In one study of 103 patients, nonoperative treatment was successful in 61 percent of patients without any prior abdominal surgery, with a recurrence rate of <10 percent over a mean 4.5 year follow-up [113].

Early postoperative small bowel obstruction — Small bowel obstruction that occurs within four to six weeks of an abdominal surgery is called early postoperative small bowel obstruction. In a single-center retrospective review, the incidence of early small bowel obstruction after exploratory laparotomy for trauma was 4 percent and was independently associated with gastrointestinal perforation at the index operation [80]. Like small bowel obstructions that occur later after abdominal surgery, early postoperative small bowel obstruction is also caused by intra-abdominal adhesions. However, because the consistency and vascularity of the adhesions in that early postoperative period are dissimilar to those of more mature adhesions, the management of early postoperative bowel obstruction is also different. In the absence of clinical deterioration, most surgeons would manage early postoperative small bowel obstruction nonoperatively for a longer duration than they would standard small bowel obstruction. (See "Management of small bowel obstruction in adults", section on 'Postoperative bowel obstruction'.)

Tumor — Tumors, predominantly metastatic malignant tumors, are the second most common cause of small bowel obstruction, accounting for approximately 20 percent of cases [114].

Primary tumor — Primary tumors of the small or large bowel may be responsible for symptoms and signs of small bowel obstruction.

Intraluminal small bowel neoplasms such as carcinoid, small bowel carcinoma, and lymphoma can cause small bowel obstruction due to luminal narrowing or intussusception. In one review of 17 patients, the most frequent primary small bowel tumors as an etiology for small bowel obstruction were gastrointestinal stromal tumors (36 percent), lymphomas (24 percent), and adenocarcinomas (18 percent). Most tumors (65 percent) causing small bowel obstruction were located in the ileum [115].

Patients who present with clinical manifestations consistent with a small bowel obstruction but do not have a history of prior abdominal surgery or any of the other common risk factors for bowel obstruction should undergo imaging to exclude a small bowel neoplasm. (See "Epidemiology and clinical features of small bowel neoplasms" and "Diagnosis and staging of small bowel neoplasms".)

Metastatic disease — Metastatic disease is the most frequent neoplastic cause of small bowel obstruction. In general, small bowel obstruction caused by metastases is frequently preceded by a period of partial small bowel obstruction, although acute obstruction can sometimes be due to twisting of the bowel around a metastatic tumor deposit, leading to small bowel volvulus.

Tumors with a propensity to cause widespread peritoneal metastases include colonic, ovarian, pancreatic, and gastric neoplasms [67]. Small bowel obstruction has been described in as many as 28 percent of patients with colorectal carcinoma and 42 percent of women with ovarian carcinoma [116]. Multiple serosal small bowel metastases can form confluent soft tissue masses that surround the bowel. Obstruction occurs by extrinsic compression of the small bowel lumen or tethering of bowel loops by these serosal deposits.

Tumors that spread hematogenously to involve the wall of the small bowel include melanoma, lung, breast, cervix, sarcoma, and colon cancer. These metastases can cause endoluminal obstruction. (See "Epidemiology and clinical features of small bowel neoplasms", section on 'Metastatic lesions'.)

In a patient with a prior history of surgery, a small bowel obstruction due to metastases cannot be differentiated from a small bowel obstruction due to adhesive disease. The diagnosis and treatment of bowel obstruction in patients with known metastatic cancer in the peritoneum are discussed elsewhere. (See "Palliative care of bowel obstruction in cancer patients".)

Complicated hernia — Hernias are the third leading cause of intestinal obstruction, accounting for approximately 10 percent of all cases, and incarcerated hernias are the leading cause of complications (ischemia, necrosis, perforation) related to bowel obstruction [3,11,17,117-119].

External hernias occur at sites of muscular or ligamentous weakness in the abdominal wall. Abdominal wall and inguinal hernias are most commonly represented; femoral, obturator, and parastomal hernias can also be complicated by small bowel obstruction.

Internal hernias cause 0.6 to 6.0 percent of small bowel obstructions and occur through acquired or congenital defects in the mesentery (table 6) [120,121]. Acquired internal hernias can be due to adhesions or be from artificial mesenteric openings created during the course of an operation, such as during small bowel Roux-en-Y (eg, Roux-en-Y gastric bypass, pancreaticoduodenectomy) or ileal conduit procedures [108,122,123].

Some patients with abdominal wall or groin hernia may present with intermittent obstructive symptoms if their hernia remains reducible; however, incarcerated hernias that cause bowel obstruction typically present acutely. Abdominal wall, inguinal, and femoral hernias can usually be detected on clinical examination. Small incisional hernias, hernias in individuals with obesity, and internal hernias may not be clinically evident but can usually be identified on computed tomography (CT) scan. Typical findings of hernias on abdominal CT are discussed elsewhere. (See "Overview of abdominal wall hernias in adults".)

Intra-abdominal inflammation or infection — Inflammation of the intestine (eg, Crohn disease flare-up, appendicitis, colonic diverticulitis, Meckel's diverticulitis) with or without abscess formation can lead to an acute mechanical small bowel obstruction as the healthy small bowel/omentum tries to contain the process and becomes involved in an inflammatory phlegmon.

However, in this setting, the symptoms of small bowel obstruction are typically overshadowed by other clinical features, such as fever and abdominal pain, and the obstruction may resolve with resolution of the underlying condition (eg, with antibiotic therapy). (See "Acute appendicitis in adults: Clinical manifestations and differential diagnosis" and "Clinical manifestations and diagnosis of acute colonic diverticulitis in adults" and "Meckel's diverticulum".)

Traumatic intramural hematoma — A history of blunt abdominal trauma (recent or remote), in the absence of other risk factors for bowel obstruction, should suggest a diagnosis of traumatic intramural hematoma as the etiology of acute mechanical bowel obstruction. Late fibrosis of a segment of bowel following traumatic interruption to the mesenteric vasculature can lead to chronic symptoms of obstruction due to gradual narrowing of the intestinal lumen [124,125].

The duodenum is the most frequently involved segment of the bowel because it is fixed in the retroperitoneum and easily compressed between the abdominal wall and the vertebral column.

A common cause is injury from a seatbelt. Other intestinal sites of hematoma causing acute mechanical obstruction have also been described [126-128].

The presence of an acute intramural hematoma can be established with abdominal CT showing findings of bowel wall thickening with or without adjacent mesenteric changes (stranding, hematoma) [127,128]. However, other studies, such as upper gastrointestinal contrast studies, may be needed to establish the diagnosis. (See "Traumatic gastrointestinal injury in the adult patient".)

Intestinal stricture — Intestinal stricture as an etiology of bowel obstruction can be due to a number of disorders, most commonly inflammatory bowel disease (eg, Crohn disease). Patients with Crohn disease can present with small bowel obstruction due to adhesions or small bowel stricture. These patients usually present with chronic, intermittent symptoms from partial rather than complete bowel obstruction. Small bowel obstruction as the source for symptoms may be overlooked because of the long-standing nature of disease symptoms, and it may be difficult to distinguish a Crohn exacerbation from small bowel obstruction. (See "Surgical management of Crohn disease", section on 'Small bowel stricture'.)

Small bowel stricture can also result from an episode of mesenteric ischemia [129]. Because the ileocolic artery is the most distal branch of the superior mesenteric artery, the usual site of ischemic stricture in the small bowel is the distal ileum [130]. (See "Overview of intestinal ischemia in adults".)

Radiation therapy for abdominal malignancy can lead to small bowel stricture, particularly in patients who have undergone prior surgery in which adhesions may fix loops of small intestine within the field of radiation [131]. (See "Surgical approach to radiation enteritis".)

Intestinal stricture can also develop due to certain drugs such as enteric-coated potassium chloride tablets and nonsteroidal anti-inflammatory drugs (NSAIDs). Strictures can also occur at the site of prior gastrointestinal anastomoses. (See "Surgical management of Crohn disease", section on 'Small bowel or ileocecal resection'.)

Volvulus — Volvulus refers to twisting of a segment of the intestinal tract around a fixed point, often leading to acute mechanical bowel obstruction. The most common sites of volvulus are the cecum and sigmoid colon [132,133]. Small bowel volvulus is less common in adults, and it is usually due to congenital intestinal anomalies (primary small bowel volvulus) but may be related to a prior abdominal procedure, for which intestinal anatomy has been altered, or tumors (secondary small bowel volvulus) [134,135]. (See "Intestinal malrotation in adults", section on 'Acute clinical presentation' and "Cecal volvulus" and "Sigmoid volvulus".)

Gallstones or foreign body — Rarely, acute mechanical small bowel obstruction can be caused by intraluminal material. The site of obstruction is usually at the ileocecal valve, where the lumen of the bowel is smallest.

- Gallstone ileus occurs when a large gallstone erodes into the small bowel via a biliary-enteric fistula. In addition to typical symptoms of small bowel obstruction and imaging findings consistent with small bowel obstruction, other imaging findings of gallstone ileus include biliary air (pneumobilia) and the finding of an aberrantly located large gallstone, which is often impacted at the ileocecal valve (image 15 and image 16). (See "Gallstone ileus".)

- Gastrointestinal bezoars, which are composed of ingested material that is not digested within the gastrointestinal tract, can obstruct the bowel lumen and may be related to a high-fiber diet (phytobezoar), improperly chewed food, hair ingestion (trichobezoar), and medications (pharmacobezoar) [136] (see "Gastric bezoars"). Primary small bowel phytobezoars almost always present as small bowel obstruction [137]. Abdominal radiographs, abdominal ultrasound, or CT scan may show the bezoar as an intraluminal mass or a filling defect.

- Heavy intestinal parasitic infestation with *Ascaris lumbricoides* can lead to acute mechanical intestinal obstruction, and in endemic areas, ascariasis causes up to one-third of all bowel obstructions, typically in children, but adults can also be affected [138-141]. Patients will have typical symptoms of acute mechanical small bowel obstruction, and emesis may contain worms. An abdominal mass may be appreciated on physical examination. (See "Ascariasis".)

Intussusception — Intestinal intussusception is rare in adults, accounting for 1 to 5 percent of mechanical bowel obstructions [142,143]. In adults, intussusception is typically due to pathologic lead point within the bowel, which is malignant in up to 77 percent of cases [120,142,144]. The lead point is pulled forward by normal peristalsis, telescoping or prolapsing the affected segment of bowel (intussusceptum) into another segment of bowel (intussuscipiens) (picture 1) [142,145].

An increased incidence of intussusception has been reported in patients with acquired immune deficiency syndrome (AIDS) [121,145]. This is due to the high incidence of infectious and neoplastic conditions of the bowel in AIDS patients, such as lymphoid hyperplasia, Kaposi sarcoma, and non-Hodgkin lymphoma that can serve as lead points. (See "Epidemiology and clinical features of small bowel neoplasms".)

Intussusception can be classified by etiology (benign lesion [eg, polyps, Meckel's diverticulum], malignant lesion, or idiopathic) or by location as entero-enteric, which is limited to the small bowel; ileo-colic with prolapse of the terminal ileum into the ascending colon; and colo-colic, which is limited to the large bowel. They can also be classified as antegrade or retrograde, such as that seen with jejuno-gastric intussusception in patients with previous gastro-jejunostomy.

In adults, intermittent abdominal pain is the most common presentation; however, patients can also present with symptoms consistent with intermittent partial bowel obstruction with nausea, vomiting, melena, weight loss, fever, and constipation [145]. Plain abdominal films may show the typical features of distal small bowel obstruction. The diagnosis is often made on abdominal CT [145,146]. The distended loop of bowel appears thickened because it represents two layers of bowel [67]. A "target sign" may be seen on the sagittal view of the abdominal CT (image 17), while on axial or coronal view, the intussusception will appear as a sausage-shaped mass.

Other unusual etiologies

- Splenosis, which is autotransplanted splenic tissue, usually as a result of traumatic splenic rupture, can cause bowel obstruction due to extrinsic compression (image 18), but intussusception has also been reported [147-149].

- Superior mesenteric artery syndrome is an unusual cause of proximal small bowel obstruction. The syndrome is characterized by compression of the third portion of the duodenum due to narrowing of the space between the superior mesenteric artery and aorta and is primarily attributed to loss of the intervening mesenteric fat pad. (See "Superior mesenteric artery syndrome".)

- Congenital anomalies of the gastrointestinal tract can cause obstructive symptoms. Although rare in adults, malrotation and annular pancreas can cause proximal small bowel obstruction. (See 'Volvulus' above and "Intestinal malrotation in adults".)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Bowel obstruction".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Small bowel obstruction (The Basics)")

SUMMARY AND RECOMMENDATIONS

- **Definition and pathophysiology** – Bowel obstruction occurs when the normal flow of intraluminal contents is interrupted, which leads to bowel dilation and sequestration of fluid within the lumen of the intestine proximal to the blockage, while distal to the blockage, as luminal contents pass, the bowel decompresses. Compromised blood flow to the intestinal tissue due to excessive bowel dilation or strangulation of the mesentery can lead to complications (ischemia, necrosis, perforation), which significantly increase mortality associated with bowel obstruction. (See 'Introduction' above and 'Pathophysiology' above.)

- **Etiologies** – In the United States and Western Europe, the most common causes of mechanical small bowel obstruction are intraperitoneal adhesions, tumors, and complicated hernias, with these three etiologies accounting for 90 percent of all cases. Less frequent causes of obstruction include Crohn disease (3 to 7 percent), gallstones (2 percent), volvulus (4 to 15 percent), and intussusception (4 to 8 percent). (See 'Etiologies' above.)

  Once a diagnosis of small bowel obstruction has been established, it is important to try to determine the specific etiology responsible for the obstruction (table 1). The patient's age or medical history often suggests the possible etiology. Unique clinical and diagnostic features associated with the more common etiologies of small bowel obstruction are

briefly reviewed above and discussed more fully in linked topic reviews. (See 'Specific etiologies' above.)

- **Clinical manifestations** – The clinical presentation of mechanical small bowel obstruction depends upon the site and etiology of obstruction. Most patients with small bowel obstruction will present acutely with an abrupt onset of colicky abdominal pain, nausea, vomiting, and abdominal distention. Vomiting can be severe in patients with proximal small bowel obstruction, while in patients with distal small bowel obstruction, abdominal distension may be more prominent. A minority of patients will present with chronic partial obstruction or intermittent symptoms that resolve only to recur again (recurrent obstructions). (See 'Clinical presentations' above.)

- **Diagnosis** – A presumptive diagnosis of acute mechanical small bowel obstruction can be made by history and physical examination in many patients, particularly those with a history of prior abdominal surgery or an obviously evident inguinal, femoral, or ventral hernia. Signs of peritonitis with generalized guarding and rebound tenderness may warrant an immediate surgical intervention. (See 'Diagnosis' above.)

  - **Laboratory studies** – In patients with acute small bowel obstruction, routine laboratory studies (complete blood count [CBC], basic metabolic panel [BMP]) help assess the presence and severity of hypovolemia and electrolyte abnormalities and may indicate the possibility of complications (eg, leukocytosis, metabolic acidosis). Although there are no reliable laboratory markers for bowel ischemia, elevated serum lactate is sensitive but not specific. Laboratory studies in patients with chronic bowel obstruction are usually normal. (See 'Laboratory studies' above.)

  - **Imaging** - Abdominal imaging is generally needed to confirm a diagnosis of mechanical bowel obstruction, identify the location of obstruction, judge whether the obstruction is partial or complete, identify complications related to obstruction (ischemia, necrosis, perforation), and determine the potential etiology, all of which will help determine the urgency and nature of further treatment (conservative, endoscopy, surgery). (See 'Diagnostic evaluation' above.)

    For most patients suspected of having mechanical small bowel obstruction, we obtain plain radiographs to quickly confirm a diagnosis of bowel obstruction, and, provided the films do not have findings that indicate the need for immediate intervention, we use computed tomography (CT) of the abdomen to further characterize the nature, severity, and potential etiologies of the obstruction (see 'Preferred initial studies for most patients' above). The typical protocols are:

- The basic plain radiographic examination should include an upright chest film and upright and supine abdominal films. If the patient cannot be placed into an upright position, a lateral decubitus abdominal film should be performed.

- Abdominal CT should be performed with intravenous contrast if not contraindicated. For patients with suspected complete small bowel obstruction based on clinical evaluation and/or plain radiographs, oral contrast should be omitted. For patients with low-grade or intermittent small bowel obstruction, CT should be performed with both intravenous and oral contrast.

If abdominal CT cannot be performed or the result is equivocal, other imaging studies may be required (see 'Alternative studies for special patient groups' above):

- Abdominal ultrasonography may be useful for the diagnosis of small bowel obstruction in patients who cannot undergo CT scanning due to contrast allergies, pregnant patients, and critically ill patients for whom the study can be performed at the bedside. (See 'Bedside imaging study' above.)

- Abdominal magnetic resonance imaging (MRI) is an option for the assessment of small bowel obstruction in pregnant women and in children and younger adult patients who have had multiple prior CT examinations. (See 'Pregnant or young patients' above.)

- For patients with clinically suspected chronic or intermittent small bowel obstruction, CT-, MRI-, or fluoroscopic-guided enteroclysis is the second-best study after abdominal CT but is not widely available and has low patient acceptance (due to the need for small bowel intubation). (See 'Enteroclysis' above.)

- CT or MRI enterography (which does not require nasogastric tube) is most useful in diagnosing Crohn-related small bowel obstruction. (See 'CT or MRI enterography' above.)

- Fluoroscopic small bowel follow-through may offer some functional information about the small bowel obstruction but has been largely supplanted by abdominal CT. (See 'Functional study' above.)

- **Differential diagnosis** - Mechanical small bowel obstruction can be differentiated from nonobstructive medical conditions (table 4), functional bowel obstructions (table 5), and large bowel obstructions, usually by history and imaging studies. (See 'Differential diagnosis' above.)

ACKNOWLEDGMENT

The UpToDate editorial staff acknowledges Richard A Hodin, MD, who contributed to earlier versions of this topic review.

REFERENCES

1. Drożdż W, Budzyński P. Change in mechanical bowel obstruction demographic and etiological patterns during the past century: observations from one health care institution. Arch Surg 2012; 147:175.
2. Kozol R. Mechanical bowel obstruction: a tale of 2 eras. Arch Surg 2012; 147:180.
3. Mucha P Jr. Small intestinal obstruction. Surg Clin North Am 1987; 67:597.
4. Miller G, Boman J, Shrier I, Gordon PH. Natural history of patients with adhesive small bowel obstruction. Br J Surg 2000; 87:1240.
5. Miller G, Boman J, Shrier I, Gordon PH. Etiology of small bowel obstruction. Am J Surg 2000; 180:33.
6. Cappell MS, Batke M. Mechanical obstruction of the small bowel and colon. Med Clin North Am 2008; 92:575.
7. Gore RM, Silvers RI, Thakrar KH, et al. Bowel Obstruction. Radiol Clin North Am 2015; 53:1225.
8. Sikirica V, Bapat B, Candrilli SD, et al. The inpatient burden of abdominal and gynecological adhesiolysis in the US. BMC Surg 2011; 11:13.
9. Behman R, Nathens AB, Look Hong N, et al. Evolving Management Strategies in Patients with Adhesive Small Bowel Obstruction: a Population-Based Analysis. J Gastrointest Surg 2018; 22:2133.
10. Ten Broek RPG, Krielen P, Di Saverio S, et al. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2017 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. World J Emerg Surg 2018; 13:24.
11. Markogiannakis H, Messaris E, Dardamanis D, et al. Acute mechanical bowel obstruction: clinical presentation, etiology, management and outcome. World J Gastroenterol 2007; 13:432.

12. Wright HK, O'Brien JJ, Tilson MD. Water absorption in experimental closed segment obstruction of the ileum in man. Am J Surg 1971; 121:96.
13. Noer RJ, Derr JW, Johnston CG. The Circulation of the Small Intestine: An Evaluation of its Revascularizing Potential. Ann Surg 1949; 130:608.
14. Bizer LS, Liebling RW, Delany HM, Gliedman ML. Small bowel obstruction: the role of nonoperative treatment in simple intestinal obstruction and predictive criteria for strangulation obstruction. Surgery 1981; 89:407.
15. Lawal OO, Olayinka OS, Bankole JO. Spectrum of causes of intestinal obstruction in adult Nigerian patients. S Afr J Surg 2005; 43:34, 36.
16. Gürleyik E, Gürleyik G. Small bowel volvulus: a common cause of mechanical intestinal obstruction in our region. Eur J Surg 1998; 164:51.
17. McEntee G, Pender D, Mulvin D, et al. Current spectrum of intestinal obstruction. Br J Surg 1987; 74:976.
18. Kirshtein B, Roy-Shapira A, Lantsberg L, et al. Laparoscopic management of acute small bowel obstruction. Surg Endosc 2005; 19:464.
19. Yang XY, Chen CX, Zhang BL, et al. Diagnostic effect of capsule endoscopy in 31 cases of subacute small bowel obstruction. World J Gastroenterol 2009; 15:2401.
20. Shafi S, Aboutanos M, Brown CV, et al. Measuring anatomic severity of disease in emergency general surgery. J Trauma Acute Care Surg 2014; 76:884.
21. Crandall ML, Agarwal S, Muskat P, et al. Application of a uniform anatomic grading system to measure disease severity in eight emergency general surgical illnesses. J Trauma Acute Care Surg 2014; 77:705.
22. Baghdadi YMK, Morris DS, Choudhry AJ, et al. Validation of the anatomic severity score developed by the American Association for the Surgery of Trauma in small bowel obstruction. J Surg Res 2016; 204:428.
23. Hernandez MC, Haddad NN, Cullinane DC, et al. The American Association for the Surgery of Trauma Severity Grade is valid and generalizable in adhesive small bowel obstruction. J Trauma Acute Care Surg 2018; 84:372.
24. Hernandez MC, Birindelli A, Bruce JL, et al. Application of the AAST EGS Grade for Adhesive Small Bowel Obstruction to a Multi-national Patient Population. World J Surg 2018; 42:3581.
25. Taylor MR, Lalani N. Adult small bowel obstruction. Acad Emerg Med 2013; 20:528.
26. Vrijland WW, Jeekel J, van Geldorp HJ, et al. Abdominal adhesions: intestinal obstruction, pain, and infertility. Surg Endosc 2003; 17:1017.

27. Cheadle WG, Garr EE, Richardson JD. The importance of early diagnosis of small bowel obstruction. Am Surg 1988; 54:565.
28. Tamijmarane A, Chandra S, Smile SR. Clinical aspects of adhesive intestinal obstruction. Trop Gastroenterol 2000; 21:141.
29. Sarr MG, Bulkley GB, Zuidema GD. Preoperative recognition of intestinal strangulation obstruction. Prospective evaluation of diagnostic capability. Am J Surg 1983; 145:176.
30. Perea García J, Turégano Fuentes T, Quijada García B, et al. Adhesive small bowel obstruction: predictive value of oral contrast administration on the need for surgery. Rev Esp Enferm Dig 2004; 96:191.
31. Lau KC, Miller BJ, Schache DJ, Cohen JR. A study of large-bowel volvulus in urban Australia. Can J Surg 2006; 49:203.
32. Flasar MH, Goldberg E. Acute abdominal pain. Med Clin North Am 2006; 90:481.
33. Murray MJ, Gonze MD, Nowak LR, Cobb CF. Serum D(-)-lactate levels as an aid to diagnosing acute intestinal ischemia. Am J Surg 1994; 167:575.
34. Lange H, Jäckel R. Usefulness of plasma lactate concentration in the diagnosis of acute abdominal disease. Eur J Surg 1994; 160:381.
35. Jackson PG, Raiji MT. Evaluation and management of intestinal obstruction. Am Fam Physician 2011; 83:159.
36. Böhner H, Yang Q, Franke C, et al. Simple data from history and physical examination help to exclude bowel obstruction and to avoid radiographic studies in patients with acute abdominal pain. Eur J Surg 1998; 164:777.
37. Eskelinen M, Ikonen J, Lipponen P. Contributions of history-taking, physical examination, and computer assistance to diagnosis of acute small-bowel obstruction. A prospective study of 1333 patients with acute abdominal pain. Scand J Gastroenterol 1994; 29:715.
38. Takeuchi K, Tsuzuki Y, Ando T, et al. Clinical studies of strangulating small bowel obstruction. Am Surg 2004; 70:40.
39. Zielinski MD, Eiken PW, Bannon MP, et al. Small bowel obstruction-who needs an operation? A multivariate prediction model. World J Surg 2010; 34:910.
40. Markogiannakis H, Memos N, Messaris E, et al. Predictive value of procalcitonin for bowel ischemia and necrosis in bowel obstruction. Surgery 2011; 149:394.
41. Cosse C, Regimbeau JM, Fuks D, et al. Serum procalcitonin for predicting the failure of conservative management and the need for bowel resection in patients with small bowel obstruction. J Am Coll Surg 2013; 216:997.

42. Ayten R, Dogru O, Camci C, et al. Predictive value of procalcitonin for the diagnosis of bowel strangulation. World J Surg 2005; 29:187.
43. Winslet M, Barraclough K, Campbell Hewson G. Subacute small bowel obstruction or chronic large bowel obstruction. BMJ 2021; 374:n1765.
44. DuPont HL. Acute infectious diarrhea in immunocompetent adults. N Engl J Med 2014; 370:1532.
45. Foster NM, McGory ML, Zingmond DS, Ko CY. Small bowel obstruction: a population-based appraisal. J Am Coll Surg 2006; 203:170.
46. Fevang BT, Fevang J, Lie SA, et al. Long-term prognosis after operation for adhesive small bowel obstruction. Ann Surg 2004; 240:193.
47. Duron JJ, Silva NJ, du Montcel ST, et al. Adhesive postoperative small bowel obstruction: incidence and risk factors of recurrence after surgical treatment: a multicenter prospective study. Ann Surg 2006; 244:750.
48. Barkan H, Webster S, Ozeran S. Factors predicting the recurrence of adhesive small-bowel obstruction. Am J Surg 1995; 170:361.
49. Behman R, Nathens AB, Mason S, et al. Association of Surgical Intervention for Adhesive Small-Bowel Obstruction With the Risk of Recurrence. JAMA Surg 2019; 154:413.
50. Behman R, Nathens AB, Haas B, et al. Surgery for adhesive small-bowel obstruction is associated with improved long-term survival mediated through recurrence prevention: A population-based, propensity-matched analysis. J Trauma Acute Care Surg 2019; 87:636.
51. Gerhardt RT, Nelson BK, Keenan S, et al. Derivation of a clinical guideline for the assessment of nonspecific abdominal pain: the Guideline for Abdominal Pain in the ED Setting (GAPEDS) Phase 1 Study. Am J Emerg Med 2005; 23:709.
52. Cartwright SL, Knudson MP. Evaluation of acute abdominal pain in adults. Am Fam Physician 2008; 77:971.
53. American College of Radiology (ACR) Appropriateness Criteria on suspected small-bowel ob struction. Available at: https://acsearch.acr.org/docs/69476/Narrative/ (Accessed on July 24, 2019).
54. Atri M, McGregor C, McInnes M, et al. Multidetector helical CT in the evaluation of acute small bowel obstruction: comparison of non-enhanced (no oral, rectal or IV contrast) and IV enhanced CT. Eur J Radiol 2009; 71:135.
55. O'Daly BJ, Ridgway PF, Keenan N, et al. Detected peritoneal fluid in small bowel obstruction is associated with the need for surgical intervention. Can J Surg 2009; 52:201.

56. Sheedy SP, Earnest F 4th, Fletcher JG, et al. CT of small-bowel ischemia associated with obstruction in emergency department patients: diagnostic performance evaluation. Radiology 2006; 241:729.
57. Jones K, Mangram AJ, Lebron RA, et al. Can a computed tomography scoring system predict the need for surgery in small-bowel obstruction? Am J Surg 2007; 194:780.
58. Biondo S, Parés D, Frago R, et al. Large bowel obstruction: predictive factors for postoperative mortality. Dis Colon Rectum 2004; 47:1889.
59. Taourel PG, Fabre JM, Pradel JA, et al. Value of CT in the diagnosis and management of patients with suspected acute small-bowel obstruction. AJR Am J Roentgenol 1995; 165:1187.
60. Lazarus DE, Slywotsky C, Bennett GL, et al. Frequency and relevance of the "small-bowel feces" sign on CT in patients with small-bowel obstruction. AJR Am J Roentgenol 2004; 183:1361.
61. Ha HK, Kim JS, Lee MS, et al. Differentiation of simple and strangulated small-bowel obstructions: usefulness of known CT criteria. Radiology 1997; 204:507.
62. Rondenet C, Millet I, Corno L, et al. CT diagnosis of closed loop bowel obstruction mechanism is not sufficient to indicate emergent surgery. Eur Radiol 2020; 30:1105.
63. Duda JB, Bhatt S, Dogra VS. Utility of CT whirl sign in guiding management of small-bowel obstruction. AJR Am J Roentgenol 2008; 191:743.
64. Ho YC. "Venous cut-off sign" as an adjunct to the "whirl sign" in recognizing acute small bowel volvulus via CT scan. J Gastrointest Surg 2012; 16:2005.
65. Balthazar EJ, Birnbaum BA, Megibow AJ, et al. Closed-loop and strangulating intestinal obstruction: CT signs. Radiology 1992; 185:769.
66. Lappas JC, Reyes BL, Maglinte DD. Abdominal radiography findings in small-bowel obstruction: relevance to triage for additional diagnostic imaging. AJR Am J Roentgenol 2001; 176:167.
67. Mullan CP, Siewert B, Eisenberg RL. Small bowel obstruction. AJR Am J Roentgenol 2012; 198:W105.
68. Thompson WM, Kilani RK, Smith BB, et al. Accuracy of abdominal radiography in acute small-bowel obstruction: does reviewer experience matter? AJR Am J Roentgenol 2007; 188:W233.
69. Maglinte DD, Reyes BL, Harmon BH, et al. Reliability and role of plain film radiography and CT in the diagnosis of small-bowel obstruction. AJR Am J Roentgenol 1996; 167:1451.

70. Suri S, Gupta S, Sudhakar PJ, et al. Comparative evaluation of plain films, ultrasound and CT in the diagnosis of intestinal obstruction. Acta Radiol 1999; 40:422.
71. Maglinte DD, Heitkamp DE, Howard TJ, et al. Current concepts in imaging of small bowel obstruction. Radiol Clin North Am 2003; 41:263.
72. Balthazar EJ. George W. Holmes Lecture. CT of small-bowel obstruction. AJR Am J Roentgenol 1994; 162:255.
73. Soyer P, Dohan A, Eveno C, et al. Carcinoid tumors of the small-bowel: evaluation with 64-section CT-enteroclysis. Eur J Radiol 2013; 82:943.
74. Gong JS, Kang WY, Liu T, et al. CT findings of a gastrointestinal stromal tumor arising from small bowel. Quant Imaging Med Surg 2012; 2:57.
75. Zalcman M, Sy M, Donckier V, et al. Helical CT signs in the diagnosis of intestinal ischemia in small-bowel obstruction. AJR Am J Roentgenol 2000; 175:1601.
76. Mallo RD, Salem L, Lalani T, Flum DR. Computed tomography diagnosis of ischemia and complete obstruction in small bowel obstruction: a systematic review. J Gastrointest Surg 2005; 9:690.
77. Colon MJ, Telem DA, Wong D, Divino CM. The relevance of transition zones on computed tomography in the management of small bowel obstruction. Surgery 2010; 147:373.
78. Matsushima K, Inaba K, Dollbaum R, et al. High-Density Free Fluid on Computed Tomography: a Predictor of Surgical Intervention in Patients with Adhesive Small Bowel Obstruction. J Gastrointest Surg 2016; 20:1861.
79. Petrovic B, Nikolaidis P, Hammond NA, et al. Identification of adhesions on CT in small-bowel obstruction. Emerg Radiol 2006; 12:88.
80. Barmparas G, Branco BC, Schnüriger B, et al. In-hospital small bowel obstruction after exploratory laparotomy for trauma. J Trauma 2011; 71:486.
81. Scrima A, Lubner MG, King S, et al. Value of MDCT and Clinical and Laboratory Data for Predicting the Need for Surgical Intervention in Suspected Small-Bowel Obstruction. AJR Am J Roentgenol 2017; 208:785.
82. Shakil O, Zafar SN, Zia-ur-Rehman, et al. The role of computed tomography for identifying mechanical bowel obstruction in a Pakistani population. J Pak Med Assoc 2011; 61:871.
83. Megibow AJ, Balthazar EJ, Cho KC, et al. Bowel obstruction: evaluation with CT. Radiology 1991; 180:313.
84. Fukuya T, Hawes DR, Lu CC, et al. CT diagnosis of small-bowel obstruction: efficacy in 60 patients. AJR Am J Roentgenol 1992; 158:765.

85. Jaffe TA, Nelson RC, Johnson GA, et al. Optimization of multiplanar reformations from isotropic data sets acquired with 16-detector row helical CT scanner. Radiology 2006; 238:292.
86. Jaffe TA, Martin LC, Thomas J, et al. Small-bowel obstruction: coronal reformations from isotropic voxels at 16-section multi-detector row CT. Radiology 2006; 238:135.
87. Maglinte DD, Gage SN, Harmon BH, et al. Obstruction of the small intestine: accuracy and role of CT in diagnosis. Radiology 1993; 188:61.
88. Schmutz GR, Benko A, Fournier L, et al. Small bowel obstruction: role and contribution of sonography. Eur Radiol 1997; 7:1054.
89. Musoke F, Kawooya MG, Kiguli-Malwadde E. Comparison between sonographic and plain radiography in the diagnosis of small bowel obstruction at Mulago Hospital, Uganda. East Afr Med J 2003; 80:540.
90. Jang TB, Schindler D, Kaji AH. Bedside ultrasonography for the detection of small bowel obstruction in the emergency department. Emerg Med J 2011; 28:676.
91. Ogata M, Mateer JR, Condon RE. Prospective evaluation of abdominal sonography for the diagnosis of bowel obstruction. Ann Surg 1996; 223:237.
92. Ogata M, Imai S, Hosotani R, et al. Abdominal ultrasonography for the diagnosis of strangulation in small bowel obstruction. Br J Surg 1994; 81:421.
93. Shrake PD, Rex DK, Lappas JC, Maglinte DD. Radiographic evaluation of suspected small bowel obstruction. Am J Gastroenterol 1991; 86:175.
94. Kohli MD, Maglinte DD. CT enteroclysis in incomplete small bowel obstruction. Abdom Imaging 2009; 34:321.
95. Caroline DF, Herlinger H, Laufer I, et al. Small-bowel enema in the diagnosis of adhesive obstructions. AJR Am J Roentgenol 1984; 142:1133.
96. Paulsen SR, Huprich JE, Fletcher JG, et al. CT enterography as a diagnostic tool in evaluating small bowel disorders: review of clinical experience with over 700 cases. Radiographics 2006; 26:641.
97. Fidler JL, Guimaraes L, Einstein DM. MR imaging of the small bowel. Radiographics 2009; 29:1811.
98. Makanjuola D. Computed tomography compared with small bowel enema in clinically equivocal intestinal obstruction. Clin Radiol 1998; 53:203.
99. Frager D, Medwid SW, Baer JW, et al. CT of small-bowel obstruction: value in establishing the diagnosis and determining the degree and cause. AJR Am J Roentgenol 1994; 162:37.

100. Frager DH, Baer JW, Rothpearl A, Bossart PA. Distinction between postoperative ileus and mechanical small-bowel obstruction: value of CT compared with clinical and other radiographic findings. AJR Am J Roentgenol 1995; 164:891.
101. Stewart RM, Page CP, Brender J, et al. The incidence and risk of early postoperative small bowel obstruction. A cohort study. Am J Surg 1987; 154:643.
102. ten Broek RP, Issa Y, van Santbrink EJ, et al. Burden of adhesions in abdominal and pelvic surgery: systematic review and met-analysis. BMJ 2013; 347:f5588.
103. Matter I, Khalemsky L, Abrahamson J, et al. Does the index operation influence the course and outcome of adhesive intestinal obstruction? Eur J Surg 1997; 163:767.
104. Parker MC, Ellis H, Moran BJ, et al. Postoperative adhesions: ten-year follow-up of 12,584 patients undergoing lower abdominal surgery. Dis Colon Rectum 2001; 44:822.
105. Beck DE, Opelka FG, Bailey HR, et al. Incidence of small-bowel obstruction and adhesiolysis after open colorectal and general surgery. Dis Colon Rectum 1999; 42:241.
106. Menzies D, Ellis H. Intestinal obstruction from adhesions--how big is the problem? Ann R Coll Surg Engl 1990; 72:60.
107. Barmparas G, Branco BC, Schnüriger B, et al. The incidence and risk factors of post-laparotomy adhesive small bowel obstruction. J Gastrointest Surg 2010; 14:1619.
108. Hongo N, Mori H, Matsumoto S, et al. Internal hernias after abdominal surgeries: MDCT features. Abdom Imaging 2011; 36:349.
109. Beardsley C, Furtado R, Mosse C, et al. Small bowel obstruction in the virgin abdomen: the need for a mandatory laparotomy explored. Am J Surg 2014; 208:243.
110. Collom ML, Duane TM, Campbell-Furtick M, et al. Deconstructing dogma: Nonoperative management of small bowel obstruction in the virgin abdomen. J Trauma Acute Care Surg 2018; 85:33.
111. Butt MU, Velmahos GC, Zacharias N, et al. Adhesional small bowel obstruction in the absence of previous operations: management and outcomes. World J Surg 2009; 33:2368.
112. Choi J, Fisher AT, Mulaney B, et al. Safety of Foregoing Operation for Small Bowel Obstruction in the Virgin Abdomen: Systematic Review and Meta-Analysis. J Am Coll Surg 2020; 231:368.
113. Tavangari FR, Batech M, Collins JC, Tejirian T. Small Bowel Obstructions in a Virgin Abdomen: Is an Operation Mandatory? Am Surg 2016; 82:1038.
114. Kendrick ML. Partial small bowel obstruction: clinical issues and recent technical advances. Abdom Imaging 2009; 34:329.

115. Beltran MA, Cruces KS. Primary tumors of jejunum and ileum as a cause of intestinal obstruction: a case control study. Int J Surg 2007; 5:183.
116. Ripamonti C, De Conno F, Ventafridda V, et al. Management of bowel obstruction in advanced and terminal cancer patients. Ann Oncol 1993; 4:15.
117. Ihedioha U, Alani A, Modak P, et al. Hernias are the most common cause of strangulation in patients presenting with small bowel obstruction. Hernia 2006; 10:338.
118. Hayden GE, Sprouse KL. Bowel obstruction and hernia. Emerg Med Clin North Am 2011; 29:319.
119. Dayton MT, Dempsey DT, Larson GM, Posner AR. New paradigms in the treatment of small bowel obstruction. Curr Probl Surg 2012; 49:642.
120. Newsom BD, Kukora JS. Congenital and acquired internal hernias: unusual causes of small bowel obstruction. Am J Surg 1986; 152:279.
121. Bergstein JM, Condon RE. Obturator hernia: current diagnosis and treatment. Surgery 1996; 119:133.
122. Lall CG, Sandrasegaran K, Maglinte DT, Fridell JA. Bowel complications seen on CT after pancreas transplantation with enteric drainage. AJR Am J Roentgenol 2006; 187:1288.
123. Lockhart ME, Tessler FN, Canon CL, et al. Internal hernia after gastric bypass: sensitivity and specificity of seven CT signs with surgical correlation and controls. AJR Am J Roentgenol 2007; 188:745.
124. Touloukian RJ. Protocol for the nonoperative treatment of obstructing intramural duodenal hematoma during childhood. Am J Surg 1983; 145:330.
125. Northcutt A, Hamidian Jahromi A, Johnson L, Youssef AM. Unusual late occurrence of bowel obstruction following blunt abdominal trauma. J La State Med Soc 2011; 163:305.
126. Vollmer CM Jr, Schmieg RE, Freeman BD, Balfe DM. Traumatic colonic hematoma. J Trauma 2000; 49:1155.
127. LeBedis CA, Anderson SW, Soto JA. CT imaging of blunt traumatic bowel and mesenteric injuries. Radiol Clin North Am 2012; 50:123.
128. Ekeh AP, Saxe J, Walusimbi M, et al. Diagnosis of blunt intestinal and mesenteric injury in the era of multidetector CT technology--are results better? J Trauma 2008; 65:354.
129. Speed CA, Bramble MG, Corbett WA, Haslock I. Non-steroidal anti-inflammatory induced diaphragm disease of the small intestine: complexities of diagnosis and management. Br J Rheumatol 1994; 33:778.
130. Thaker P, Weingarten L, Friedman IH. Stenosis of the small intestine due to nonocclusive

ischemic disease. Arch Surg 1977; 112:1216.

131. Jackson BT. Bowel damage from radiation. Proc R Soc Med 1976; 69:683.
132. Ballantyne GH, Brandner MD, Beart RW Jr, Ilstrup DM. Volvulus of the colon. Incidence and mortality. Ann Surg 1985; 202:83.
133. Northeast AD, Dennison AR, Lee EG. Sigmoid volvulus: new thoughts on the epidemiology. Dis Colon Rectum 1984; 27:260.
134. Ruiz-Tovar J, Morales V, Sanjuanbenito A, et al. Volvulus of the small bowel in adults. Am Surg 2009; 75:1179.
135. Coe TM, Chang DC, Sicklick JK. Small bowel volvulus in the adult populace of the United States: results from a population-based study. Am J Surg 2015; 210:201.
136. Altintoprak F, Gemici E, Yildiz YA, et al. Intestinal Obstruction due to Bezoar in Elderly Patients: Risk Factors and Treatment Results. Emerg Med Int 2019; 2019:3647356.
137. Razavianzadeh N, Foroutan B, Honarvar F, Forozeshfard M. Small bowel obstruction attributable to phytobezoar. Oxf Med Case Reports 2016; 2016:omw092.
138. Hesse AA, Nouri A, Hassan HS, Hashish AA. Parasitic infestations requiring surgical interventions. Semin Pediatr Surg 2012; 21:142.
139. Teneza-Mora NC, Lavery EA, Chun HM. Partial small bowel obstruction in a traveler. Clin Infect Dis 2006; 43:214, 256.
140. Khuroo MS. Ascariasis. Gastroenterol Clin North Am 1996; 25:553.
141. Reeder MM. The radiological and ultrasound evaluation of ascariasis of the gastrointestinal, biliary, and respiratory tracts. Semin Roentgenol 1998; 33:57.
142. Marinis A, Yiallourou A, Samanides L, et al. Intussusception of the bowel in adults: a review. World J Gastroenterol 2009; 15:407.
143. Zubaidi A, Al-Saif F, Silverman R. Adult intussusception: a retrospective review. Dis Colon Rectum 2006; 49:1546.
144. Honjo H, Mike M, Kusanagi H, Kano N. Adult intussusception: a retrospective review. World J Surg 2015; 39:134.
145. Gayer G, Zissin R, Apter S, et al. Pictorial review: adult intussusception--a CT diagnosis. Br J Radiol 2002; 75:185.
146. Lvoff N, Breiman RS, Coakley FV, et al. Distinguishing features of self-limiting adult small-bowel intussusception identified at CT. Radiology 2003; 227:68.
147. Gincu V, Kornprat P, Thimary F, et al. Intestinal obstruction caused by splenosis at the rectosigmoid junction, mimicking malignant pelvic tumor. Endoscopy 2011; 43 Suppl 2

UCTN:E260.

148. Abeles DB, Bego DG. Occult gastrointestinal bleeding and abdominal pain due to entero-enteric intussusception caused by splenosis. Surg Endosc 2003; 17:1494.

149. Sirinek KR, Livingston CD, Bova JG, Levine BA. Bowel obstruction due to infarcted splenosis. South Med J 1984; 77:764.

Topic 8037 Version 41.0

GRAPHICS

Causes of bowel obstruction

Lesion	Etiology	Risk factors
Extrinsic lesions	Adhesions	Prior surgery, diverticulitis, Crohn disease, VP shunt, peritonitis (eg, tuberculous peritonitis)
	Hernia (congenital, acquired)	Abdominal wall hernia, inguinal hernia, femoral hernia, diaphragmatic hernia
	Volvulus	Chronic constipation, congenital abnormal mesenteric attachments
	Intra-abdominal abscess	Diverticulitis, appendicitis, Crohn disease
	Peritoneal carcinomatosis	Ovarian cancer, colon cancer, gastric cancer
	Endometriosis	
	Sclerosing mesenteritis	Prior surgery, abdominal trauma, autoimmune disorders, malignancy, neuroendocrine tumor
	Desmoid tumor/other soft tissue sarcoma (rare)	
	Superior mesenteric artery syndrome	Rapid weight loss
Intrinsic lesions	Congenital malformations, atresia, duplication	Refer to appropriate topic reviews
	Large bowel neoplasm	
	Adenocarcinoma	Hereditary colorectal cancer syndromes (HNPCC, FAP), inflammatory bowel disease, bowel irradiation, others (refer to appropriate topic reviews)
	Desmoid	
	Carcinoid	
	Neuroendocrine tumor	
	Lymphoma	
	Small bowel neoplasm*	
	Adenocarcinoma	Hereditary cancer syndromes (HNPCC, FAP, Peutz-Jeghers, *MUTYH*-associated

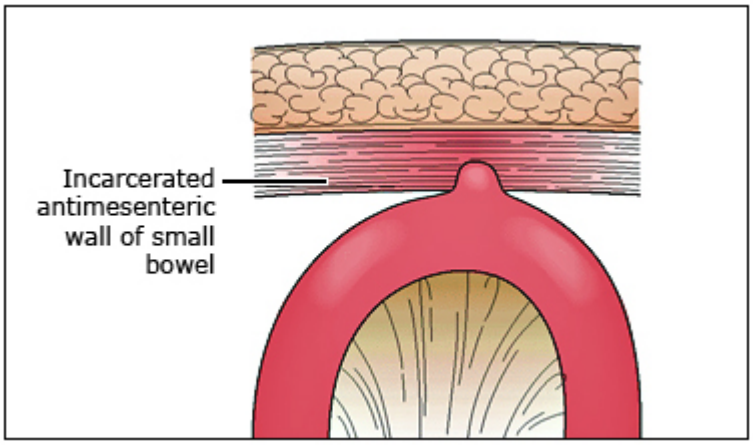
		polyposis, attenuated FAP)
	Leiomyosarcoma	
	Paraganglioma	
	Schwannoma	
	Metastatic disease	Melanoma, breast cancer, cervical cancer, colon cancer (refer to appropriate topic reviews)
	Gastrointestinal stromal tumor	
	Neuroendocrine tumor	
	Lymphoma	Chronic inflammation
	Benign lesions	Peutz-Jeghers polyps, xanthomatosis, leiomyoma
	Anastomotic stricture	Prior intestinal surgery
	Inflammatory stricture	Crohn disease, diverticular disease, NSAID enteropathy
	Ischemic stricture	Peripheral artery disease, aortic surgery, colon resection
	Radiation enteritis/stricture	Prior abdominal or pelvic irradiation
Intraluminal obstruction of normal bowel	Intussusception*	Small bowel tumor*
	Gallstones	Cholecystitis
	Congenital webs	
	Feces or meconium	Cystic fibrosis, severe constipation
	Bezoar (phytobezoar, pharmacobezoar)	Intestinal motility disorders
	Intramural hematoma	
	Traumatic	Blunt abdominal trauma
	Spontaneous	Antithrombotic therapy
	Foreign body	
	Ingested	Psychiatric disturbance
	Medical device migration	PEG tube, jejunal tube
	Parasites	*Ascaris lumbricoides*, *Strongyloides stercoralis*

VP: ventriculoperitoneal; HNPCC: hereditary nonpolyposis colorectal cancer; FAP: familial adenomatous polyposis; NSAID: nonsteroidal anti-inflammatory drug; PEG: percutaneous endoscopic gastrostomy.

* May be due to an intrinsic lesion serving as a lead point.

Graphic 53183 Version 8.0

Richter hernia



Schematic diagram showing a Richter hernia, in which the antimesenteric border, but not the whole wall, of the bowel is incarcerated.

Graphic 58994 Version 4.0

AAST grading criteria for small bowel obstruction

Grade	Description	Radiographic criteria	Operative criteria
I	Partial SBO	Minimal intestinal distension	Minimal intestinal distension with no evidence of obstruction
II	Complete SBO; bowel viable and not compromised	Intestinal distension with transition point without bowel compromise	Intestinal distension with transition point; no evidence of bowel compromise
III	Complete SBO with compromised but viable bowel	Intestinal distension with transition point, no distal contrast flow, evidence of complete obstruction or impending bowel compromise	Intestinal distention with impending bowel compromise
IV	Complete SBO with nonviable bowel or perforation with localized spillage	Evidence of localized perforation or free air; bowel distension with free air or free fluid	Intestinal distension with localized perforation or free fluid
V	SB perforation with diffuse peritoneal contamination	Bowel perforation with free air and free fluid	Intestinal distension with perforation, free fluid, and evidence of diffuse peritonitis

AAST: American Association for the Surgery of Trauma; SBO: small bowel obstruction; SB: small bowel.

From: Hernandez MC, Haddad NN, Cullinane DC, et al. The American Association for the Surgery of Trauma Severity Grade is valid and generalizable in adhesive small bowel obstruction. J Trauma Acute Care Surg 2018; 84:372. DOI: 10.1097/TA.0000000000001736.

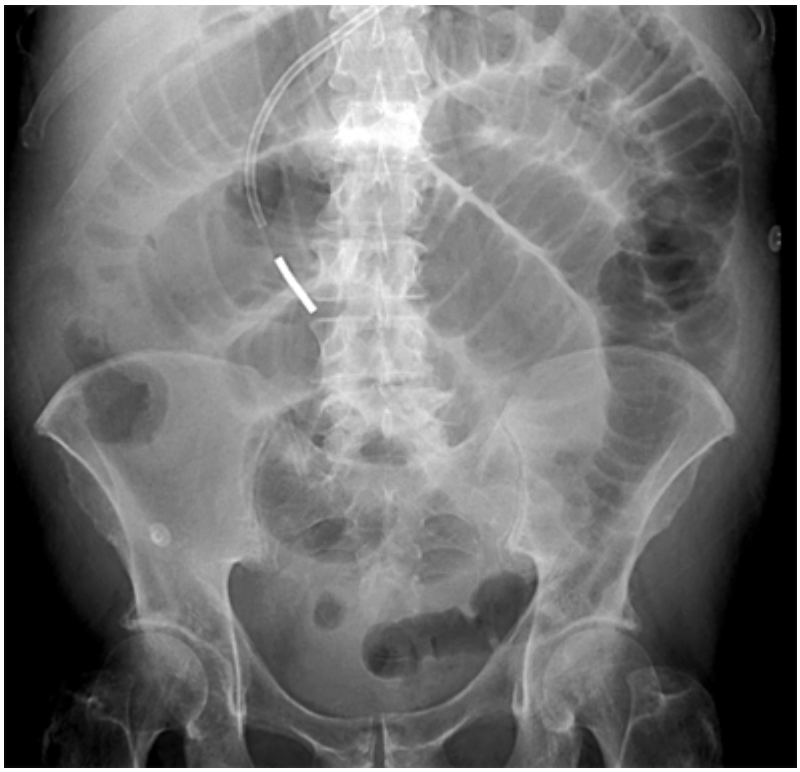
Graphic 115729 Version 5.0

Drugs associated with constipation

Analgesics
Anticholinergics
Antihistamines
Antispasmodics
Antidepressants
Antipsychotics
Cation-containing agents
Iron supplements
Aluminum (antacids, sucralfate)
Barium
Neurally active agents
Opiates
Antihypertensives
Ganglionic blockers
Vinca alkaloids
Calcium channel blockers
5HT3 antagonists

Graphic 62307 Version 2.0

Small bowel obstruction plain radiograph (supine)

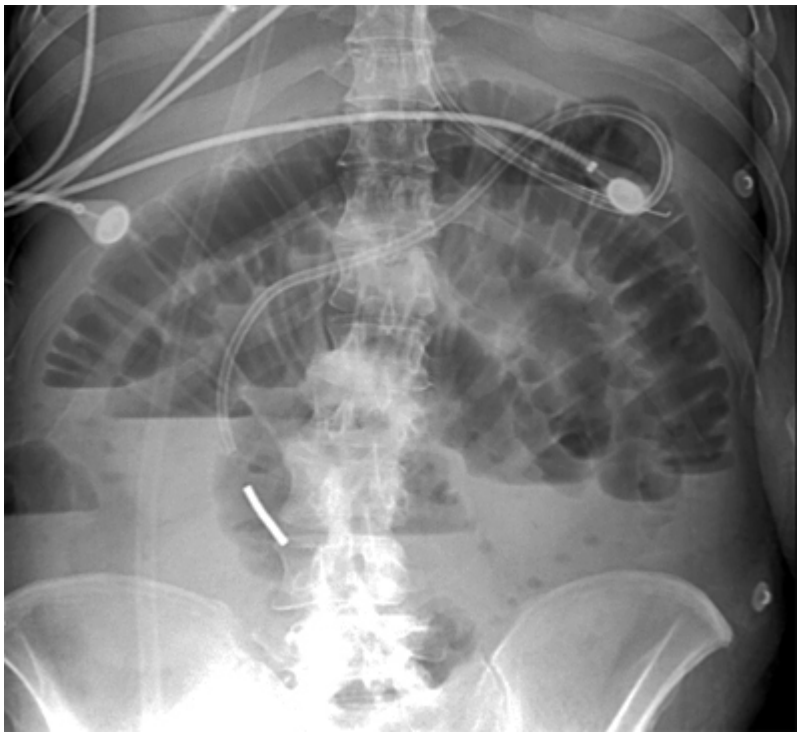


Plain, supine abdominal radiograph showing dilated small bowel. Note a feeding tube has passed beyond the pylorus into the duodenum.

Courtesy of Richard A Hodin, MD.

Graphic 81325 Version 5.0

Upright abdominal x-ray of small bowel obstruction

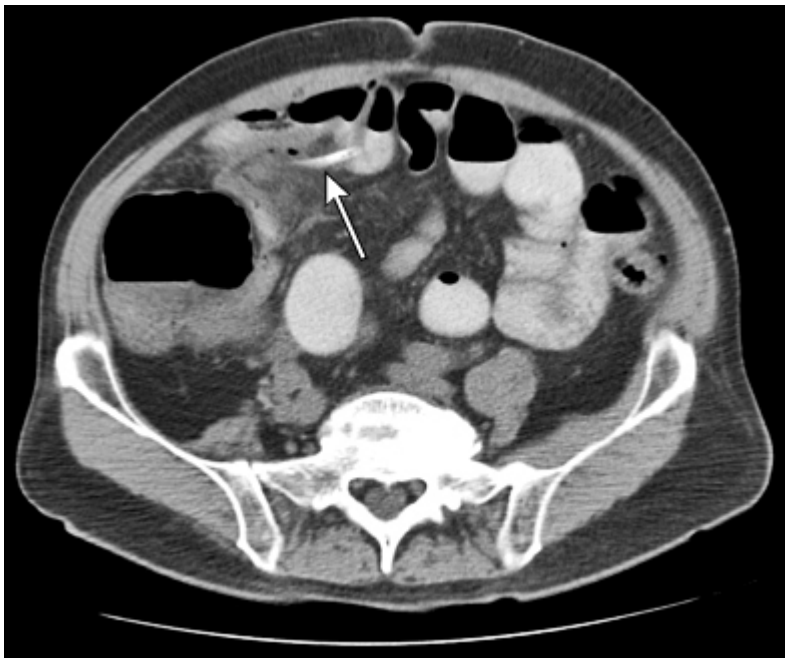


This plain, upright abdominal radiograph shows dilated loops of small bowel with air-fluid levels consistent with a diagnosis of small bowel obstruction.

Courtesy of Richard A Hodin, MD.

Graphic 68738 Version 4.0

Small bowel obstruction with perforation



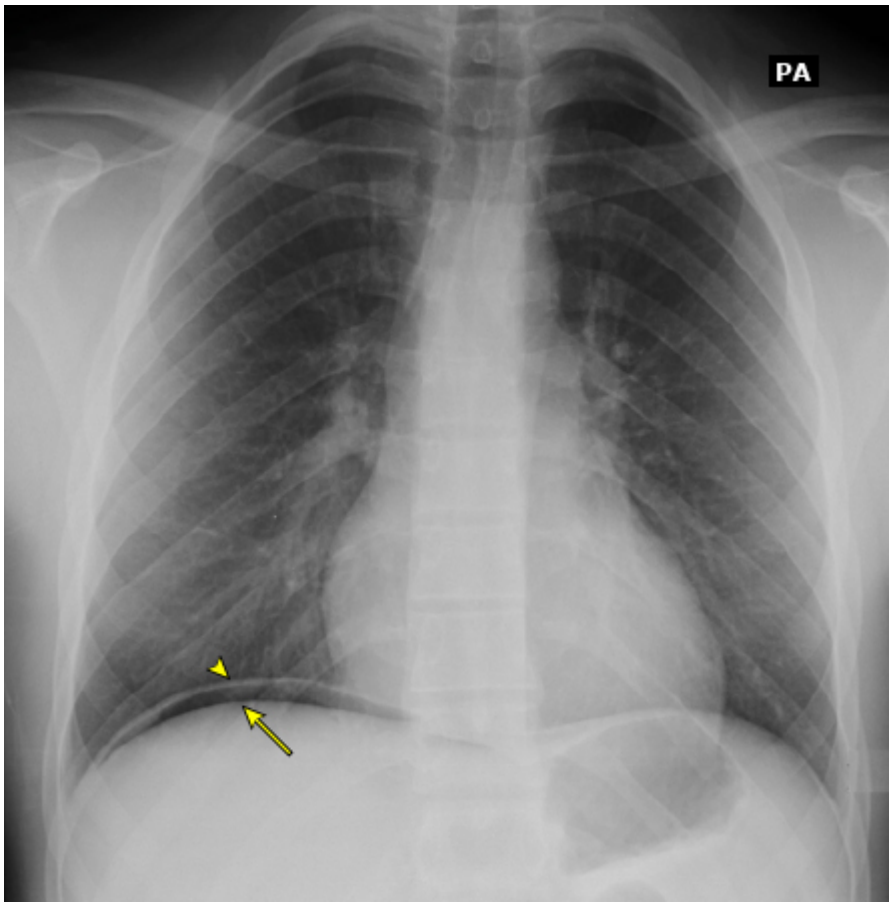
CT scan demonstrating partial small bowel obstruction and perforation of the small bowel by a chicken bone (arrow). There is dilated small bowel in the left abdomen and collapsed small bowel in the right abdomen. Gas is present in the colon.

CT: computed tomography.

Courtesy of Anthony Samir, MD.

Graphic 56792 Version 4.0

Chest radiograph of intraperitoneal free air

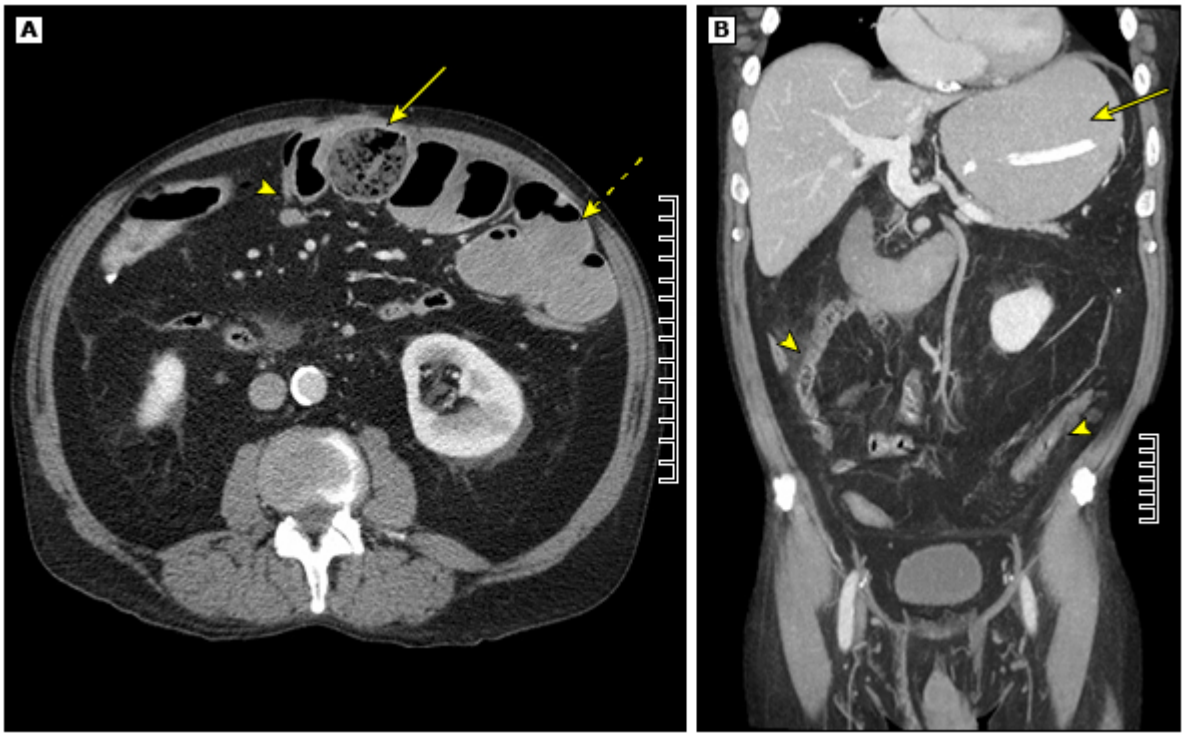


This plain PA radiograph of the chest taken with the patient upright reveals a small amount of free air under the right hemidiaphragm confirming the diagnosis of a perforated abdominal viscus. The lucent, crescent-shaped free air is noted between the arrows. The dome of the liver (arrow) and the soft tissue shadow of the right hemidiaphragm (arrowhead) border the free air.

PA: posterior-anterior.

Graphic 83050 Version 4.0

Small bowel obstruction with small bowel feces sign on CT scan



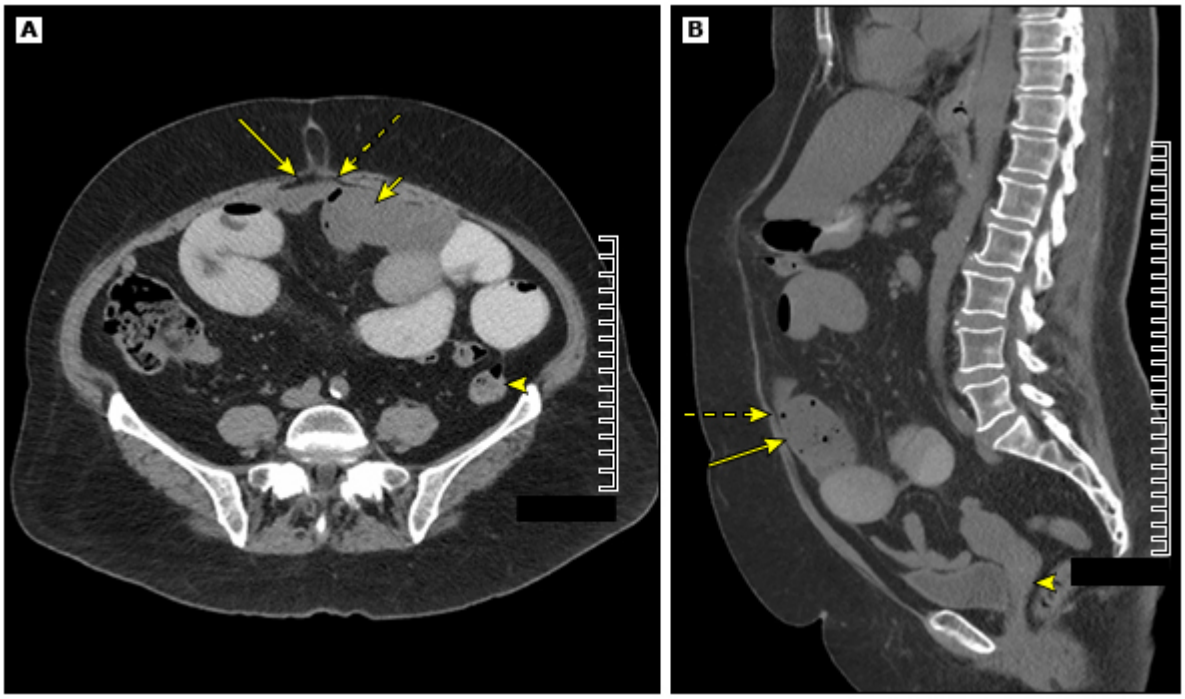
A CT scan of the abdomen (A) shows a zone of transition at the site of a small bowel obstruction (arrowhead). A small bowel feces sign is present in the small bowel adjacent to the obstruction (arrow), and the remaining upstream small bowel is dilated (dashed arrow).

(B) is a coronal reconstruction of the CT and shows a fluid-filled and distended stomach (arrow) despite the presence of a nasogastric tube. Both the ascending colon and descending colon are decompressed (arrowheads).

CT: computed tomography.

Graphic 87585 Version 4.0

Small bowel obstruction and small bowel feces sign on a CT scan

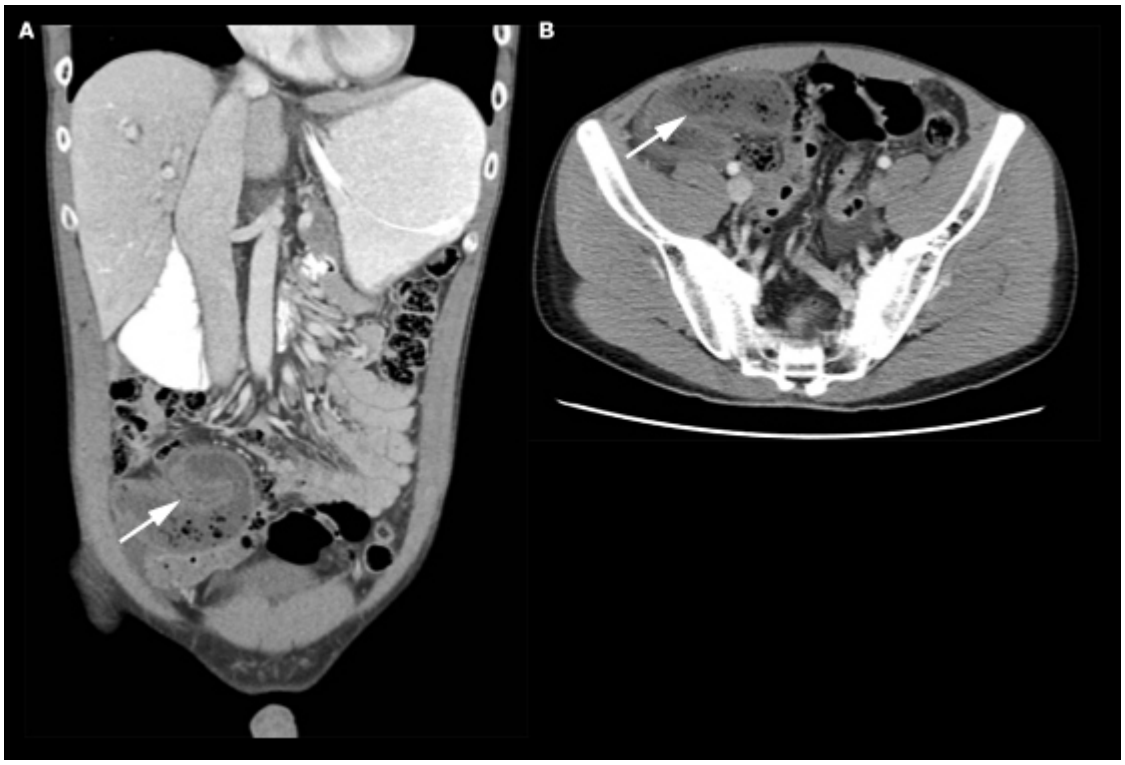


A CT scan of the abdomen at the level of the umbilicus (A) shows a transition zone defining the level of a small bowel obstruction (dashed arrow). The upstream small bowel (short arrow) is dilated and the downstream small bowel is decompressed (arrow). The descending colon is also decompressed (arrowhead). Image B is a sagittal reconstruction of the CT and shows the zone of transition (dashed arrow) and a small bowel feces sign (arrow) in the adjacent upstream small bowel. The rectum is empty (arrowhead).

CT: computed tomography.

Graphic 88525 Version 1.0

Closed loop obstruction with necrosis of the ileum



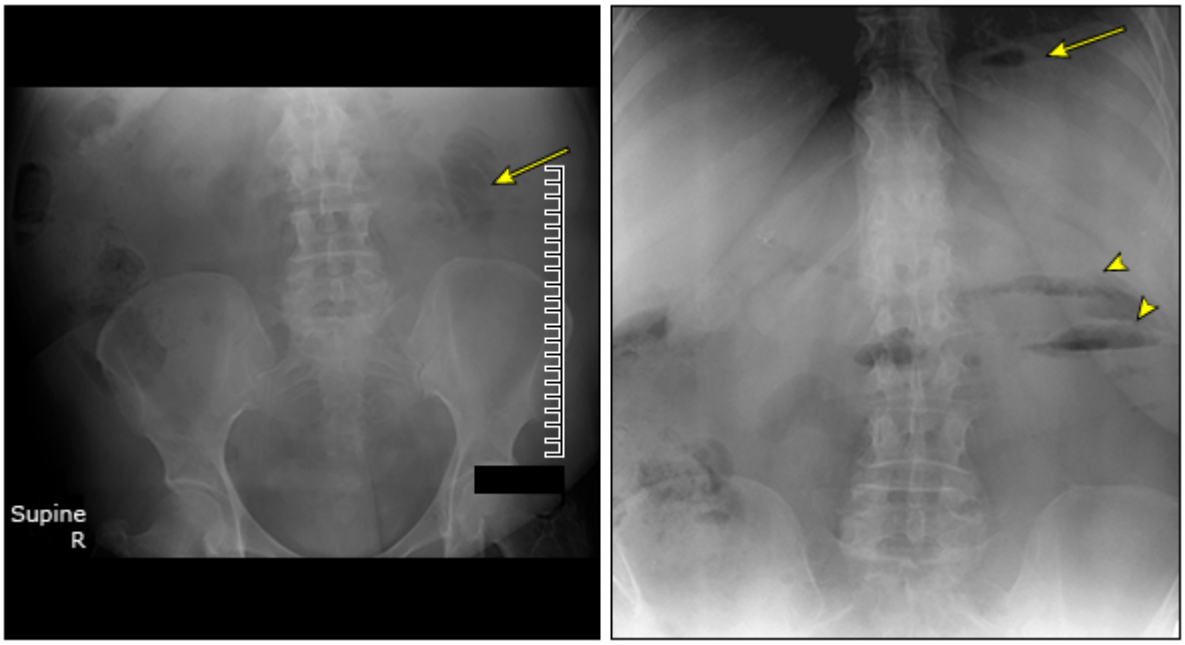
CT images (A: coronal view and B: cross-sectional view) showing a markedly dilated and thick-walled loop of ileum with focal mesenteric edema (arrows). Because the patient developed acute onset of obstruction, the proximal small bowel has not yet dilated.

CT: computed tomography.

Courtesy of Anthony Samir, MD.

Graphic 53816 Version 5.0

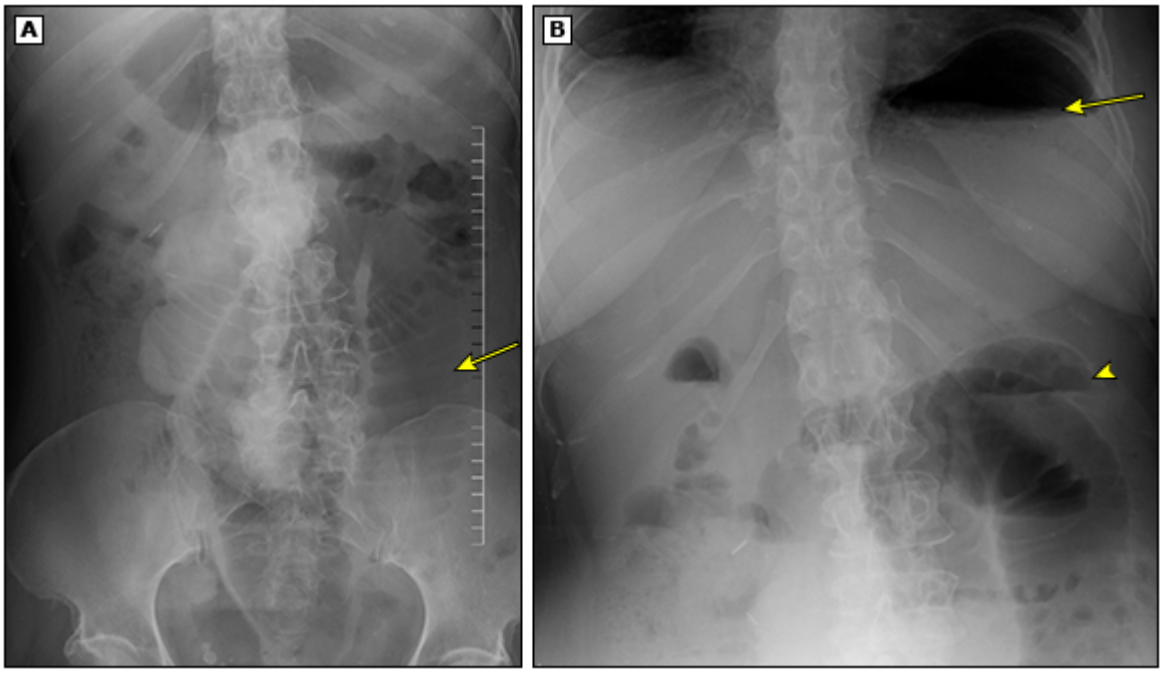
Small bowel obstruction on plain radiograph of the abdomen



A supine examination of the abdomen (left panel) shows a dilated loop of small bowel in the left upper quadrant (arrow). The descending colon is not visualized and implies that it is decompressed, and there is no air in the rectum. The stomach is distended with fluid, and the upright examination (right panel) shows a small air fluid level in the stomach (arrow) and more obvious air fluid levels in the small bowel (arrowheads).

Graphic 87614 Version 2.0

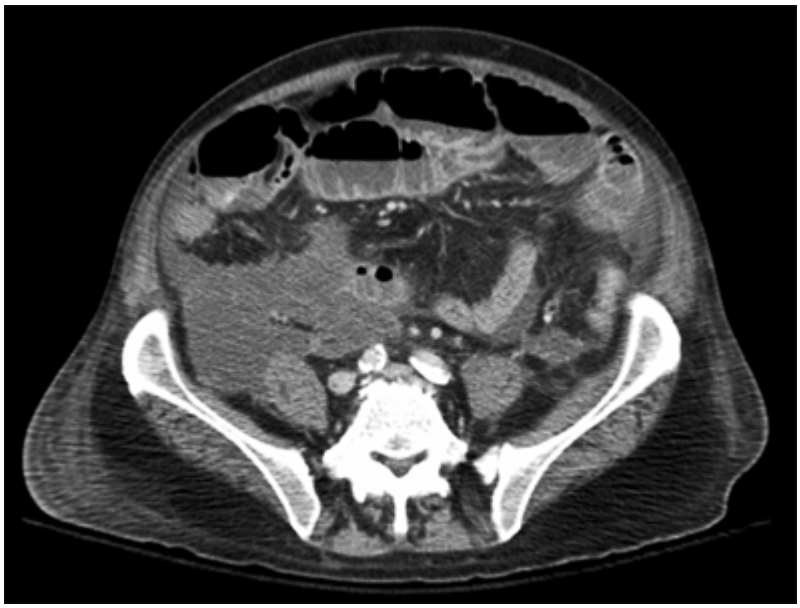
Small bowel obstruction on x-ray of the abdomen



A supine examination of the abdomen (A) shows a dilated loop of small bowel on the left side of the abdomen (arrow). The upright examination (B) shows an air fluid level in the stomach (arrow) and in the small bowel (arrowhead).

Graphic 88524 Version 2.0

Small bowel obstruction CT



Small bowel obstruction seen on CT scan showing dilated, fluid-filled loops of small bowel.

CT: computed tomography.

Courtesy of Richard A Hodin, MD.

Graphic 81165 Version 3.0

Small bowel obstruction CT (coronal images)

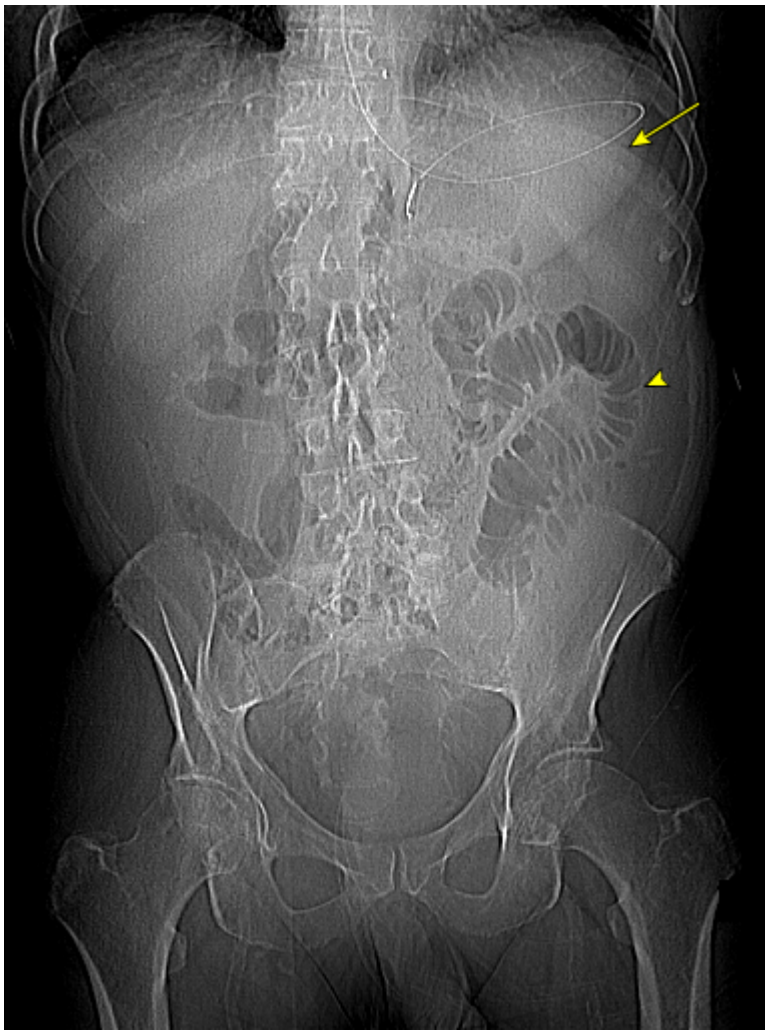
Small bowel obstruction seen by CT scan (coronal images) showing dilated, fluid-filled loops of small intestine.

CT: computed tomography.

Courtesy of Richard A Hodin, MD.

Graphic 61824 Version 4.0

Small bowel obstruction on the scout film of a CT scan

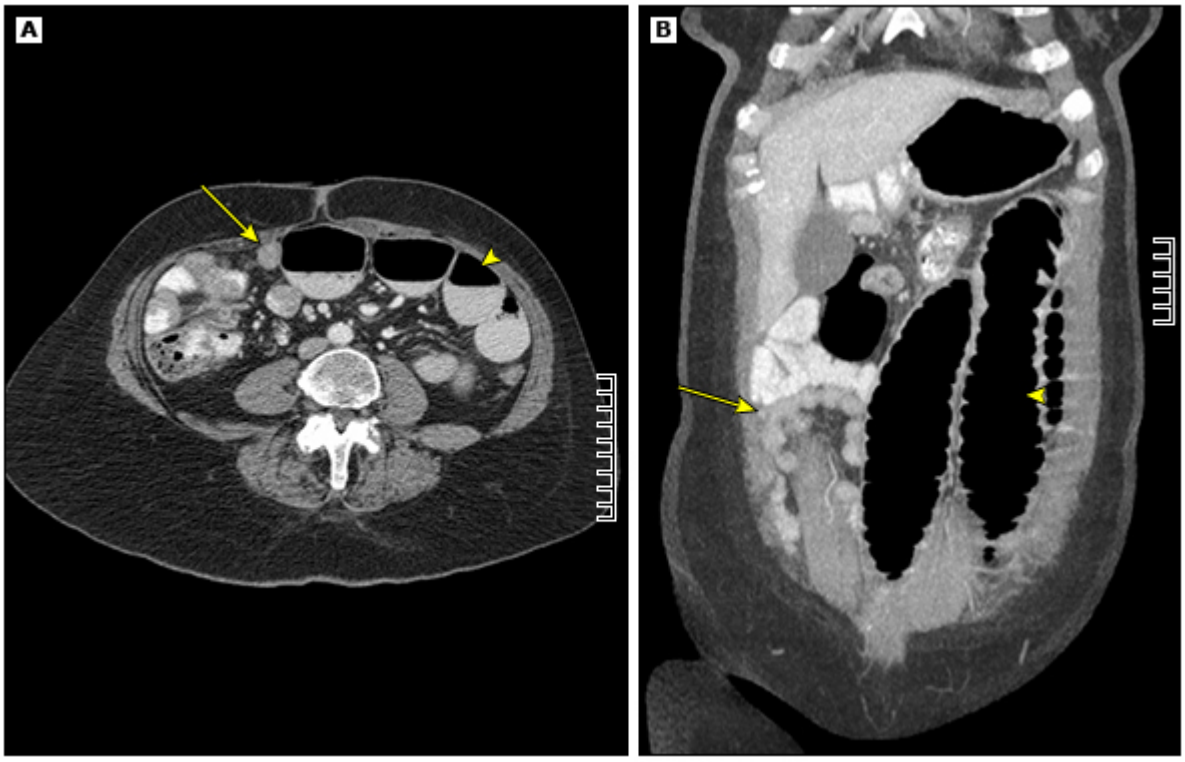


A supine examination of the abdomen shows a fluid-filled stomach (arrow) and a dilated loop of air-filled small bowel in the left upper quadrant (arrowhead). The colon is barely visualized, implying that it is decompressed and there is no air in the rectum.

CT: computed tomography.

Graphic 87584 Version 1.0

Small bowel obstruction caused by metastatic ovarian carcinoma on CT scan



A CT scan of the abdomen (A) shows dilated upstream small bowel (arrowhead). The downstream small bowel is decompressed (arrow). Image B is a coronal reconstruction of the CT and shows dilated upstream small bowel (arrowhead). The downstream small bowel is decompressed (arrow).

CT: computed tomography.

Graphic 87586 Version 1.0

Differential diagnosis of nausea and vomiting

Medications and toxic etiologies
Cancer chemotherapy
▪ Severe – cisplatinum, dacarbazine, nitrogen mustard
▪ Moderate – etoposide, methotrexate, cytarabine
▪ Mild – fluorouracil, vinblastine, tamoxifen
Analgesics
▪ Aspirin
▪ Nonsteroidal antiinflammatory drugs
▪ Auranofin
▪ Antigout drugs
Cardiovascular medications
▪ Digoxin
▪ Antiarrhythmics
▪ Antihypertensives
▪ Beta blockers
▪ Calcium channel antagonists
Diuretics
Hormonal preparations/therapies
▪ Oral antidiabetics
▪ Oral contraceptives

Infectious causes
Gastroenteritis
▪ Viral
▪ Bacterial
Nongastrointestinal infections
▪ Otitis media
Disorders of the gut and peritoneum
Mechanical obstruction
▪ Gastric outlet obstruction
▪ Small bowel obstruction
Functional gastrointestinal disorders
Gastroparesis
Chronic intestinal pseudo-obstruction
Nonulcer dyspepsia
Irritable bowel syndrome
Organic gastrointestinal disorders
▪ Pancreatic adenocarcinoma
▪ Inflammatory intraperitoneal disease
▪ Peptic ulcer disease
▪ Cholecystitis
▪ Pancreatitis

CNS causes
Migraine
Increased intracranial pressure
▪ Malignancy
▪ Hemorrhage
▪ Infarction
▪ Abscess
▪ Meningitis
▪ Congenital malformation
▪ Hydrocephalus
▪ Pseudotumor cerebri
Seizure disorders
Demyelinating disorders
Cranial radiation
Emotional responses
Psychiatric disease
▪ Psychogenic vomiting
▪ Anxiety disorders
▪ Depression
▪ Pain
▪ Anorexia nervosa
▪ Bulimia nervosa
Labyrinthine disorders
▪ Motion sickness
▪ Labyrinthitis

- Antibiotics/antivirals
  - Erythromycin
  - Tetracycline
  - Sulfonamides
  - Antituberculous drugs
  - Acyclovir
- Gastrointestinal medications
  - Sulfasalazine
  - Azathioprine
- Nicotine
- CNS active drugs
  - Narcotics
  - Antiparkinsonian drugs
  - Antiseizure medications
- Antiasthmatics
  - Theophylline
- Radiation therapy
- Ethanol abuse
- Jamaican vomiting sickness
- Hypervitaminosis
  - Hepatitis
  - Crohn disease
  - Mesenteric ischemia
  - Retroperitoneal fibrosis
  - Mucosal metastases
  - Tumors
  - Ménière disease
  - Iatrogenic
  - Fluorescein angiography

Endocrinologic and metabolic causes

- Pregnancy
- Other endocrine and metabolic
  - Uremia
  - Diabetic ketoacidosis
  - Hyperparathyroidism
  - Hypoparathyroidism
  - Hyperthyroidism
  - Addison's disease
  - Acute intermittent porphyria

Miscellaneous causes

- Postoperative nausea and vomiting
- Cyclic vomiting syndrome
- Cannabis hyperemesis syndrome
- Cardiac disease
  - Myocardial infarction
  - Heart failure
  - Radiofrequency ablation of the liver
- Starvation

Radiation therapy to the upper abdomen and lower chest

CNS: central nervous system.

Graphic 78422 Version 12.0

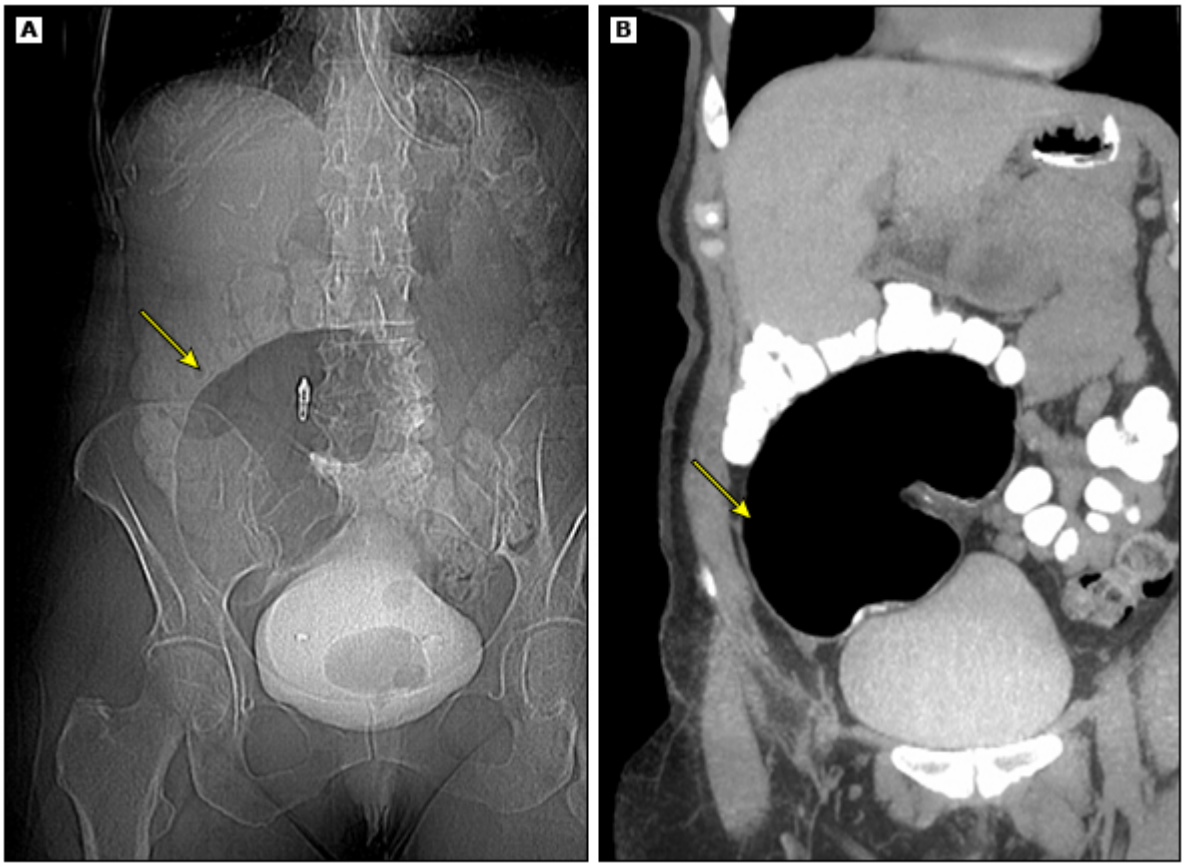
Main differences between mechanical versus functional intestinal obstruction

	Mechanical obstruction	POI	AIPO/ACPO	CIPO
Luminal obstruction	Yes	No	No	No
Motility	Initially ↑ then ↓ proximal to obstruction	↓	↓/uncoordinated	↓/uncoordinated
Dilatation	Yes (proximal to obstruction)	No	Yes	Yes
GI involvement	Proximal to obstruction	Mainly small bowel	Mainly colon	Pan-enteric
Radiology	Typical "cut-off" point; presence of air-fluid levels	"Cut-off point" occasionally present; air-fluid levels usually absent	"Cut-off point" occasionally present; air-fluid levels sometimes detected	"Cut-off point" occasionally present; air-fluid levels detectable
Course	Acute	Acute	Acute	Chronic
Progression	Rapidly evolving toward total obstruction	Self-limiting, slowly improving	May respond to medical treatment; major complication may occur	Variable, generally self-limiting
Treatment	Surgery	Supportive measures	Medical treatment (neostigmine); decompressive endoscopy or surgery in unresponsive cases	Variable; EN, TPN/HPN often needed

↑: increased; ↓: decreased; AIPO/ACPO: acute intestinal pseudo-obstruction/acute colonic pseudo-obstruction; CIPO: chronic intestinal pseudo-obstruction; EN: enteral nutrition; GI: gastrointestinal; POI: postoperative ileus; TPN/HPN: total/home parenteral nutrition.

Graphic 84010 Version 2.0

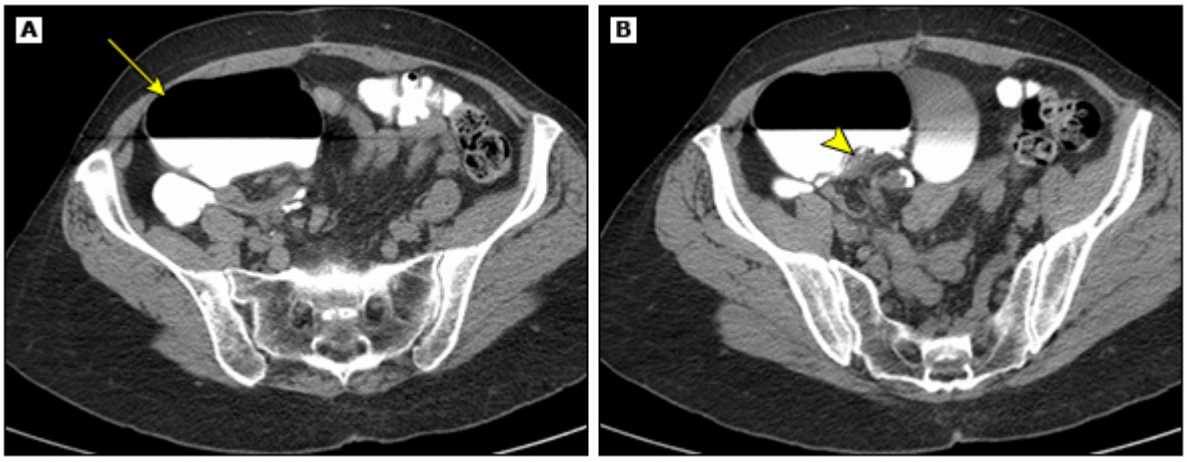
Scout and coronal computed tomography (CT) cecal volvulus



The scout film (A) shows a dilated cecum (arrow). The CT scan reformatted in the coronal plane (B) shows a large air pocket trapped in the cecal volvulus (arrow).

Graphic 87765 Version 2.0

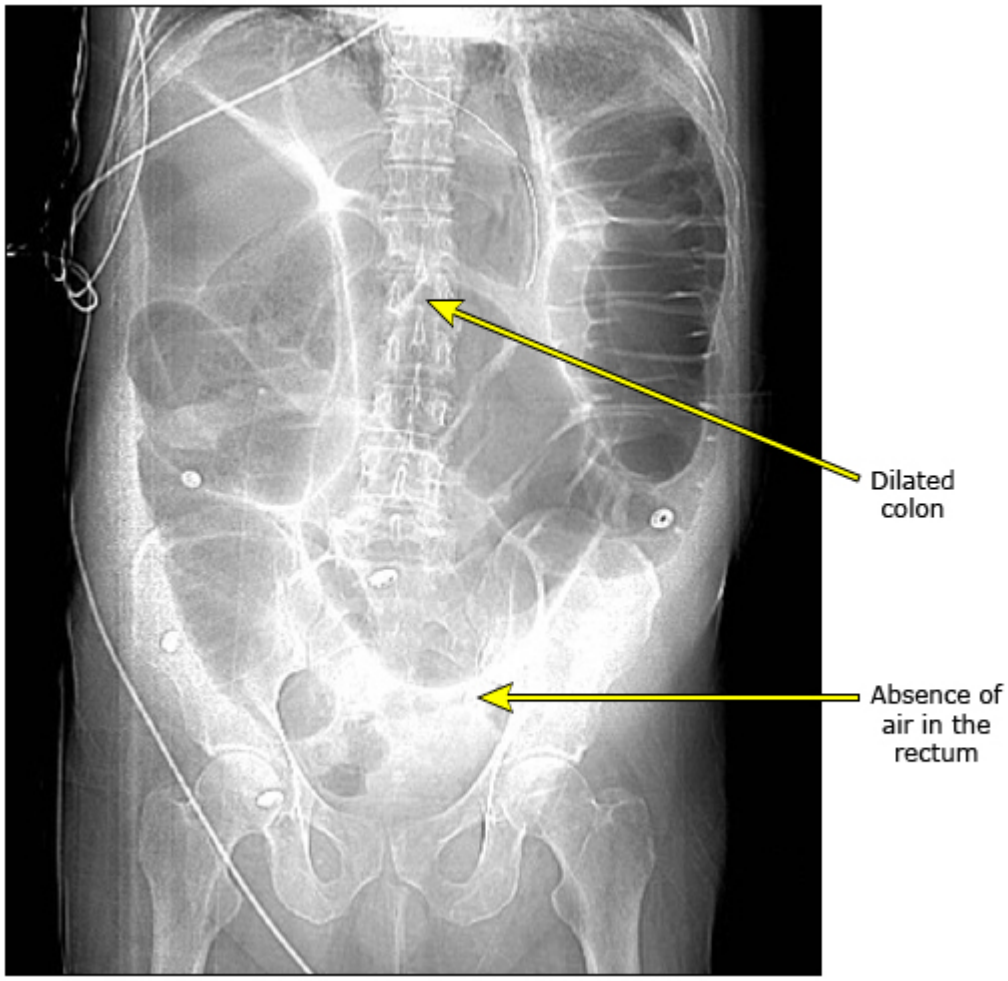
Computed tomography (CT) cecal volvulus



The axial CT scan (A) shows an air contrast level trapped in the dilated cecum (arrow). In image B, the counterclockwise "whirl sign" is evident (arrowhead).

Graphic 87766 Version 2.0

Sigmoid volvulus



Plain abdominal radiograph of a patient with a sigmoid volvulus demonstrates a large air-filled sigmoid colon (arrow) extending from the pelvis to the right upper quadrant and the absence of air in the rectum (arrow).

Courtesy of Mukesh Harisinghani, MD, Department of Radiology, Massachusetts General Hospital, Boston, MA.

Graphic 67675 Version 3.0

Classification of internal hernias

Type	Name	Etiology	Notes
A	Paraduodenal		Most common
B	Foramen of Winslow		
C	Intersigmoid		
D	Pericecal		2^{nd} most common
E	Transmesenteric	Roux-en-Y procedures	
F	Retroanastomotic		

Graphic 89073 Version 3.0

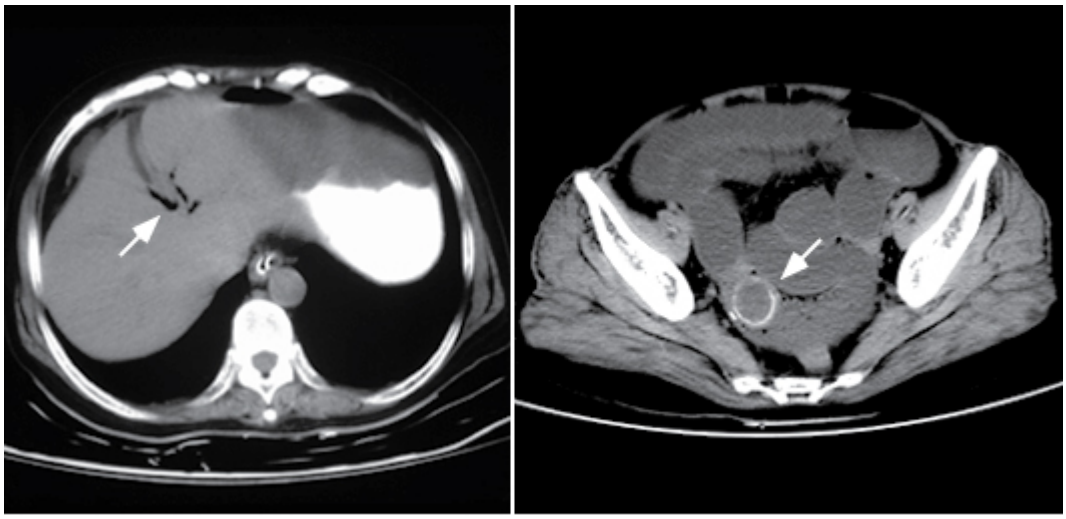
Pneumobilia due to gallstone ileus

Plain film of the abdomen showing air in the intrahepatic biliary tree (arrows) and dilated loops of small bowel. Pneumobilia implies either a patent cystic duct or a fistula involving the common bile duct. The gallstone cannot be identified on this film. This is a common finding that is due to two factors: most stones are radiolucent, and gas or bony structures can obscure gallstones outside the biliary tree.

Courtesy of Nezam Afdhal, MD.

Graphic 68491 Version 5.0

Gallstone ileus seen on computed tomography (CT) scan

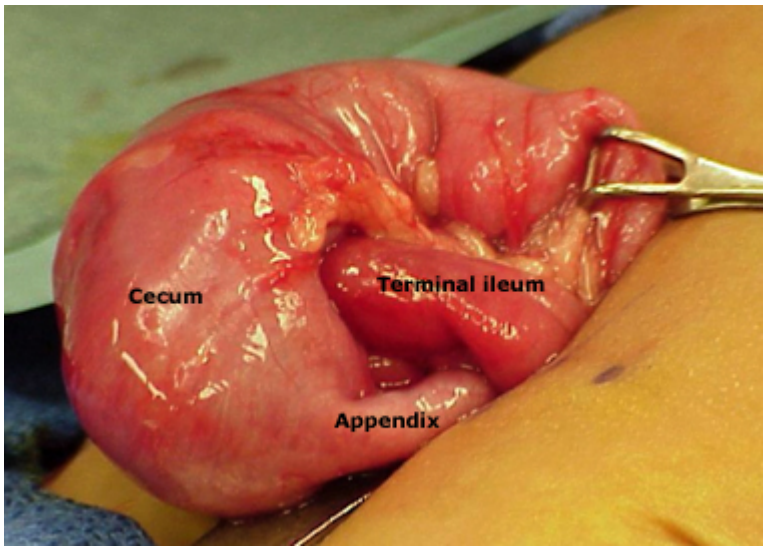


CT scan in a 75-year-old woman with small bowel obstruction due to gallstone ileus. Left panel: Free air is seen in the biliary tree and gallbladder (arrow). Right panel: Dilated loops of small bowel with large gallstone with a calcified rim (arrow) impacted in the terminal ileum.

Courtesy of Nezam Afdhal, MD.

Graphic 80522 Version 5.0

Ileocolonic intussusception

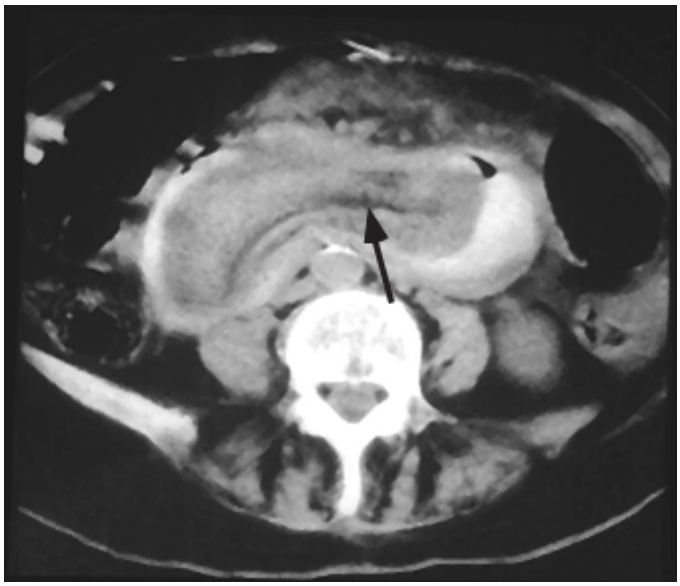


Surgical view of an ileocolonic intussusception, the most common form of intussusception in infants and young children. The terminal ileum (intussusceptum) is seen extending in to the cecum (intussuscipiens).

Courtesy of David Wesson, MD.

Graphic 71734 Version 2.0

Intussusception of small bowel lymphoma

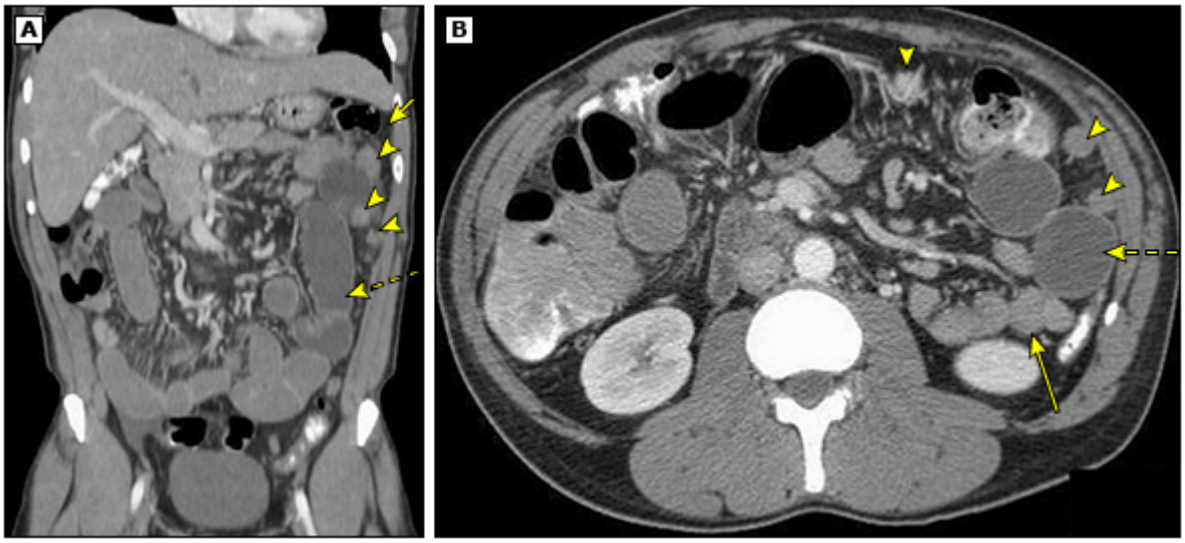


Computed tomography scan of the abdomen demonstrates a large mass in the lumen of a distended loop of small bowel. Note mesenteric fat in the center of this intraluminal mass (arrow).

Courtesy of Jonathan Kruskal, MD, PhD.

Graphic 75825 Version 3.0

Splenosis causing small bowel obstruction on CT scan



A CT scan reformatted in the coronal plane (A) shows an empty splenic bed (short arrow), multiple peritoneal nodules (arrowheads), and dilated small bowel (dashed arrow). An axial image through the abdomen (B) shows multiple splenic peritoneal implants (arrowheads), dilated upstream small bowel (dashed arrow), and decompressed distal small bowel (arrow).

CT: computed tomography; SBO: small bowel obstruction.

Graphic 90042 Version 2.0

Contributor Disclosures

Liliana Bordeianou, MD, MPH Grant/Research/Clinical Trial Support: American Society of Colon and Rectal Surgery Research Foundation [Rectal prolapse]; Crohn's & Colitis Foundation [Ileoanal anastomosis (J-pouch) surgery]. Consultant/Advisory Boards: Cook Medical [Fecal incontinence]. All of the relevant financial relationships listed have been mitigated. **Daniel Dante Yeh, MD, MHPE, FACS, FCCM, FASPEN** Consultant/Advisory Boards: Takeda [Gastrointestinal]. Other Financial Interest: American Society for Parenteral and Enteral Nutrition [Honorarium]; Eastern Association for the Surgery of Trauma (EAST) [Board of Directors]. All of the relevant financial relationships listed have been mitigated. **Krishnan Raghavendran, MD, FACS** No relevant financial relationship(s) with ineligible companies to disclose. **Korilyn S Zachrison, MD, MSc** No relevant financial relationship(s) with ineligible companies to disclose. **Wenliang Chen, MD, PhD** No relevant financial relationship(s) with ineligible companies to disclose.

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy

→