Bowel Obstructions in Older Children

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In older children, bowel obstruction can be due to a variety of congenital and acquired causes that are often different from the causes of bowel obstruction in neonates or adults. Among neonates, bowel obstruction is almost always due to congenital causes, including bowel atresia, malrotation, and Hirschsprung disease. In adults, the list of common causes of bowel obstruction is relatively short, with the vast majority arising from postoperative adhesions, incarcerated hernias, or neoplasms. However, in older children, the causes of bowel obstruction are more extensive and varied, and a more diverse list of diagnoses should be entertained (Table 1).

Almost all pediatric patients with bowel obstructions present with abdominal pain, distention, and vomiting. Because these are not specific, diagnosing a bowel obstruction in an older child requires imaging to determine its cause, location, and extent. Conventional abdominal radiography is often the initial imaging study for assessing bowel obstruction in older children. However, this study is often rapidly followed by an upper gastrointestinal (UGI) or enema study, ultrasound, CT, or MRI. By understanding the proper selection of imaging modalities and developing familiarity with the characteristic appearances of common causes of bowel obstruction, the radiologist can assist in optimizing the management of older children with this condition.

**Congenital Causes**

**Meckel Diverticulum**

A Meckel diverticulum forms when there is incomplete closure of the vitelline duct during fetal development. Although most Meckel diverticula are asymptomatic, children with symptoms most commonly present with bowel obstruction (seen in approximately 40%), with a smaller number developing either painless bleeding secondary to ectopic gastric mucus within the diverticulum or inflammation. Bowel obstruction due to a Meckel diverticulum presents in one of two typical patterns: First, a distal ileal obstruction can occur secondary to bowel torsion around an omphalo-mesenteric band (Fig. 1). Second, obstruction can be due to intussusception of a Meckel diverticulum (Fig. 2). In addition, Meckel diverticulum varies in size and can be incidentally seen on CT when very large. It may mimic a single enlarged bowel loop. Notably, patients with intussuspecting Meckel diverticula are usually older than patients with idiopathic intussusception. In both cases, surgical resection of the Meckel diverticulum is essential for definitive treatment.

**Malrotation**

When a child presents with acute bilious vomiting and clinical signs and symptoms suspicious for bowel obstruction, malrotation should be considered as a possible underlying cause. Although the majority of cases are seen in the first year of life, older children may also present with malrotation and concomitant midgut volvulus. On upper gastrointestinal studies, malrotation with midgut volvulus typically appears as a “beak” of contrast enhancement at the site of obstruction, with a corkscREW appearance of proximal small bowel loops in the right upper abdomen (Fig. 3B), without a normally positioned duodenoejunal junction. In cases of a tight volvulus, contrast material may not pass distal to the mid duodenum, and the classic corkscREW appearance may be absent; instead, findings will only suggest an extremely high-grade proximal small bowel obstruction. Cross-sectional imaging, such as ultrasound or CT, may show an abnormal relationship of the superior mesenteric artery (SMA) and vein (SMV), with the SMA to the right of the SMV (Fig. 3A), or swirling of the mesenteric vessels (whirlpool sign). In addition to reversal of the normal SMA-SMV...
orientation, CT may also show the absence of a retroperitoneal third portion of the duodenum (Fig. 4). Treatment of malrotation is surgical, with an urgent Ladd procedure performed in cases of midgut volvulus.

**Congenital Inguinal Hernia**

Although congenital inguinal hernias affect only 1–2% of children, 10% of these hernias may be complicated by incarceration and bowel obstruction. Risk factors for bowel obstruction in children with congenital inguinal hernias include a young age at presentation, male sex, and a right-sided hernia. An inguinal hernia is often a clinical diagnosis managed with manual reduction and surgical repair without the need for imaging. However, the diagnosis may not be immediately apparent in a patient presenting with vomiting, and a further imaging evaluation may be obtained. In some cases, conventional abdominal radiographs may show gas within the scrotal sac or an apparent soft-tissue scrotal mass, which, in conjunction with findings of bowel obstruction, should raise suspicion for an incarcerated inguinal hernia. However, findings may be less specific and simply suggest bowel obstruction (Fig. 5A). Although hernias are often diagnosed on physical examination, ultrasound may be subsequently obtained if there is concern for a scrotal mass or another cause for bowel obstruction, such as intussusception. Bowel loops identified within the scrotal sac on ultrasound can provide a definitive diagnosis (Fig. 5B). Hernias are typically treated by rapidly reducing the herniated bowel loop into the abdominal cavity through either a closed or open reduction. A surgical herniorrhaphy is also performed in these cases to mend the defect in the inguinal canal. With prolonged herniation, care must be taken at the time of surgical intervention to assess the bowel viability and then resect any nonviable loops.

**Infectious and Inflammatory Causes**

**Appendicitis**

Bowel obstruction is a known complication of acute appendicitis. Most cases occur with complicated and perforated appendicitis, in which adhesive bands develop in a background of surrounding inflammation. If patients are initially imaged with conventional radiography, a paucity of gas in the right lower quadrant or a calcified appendix may serve as an initial suggestion of the final diagnosis. The initial imaging modality is ultrasound, which may show a dilated appendix, appendicolith, or focal right lower quadrant inflammatory mass or abscess.

Interloop fluid between the intussusception and intussuscipiens should be noted because this finding is associated with a lower rate (50%) of successful intussusception reduction. Bowel obstruction, free fluid, diminished Doppler flow, and prolonged symptoms are also indicators suggesting lower rates of successful intussusception reduction, but these are not absolute contraindications for attempted reduction. Children with intussusception and subsequent bowel obstruction are currently treated with fluoroscopy-guided reduction (Fig. 7C), using either an air or contrast enema. Although 80% of intussusceptions are reduced with fluoroscopic guidance, surgical reduction is reserved for patients in whom fluoroscopic treatment is not effective. Immediate surgical intervention is required for children who develop bowel perforation during the reduction procedure, amounting to approximately 0.5% of patients.

**Inflammatory Bowel Disease and Crohn Disease**

Children with inflammatory bowel disease (IBD) are more likely to have Crohn disease than ulcerative colitis. In patients with Crohn disease, bowel obstruction may represent a complication either from strictureting disease or extensive inflammatory change. Although MR enterography is emerging as the primary imaging modality for the serial monitoring of children with IBD, patients who present acutely with clinically suspected bowel obstruction may be directed to CT for more rapid imaging. CT can show dilated loops of bowel terminating at the site of bowel wall thickening and inflammatory change (Fig. 8). Treatment is predominantly nonsurgical, with bowel rest and immunotherapy representing the primary therapeutic interventions.

In an acute setting in which a child presents with bowel obstruction and right lower quadrant inflammatory change or abscesses, a common clinical concern is often whether the child has appendicitis or IBD. Although imaging may not definitively solve this clinical dilemma, identifying whether the epicenter of inflammatory change is surrounding the appendix or terminal ileum may aid clinicians in directing patients to appropriate medical or surgical care.

**Iatrogenic Causes**

**Adhesions**

After abdominal surgery, approximately 5% of children develop adhesions that eventually result in bowel obstruction (Fig. 9). Because these pediatric patients have a known

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**TABLE 1: Causes of Bowel Obstruction in Older Children**

<table>
<thead>
<tr>
<th>Category</th>
<th>Cause</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congenital</td>
<td>Adhesions</td>
<td>Nonadherent, nonsequestered adhesions, may represent a complication</td>
</tr>
<tr>
<td></td>
<td>Intussusception</td>
<td>Intussusception represents a complication</td>
</tr>
<tr>
<td></td>
<td>Inflammatory bowel disease</td>
<td>Inflammatory bowel disease represents a complication</td>
</tr>
<tr>
<td></td>
<td>Iatrogenic</td>
<td>Bacterial, viral, chemical, or thermal injury</td>
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<tr>
<td></td>
<td>Meckel diverticulum</td>
<td>Meckel diverticulum represents a complication</td>
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<tr>
<td></td>
<td>Malrotation</td>
<td>Malrotation represents a complication</td>
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<tr>
<td></td>
<td>Meckel diverticulum</td>
<td>Meckel diverticulum represents a complication</td>
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</tbody>
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Note—A popular mnemonic for remembering several common causes of pediatric bowel obstruction is AIM, where A = adhesions, appendicitis; I = intussusception, inguinal hernia, inflammatory bowel disease, ingested foreign body; and M = Meckel diverticulum, malrotation.

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**Infectious and Inflammatory Causes**

**Appendicitis**

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In children who are developing a bowel obstruction, there may be dilated and fluid-filled loops of small bowel. These patients often require CT (Fig. 6) for further delineation of the location and extent of bowel obstruction as well as to detect the size of any fluid collections. This information is particularly useful in planning either surgery or more conservative treatment (e.g., percutaneous abscess drainage with antibiotic therapy) of pediatric patients with acute appendicitis complicated by bowel obstruction.

**Ileocolic Intussusception**

In ileocolic intussusception, invagination of the distal small bowel into the cecum leads to abdominal pain and obstruction. Intussusception is the most common cause of bowel obstruction among children 6 months to 3 years old. It is most often idiopathic, suspected to be secondary to lymphoid hyperplasia in the bowel wall serving as a lead point for the invagination. Among children above this age range, a possible pathologic lead point, including lymphoma or a duplication cyst, can be considered. Affected children may be initially evaluated by conventional abdominal radiography, which can show a paucity of gas in the right lower quadrant. Left lateral decubitus views may show an absence of air rising into the cecum. Ultrasound (Fig. 7A) shows a focal mass with alternating hypo- and hyperechoic layers.

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Bowel Obstructions in Older Children

history of abdominal surgery, bowel obstruction and adhesive disease are often primary diagnostic considerations when patients present with acute vomiting, distention, and abdominal pain. Historically, small bowel follow-through was performed in cases of suspected adhesive bowel obstruction. However, this examination has fallen out of favor because the results do not change clinical management and the examination incurs unnecessary costs and radiation exposure. Although conventional radiography may provide adequate diagnostic information in the presence of an appropriate history, many patients may undergo CT for further evaluation, especially in the more acute postoperative period. Bowel rest and conservative management are often the initial treatment in these patients; however, more than 85% of patients do not respond to conservative management and eventually require surgical intervention.

**Acquired Hernia**

Although intraabdominal adhesions are a more common cause of bowel obstruction among postoperative pediatric patients, children who have had prior surgeries may also be at risk for obstruction secondary to an acquired or iatrogenic hernia. Patients who have undergone cardiac procedures may be at risk for a diaphragmatic hernia (Fig. 10), and those with prior abdominal incisions are at risk for incisional hernias. Imaging may show loops of bowel herniating through a defect in the diaphragm or abdominal wall. Definitive treatment requires surgical reduction and hernia repair.

**Other Causes**

**Ingested Foreign Body**

Ingested foreign bodies are relatively common among the pediatric population, with more than 100,000 ingestions per year in the United States. The majority of these foreign bodies either pass spontaneously or are removed endoscopically; less than 1% of patients require surgical intervention. Bezoars, which are indigestible masses of foreign material, represent a special form of obstructing foreign body and often require surgical removal. Bezoars can occur throughout the gastrointestinal tract, from the stomach to the rectum, and may be rapidly identified as the cause of bowel obstruction if abdominal radiographs show radiopaque foreign bodies in the presence of multiple dilated bowel loops (Fig. 11).

Among ingested foreign bodies, magnets merit special attention because of the specific complications that may occur when children ingest multiple magnets (Fig. 12). If a child consumes multiple magnets, there is a risk of bowel obstruction and perforation caused by magnets in distant loops of bowel that may adhere together. If this occurs, the child is at risk for volvulus and perforation secondary to pressure necrosis at the site of magnet adherence. Because of this risk, it is imperative that patients who have ingested magnets receive close clinical follow-up as well as early endoscopic removal or surgical intervention if there are signs of bowel obstruction or peritonitis.

**Distal Intestinal Obstruction Syndrome**

Distal intestinal obstruction syndrome (previously referred to as “meconium ileus equivalent”) represents a specific type of bowel obstruction that is rare but occurs in children with cystic fibrosis. Viscous secretions in the terminal ileum may create thick fecal matter that obstructs the distal small bowel. Imaging will typically show a fecalized segment of distal ileum (Fig. 13), with dilatation of proximal bowel loops. Treatment of these patients is predominantly nonsurgical, with laxatives and enemas serving as the primary methods for management. Conventional radiography is commonly used to assess stool burden, although CT may be considered in cases of persistent clinical symptoms or if operative intervention is under consideration.

**Conclusion**

Clear knowledge of the spectrum of causes of bowel obstruction is essential for the appropriate management of older pediatric patients with bowel obstruction. Although this diverse population may present with similar symptoms of vomiting, abdominal pain, and distention, the causes of bowel obstruction are varied and identification is essential for timely and appropriate management.

**Suggested Reading**

Fig. 1—Obstructing Meckel diverticulum (surgically confirmed) in 8-year-old girl who presented with acute onset of abdominal pain. A, Frontal conventional radiograph shows multiple air-fluid levels in dilated loops of bowel (arrows), suspicious for bowel obstruction. B, Contrast-enhanced coronal CT image shows dilated loops of proximal bowel (asterisks), with apparent decompressed loops (arrow) in right lower quadrant and adjacent free fluid.

Fig. 2—Intussuscepting Meckel diverticulum in 11-year-old boy who presented with 3 days of abdominal pain. Abdominal radiograph (not shown) revealed multiple dilated bowel loops, concerning for small bowel obstruction. Contrast-enhanced coronal CT image shows mesenteric fat and bowel within distal ileal lumen (arrow), as well as dilatation of proximal loops of small bowel (asterisks). Given patient’s age and appearance of intussusception on CT, there was high suspicion for pathologic lead point, and patient was taken for surgery, where he underwent resection of intussuscepting Meckel diverticulum.

Fig. 3—Malrotation in 3-week-old boy who presented with lethargy and feeding difficulties. Surgery confirmed presence of malrotation and midgut volvulus. Patient subsequently underwent Ladd procedure. A, Transverse ultrasound image (obtained during assessment for possible pyloric stenosis) shows abnormal orientation of superior mesenteric artery (straight arrow) and superior mesenteric vein (curved arrow). This raised suspicion for possible malrotation. B, Image from subsequent upper gastrointestinal series shows corkscrew loops of bowel (arrow) in left upper quadrant, consistent with malrotation and midgut volvulus.
Fig. 4—Malrotation in 8-year-old boy who presented with vomiting and abdominal pain. After imaging evaluation, patient was immediately directed to surgery, which confirmed malrotation with volvulus. Patient subsequently underwent Ladd procedure.

A, Contrast-enhanced axial CT image shows absence of retroperitoneal third portion of duodenum as well as apparent reversal of superior mesenteric artery (SMA) (straight arrow) and superior mesenteric vein (curved arrow).

B, Normally located retroperitoneal third portion of duodenum (arrow) crossing posterior to SMA is shown for comparison.

C, Enhanced coronal CT image shows dilated proximal bowel loops (asterisk) in right and mid abdomen.
Fig. 5—Incarcerated inguinal hernia in 2-year-old boy who presented with vomiting. Patient underwent surgical reduction of incarcerated inguinal hernia without complication.

A, Frontal upright abdominal radiograph shows dilated loops of bowel with multiple air-fluid levels (arrows), raising concern for bowel obstruction.

B, Transverse ultrasound image for evaluation of intussusception shows dilated loops of bowel (asterisk) and free fluid. Intussusception was not identified, but scrotal mass was detected during ultrasound examination.

C, Longitudinal view of right inguinal region shows loops of bowel (B) adjacent to testicle (T) within scrotal sac.

Fig. 6—Appendicitis in 15-year-old boy who presented with 2 weeks of progressive abdominal pain, fever, and vomiting. Initial ultrasound and CT showed perforated appendicitis with large right abdominal fluid collection that was drained. Patient’s symptoms persisted, and second CT was performed for further evaluation. This enhanced coronal CT image shows multiple dilated proximal loops of bowel (B) terminating in extensive fluid collection (asterisk), which extends from right lower quadrant-appendiceal tip to left mid abdomen. Drain is seen (straight arrow) in prior right abdominal fluid collection and appendicolith (curved arrow) in dilated appendix (A). Second drain was placed in this central abdominal fluid collection, and patient slowly improved after drainage and antibiotic therapy.
Bowel Obstructions in Older Children

Fig. 7—Ileocolic intussusception in 3-month-old girl who presented with vomiting. Radiographs (not shown) revealed dilated loops of bowel. Because of incomplete reduction with air enema, patient subsequently proceeded to operative treatment. 

A, Transverse ultrasound image shows right lower quadrant mass (arrow) with characteristic appearance of ileocolic intussusception (alternating hyper- and hypoechoic layers). Note dilated, fluid-filled adjacent loop of bowel (asterisk), compatible with bowel obstruction.

B, Fluoroscopic image obtained at conclusion of attempted reduction of intussusception shows persistent filling defect (asterisk) in region of cecum, indicating incomplete reduction.

Fig. 8—Inflammatory bowel disease in 16-year-old boy who presented with vomiting. Patient improved with medical therapy and bowel rest. Contrast-enhanced coronal CT image provides further delineation of location and extent of dilated bowel loops (asterisks). Prominent mesenteric adipose tissue is also identified (curved arrow) near inflamed terminal ileum (straight arrow), compatible with “creeping fat” appearance. B = bladder.

Fig. 9—Adhesions in 16-year-old girl with history of complicated appendicitis who presented with acute onset abdominal pain and vomiting. Axial CT image shows dilated loops of proximal small bowel (asterisk) with abrupt right lower quadrant transition point (arrow). Patient subsequently underwent lysis of right lower quadrant adhesion that had caused bowel obstruction.
**Fig. 10**—Iatrogenic diaphragmatic hernia in 3-year-old boy with history of cardiac surgery and pacemaker placement who presented with abdominal pain and vomiting. Surgical reduction was performed, and hernia was repaired.

A. Frontal abdominal radiograph shows loop of bowel (arrow) projecting over lower chest, above expected area of diaphragm.

B. Sagittal CT image shows diaphragmatic hernia with bowel (B) and omental fat (F) extending through defect in diaphragm (arrows).

**Fig. 11**—Bezoar in 20-year-old woman with developmental delay and pica who developed vomiting, with hair elastics identified in vomited material. Frontal abdominal radiograph shows multiple radiopaque structures within heterogeneous mass that appeared to conform to gastric contour. Surgical exploration was immediately performed, revealing large gastric bezoar resulting in gastric outlet obstruction.

**Fig. 12**—9-year-old girl who swallowed multiple round magnets. Abdominal radiograph shows 19 radiopaque bodies projecting over distal stomach. These magnets were removed endoscopically.

**Fig. 13**—Distal intestinal obstruction syndrome in 17-year-old girl with cystic fibrosis who developed abdominal pain and vomiting. Enhanced coronal CT image better shows location and extent of multiple bowel dilatation (asterisks) with fecalization of more distal loops of small bowel (straight arrow) extending to terminal ileum (curved arrow).