
How to Diagnose Intussusception in Children

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Abdominal pain is a frequent complaint in the pediatric emergency department. One of the top diagnostic considerations is intussusception, particularly in patients between 3 months and 3 years of age. An intussusception is a loop of bowel telescoping into an adjacent loop of bowel. There are two subtypes of intussusception, ileocolic and small bowel-small bowel. The receiving loop of bowel is called the intussusciens and the inner bowel is called the intussusceptum. Both ileocolic and small bowel-small bowel intussusceptions can occur in children. An ileocolic intussusception is the most common type of intussusception in children and requires urgent treatment. Patients can present with lethargy, vomiting or decreased appetite, with fewer than 50% of patients presenting with the classic triad of red-currant jelly stool, colicky abdominal pain, and palpable abdominal mass.¹ Delay in diagnosis increases morbidity, including bowel ischemia and perforation, as well as mortality.

Small bowel-small bowel intussusceptions are frequent incidental findings as more cross-sectional imaging

is performed in children. Most of these occur in the left upper quadrant in the jejunum and less often require additional workup or intervention. As small bowel-small bowel intussusceptions are incidental findings, children are usually asymptomatic. Symptomatic cases of small bowel intussusception can occur in a subset of children with predisposing underlying conditions.

In this article, we review the typical findings of intussusception in various imaging modalities used to diagnose ileocolic and small bowel intussusceptions and briefly discuss intussusception reduction. Key points regarding the lead points and ultrasound features of possible non-reducibility are highlighted, as they can be potential challenges to reducing an intussusception.

Imaging Modalities Used To Diagnose Intussusception Radiography

Radiography is neither diagnostic nor sensitive for intussusception detection, with a wide range of documented sensitivities that correspond to the number of views obtained. Two-view radiographs, including a supine view with a lateral decubitus or upright view, demonstrate a sensitivity of 62%.² There are findings that raise the concern for intussusception and would warrant further imaging. The most specific finding on radiography is a round,

soft-tissue mass within the upper abdomen that can be seen in up to 60% of X-rays (Figure 1).³ Surrounding regions of fat density corresponding to mesentery within the intussusciens may be identified. The crescent sign, a curvilinear area of air surrounding the soft tissue mass, may also be seen (Figure 1).³

A paucity of bowel gas and stool within the region of the cecum could also raise concern for an intussusception but does not exclude diagnosis because a stool-filled sigmoid colon may be located within the right lower quadrant and be mistaken for the cecum.¹ Depending on the duration of symptoms, the abdominal radiograph may demonstrate a wide variety of bowel gas patterns ranging from normal to signs of a small-bowel obstruction. Radiographs are useful to exclude other diagnoses such as foreign body ingestion or pneumoperitoneum from a perforated viscus. If an ileocolic intussusception is present, a radiograph should be performed prior to reduction to exclude free air, as the presence of free air would preclude reduction.

Overall, radiography has poor diagnostic performance in intussusception and should *not* be considered first-line imaging.² The recommended imaging algorithm is always to perform ultrasound first in a child with suspected intussusception.

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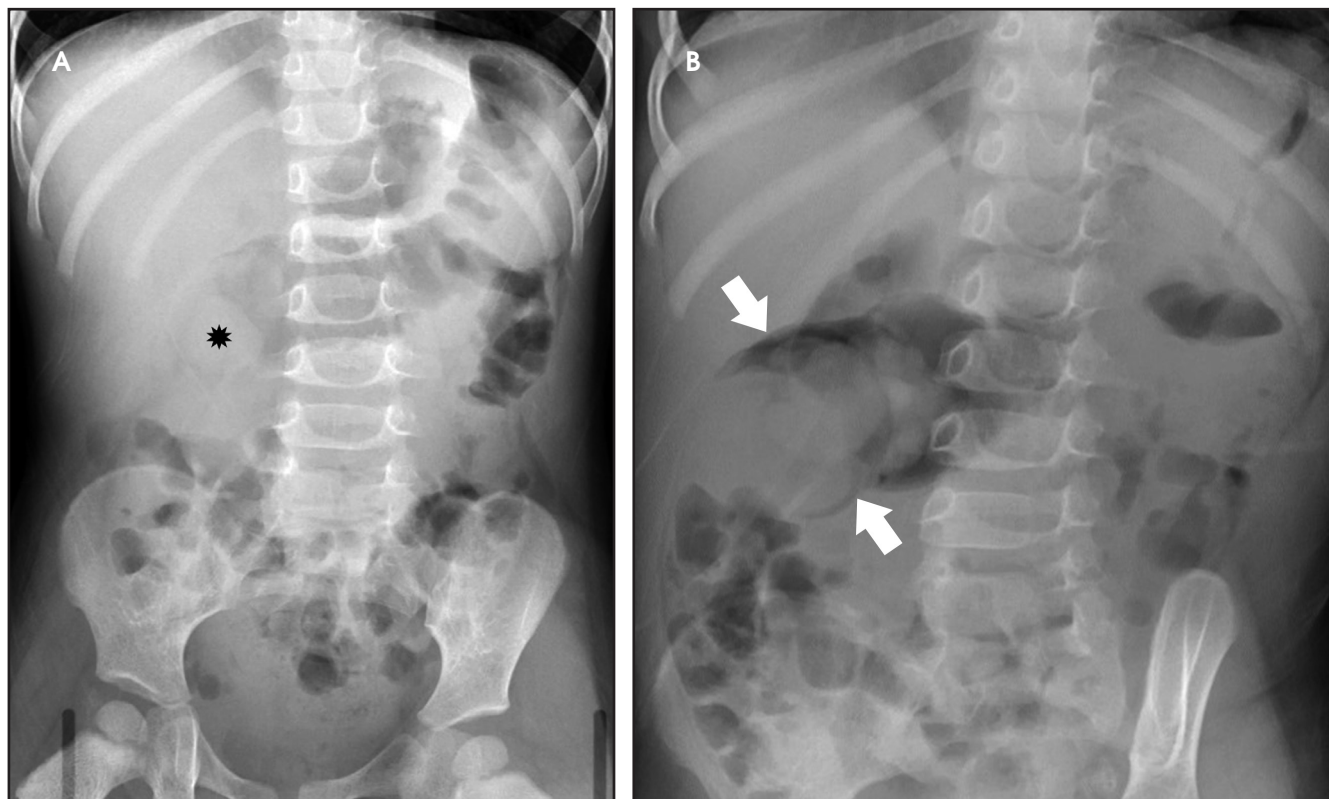


FIGURE 1. 2-year-old with intermittent abdominal pain. (A) AP view of the abdomen shows a rounded soft-tissue density “mass” at the hepatic flexure (*), compatible with an ileocolic intussusception. (B) Left lateral decubitus view better demonstrates colonic gas dissecting around the intussusception (arrows).

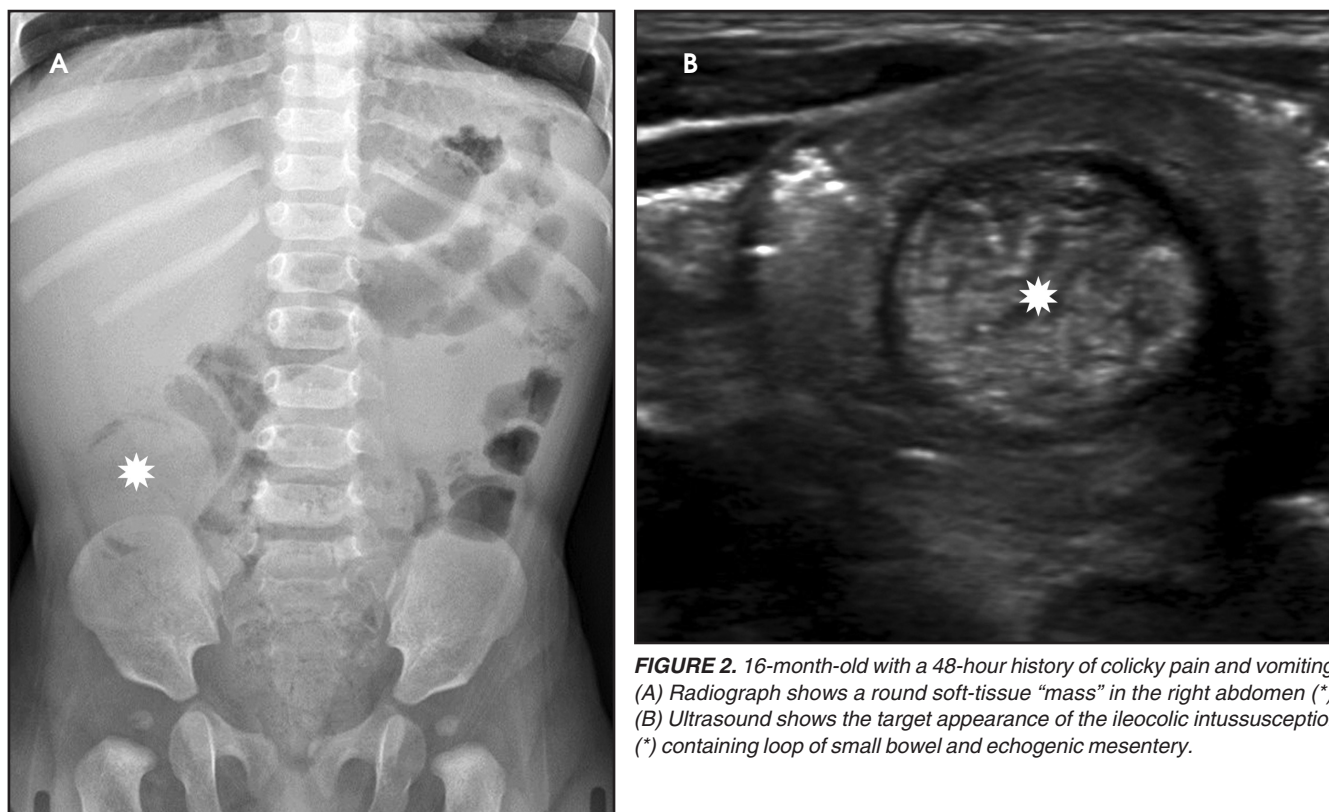


FIGURE 2. 16-month-old with a 48-hour history of colicky pain and vomiting. (A) Radiograph shows a round soft-tissue “mass” in the right abdomen (*). (B) Ultrasound shows the target appearance of the ileocolic intussusception (*) containing loop of small bowel and echogenic mesentery.

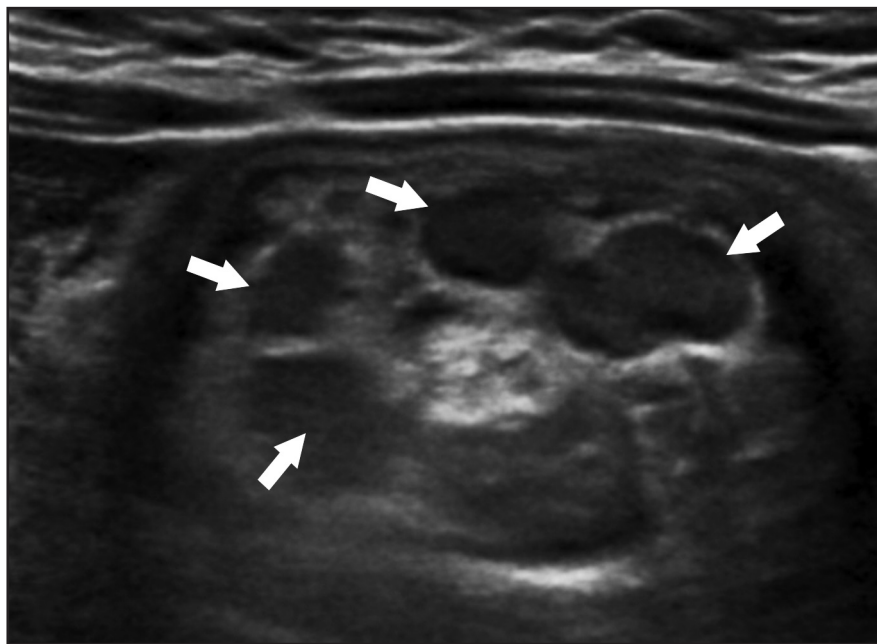


FIGURE 3. 14-month-old with lethargy and vomiting. Ultrasound shows an ileocolic intussusception containing echogenic mesentery, small bowel, and multiple prominent lymph nodes (arrows).

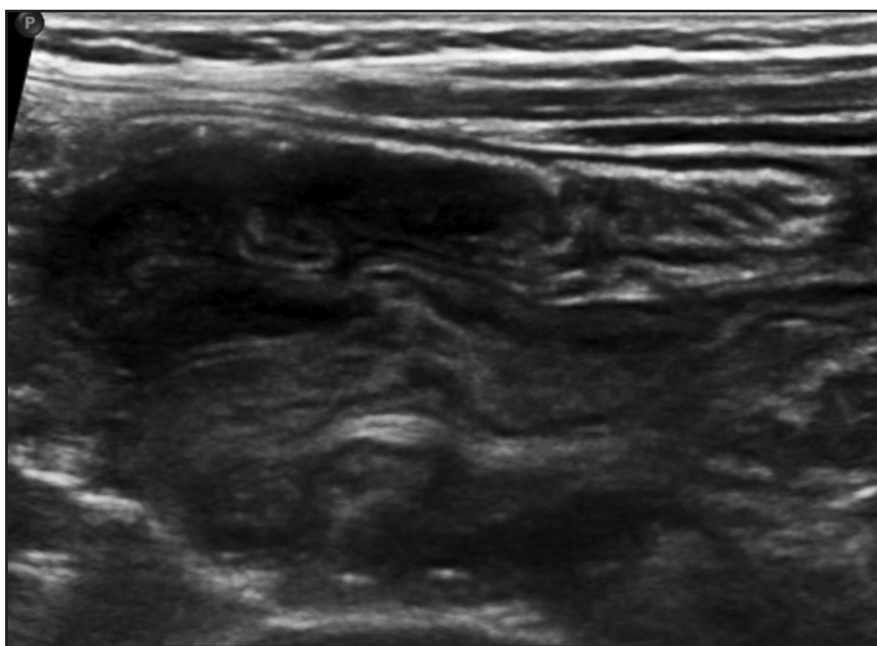


FIGURE 4. 3-year-old with lethargy and bilious vomiting. Ultrasound along the long axis of an ileocolic intussusception shows alternating layers of hypo- and hyper-echogenicity, the “sandwich” sign.

Ultrasound

With a sensitivity of 97.9%, specificity of 97.8%, positive predictive value of 86.6%, and negative predictive value of 99.7%, ultrasound (US) is the gold standard for evaluating a suspected intussusception.⁴ An intussusception

presents as a round mass with a target bowel-in-bowel appearance in the transverse plane, the classic finding on ultrasound (Figure 2). The features are unique in that they consist of concentric rings of bowel wall and internal hyper-echoic mesenteric fat. Lymph nodes or

the appendix may also be noted within the intussusceptum (Figure 3).

The diameter of an ileocolic intussusception can range from 1.4 cm to 4 cm, with a mean diameter of 2.6 cm.^{5,6} This is larger than the mean diameter of small bowel-small bowel intussusceptions, which is 1.4 cm.^{5,6} The target-appearing mass may be located anywhere in the abdomen depending on the site and length of the intussusception. In the longitudinal plane, the intussusceptum can be seen extending into the intussusciptens and demonstrating multiple alternating hypoechoic and hyperechoic lines known as the “sandwich” sign (Figure 4). The “pseudo-kidney” sign can be seen on longitudinal scans depicted by a thickened intussusceptum bowel wall mimicking a reniform shape, with the internal echogenic mesentery of the intussusception representing the central echogenic fat complex of a normal adult kidney (Figure 5).⁷ Concomitant intraperitoneal free fluid can be seen in greater than 50% of cases.⁸

Specific findings on US can also assess the reducibility and potential complications related to reduction. Fluid trapped within the intussusciptens and a lack of internal vascular flow on Doppler within the intussusceptum may indicate ischemia or necrosis and a potentially increased risk of enema reduction failure. However, this is not a contraindication; 26% of cases with trapped fluid and 31% cases without internal vascular flow result in a successful reduction (Figures 6,7).⁹⁻¹¹ Irregular bowel wall or decreased bowel wall vascularity also suggests friable mucosa, a risk for perforation (Figure 8). Recognizing these features are important prior to performing any type of reduction because they can indicate potential procedural difficulty, predict non-reducibility, and alert the radiologist to have surgery on standby, owing to a higher-than-normal risk of perforation. All of these factors need to be considered in the decision process whether to pursue reduction.

One diagnostic limitation of US is the presence of extensive bowel gas,

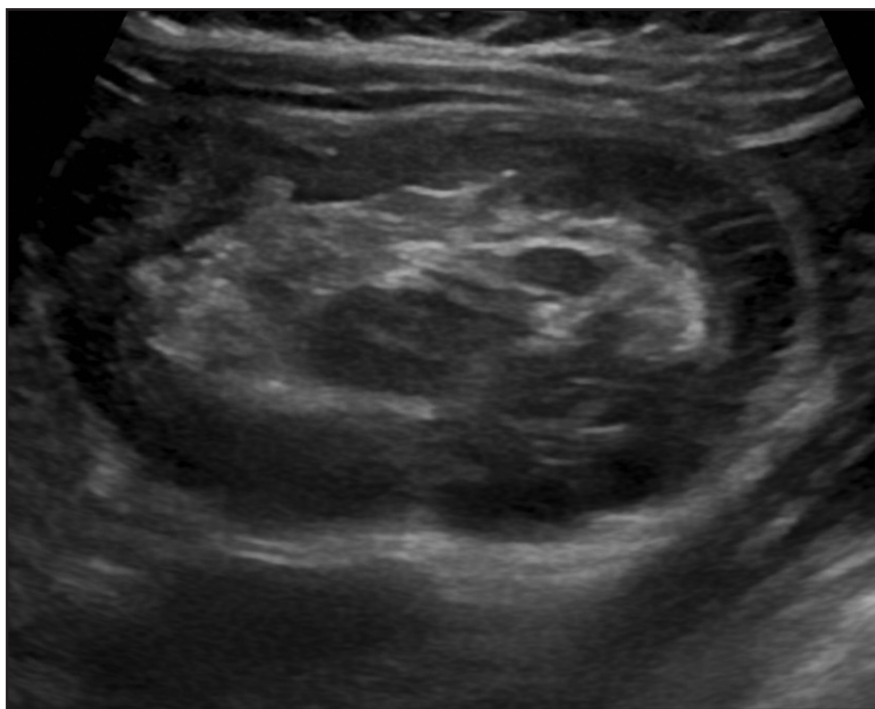


FIGURE 5. 3-month-old presenting with bloody stools and abdominal discomfort. Ultrasound shows the “pseudokidney” appearance of an ileocolic intussusception resulting from thickened bowel wall with internal mesenteric increased echogenicity having the appearance of echogenic renal sinus fat.

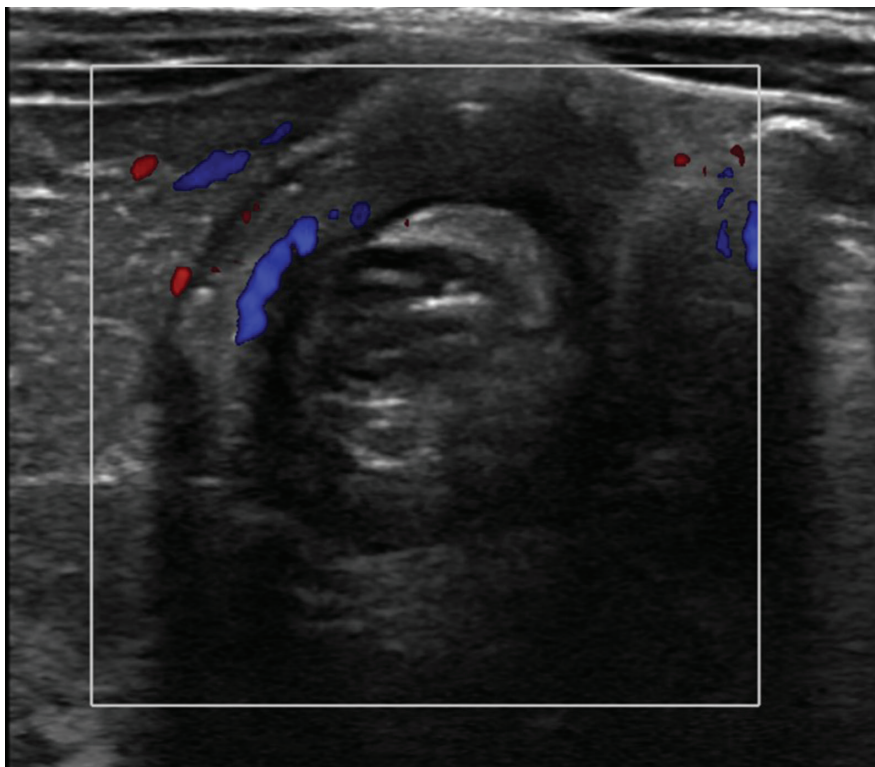


FIGURE 6. 5-month-old with emesis and episodes of inconsolable crying. The patient had symptoms intermittently for a week with more sustained pain for the previous 24 hours. Ultrasound shows a lack of color Doppler blood flow within the intussusceptum. Enema was unsuccessful and the patient had successful surgical reduction with no resection.

which can obscure evaluation. Also, a small bowel-small bowel intussusception can erroneously be diagnosed as an ileocolic intussusception owing to the overlap in size ranges of the targetoid mass.^{5,6} Perforated appendicitis can be mistaken for an intussusception if it is contained due to internal debris or if an appendicolith is inaccurately interpreted as mesenteric fat within an intussusciens.¹² Despite these limitations, ultrasound still has a very low false-negative rate of less than 1% and a low false-positive rate of 13%.⁴

MRI and CT

Magnetic resonance imaging (MRI) and computed tomography (CT) are not the conventional first-line imaging modalities for diagnosing intussusception. Unlike in children, intussusceptions are more commonly identified on CT and MRI in adults. There are no dedicated studies, only case reports, in the pediatric literature on the use of CT and MRI for intussusception. Radiologists should be aware of the MRI and CT appearances of intussusception, however, as they may be seen in children undergoing studies for other possible conditions. Small-bowel-small bowel intussusceptions are incidentally identified on CT and MRI more often than the ileocolic subtype. Whether an ileocolic or small bowel intussusception, these entities may involve a short or long segment and be seen anywhere in the abdomen.

On CT, the typical target appearance of bowel within bowel will be seen with high-attenuation bowel wall, a concentric ring of hypodense mesenteric fat, and an additional internal region of higher-attenuation bowel (Figure 9). Intussusceptions of longer duration can appear more elongated and “sausage shaped” owing to associated edema.³ If administered, oral contrast can extend into the intussusciens. Computed tomography can also demonstrate sequelae of intussusception, such as small-bowel obstruction, as well as lead points in older children.

On MRI, an intussusception can best be visualized on a fluid sensitive

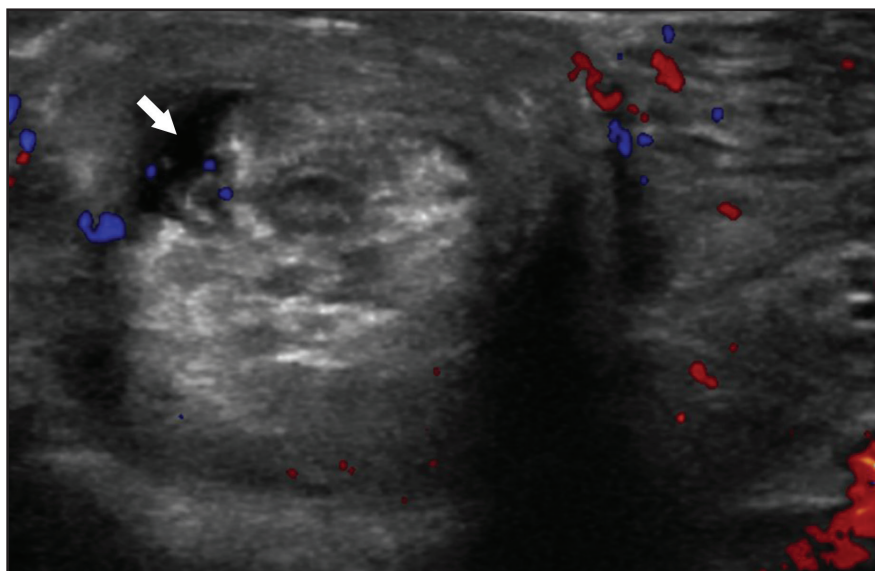


FIGURE 7. 6-month-old with frequent emesis, lethargy, and palpable abdominal mass. Ultrasound shows a small amount of trapped fluid (arrow) within the intussusception. Enema reduction was unsuccessful, followed by successful surgical reduction.

sequence, which would demonstrate hyperintense intraluminal fluid with low-to-intermediate signal intensity of the bowel wall (Figure 10).³ Surrounding perienteric edema would also be present, as soft-tissue contrast is greater on MRI than on CT. Magnetic resonance imaging, like CT, can also readily visualize lead points such as duplication cysts, solid masses, or polyps.

Small bowel-Small bowel Intussusception

Small bowel-small bowel intussusceptions are often incidentally seen on US, CT, and MRI, and are typically self-limiting; therefore, they do not typically require follow-up imaging to document resolution. They are distinguished by location, often in the left upper quadrant, and by size, usually less than 2.5 cm.⁵ Many times when performing an US in real time, a small bowel-small bowel intussusception visualized at the beginning of the examination is resolved by the end of the examination and is reported as being transient. While the majority of small bowel-to-small bowel intussusceptions do not require intervention, ascites, small-bowel obstruction, or an intussusception length greater than 3.5 cm may require follow-up and possible surgical intervention.¹³

Small bowel-small bowel intussusceptions are seen in specific conditions such as celiac disease and Henoch-Schönlein Purpura and can be visualized along the jejunal arm of a G-J tube (Figure 11). Radiologists should scrutinize for this when performing studies in this subset of pediatric patients. These small-bowel intussusceptions should be reported when interpreting US, CT, or MRI scans. We report location, size, associated findings, and the presence/absence of lead points, as well as whether they are persistent or transient throughout the examination.

Lead Points

While most ileocolic intussusceptions are idiopathic owing to lymphoid hypertrophy, 1.5-12% have a pathologic lead point.¹⁴ In contrast, intussusceptions in adults are rare; about 90% are caused by a definite lead point, such as neoplasm, or secondary to a post-operative condition.¹⁵ The most common pathologic lead point in a child is a Meckel diverticulum, with other etiologies including duplication cysts, polyps, or malignancies such as lymphoma.^{-14,16,17} Although most intussusceptions occur within the first year of life, the percentage of those with pathologic lead points increases with age.^{14,18}

Pathologic lead points can cause small bowel-small bowel, ileocolic, or even colocolonic intussusceptions.¹⁹ Intussusceptions may also result from a preexisting condition with predisposition such as Henoch-Schönlein Purpura, Peutz-Jeghers syndrome, and cystic fibrosis.^{-14,16,17} A pathologic lead point may be seen on US; up to 66% of lead points are detected with the modality (Figure 12).¹⁶ A pathologic lead point is not a contraindication to enema reduction; however, while the intussusception can be reduced, there is an increased incidence of recurrence, with a recent study by Lin et al finding a recurrent intussusception rate of 78.5%.¹⁷ Ultimately, whether the intussusception is reduced, the pathologic lead point will require surgical treatment.

Techniques To Reduce Ileocolic Intussusception

Intussusception reduction can be performed under fluoroscopic guidance with either air or liquid contrast, or under ultrasound-guided hydrostatic reduction. The choice can be based on one's training, experience, and available resources. However, a 2015 meta-analysis found air reduction superior to liquid, with no differences in perforation rates in either group.²⁰ There is also significant contrast dose saving with air reduction; air reduction requires 2.7 times less contrast than liquid reduction.²¹ Prior to beginning the procedure, it is imperative to secure intravenous access, an abdominal radiograph excluding free air, all necessary equipment, and a pediatric surgeon to be available in the event of a complication such as a perforation.

Contraindications to the procedure include pneumoperitoneum or signs of peritonitis. The equipment required for reduction include a rectal tube and either a sphygmomanometer with a pressure release valve for pneumatic reduction, or a choice of contrast if performing a liquid reduction. The child should be accompanied by a nurse and monitored for the duration of the study. In addition, to prepare for possible perforation, a

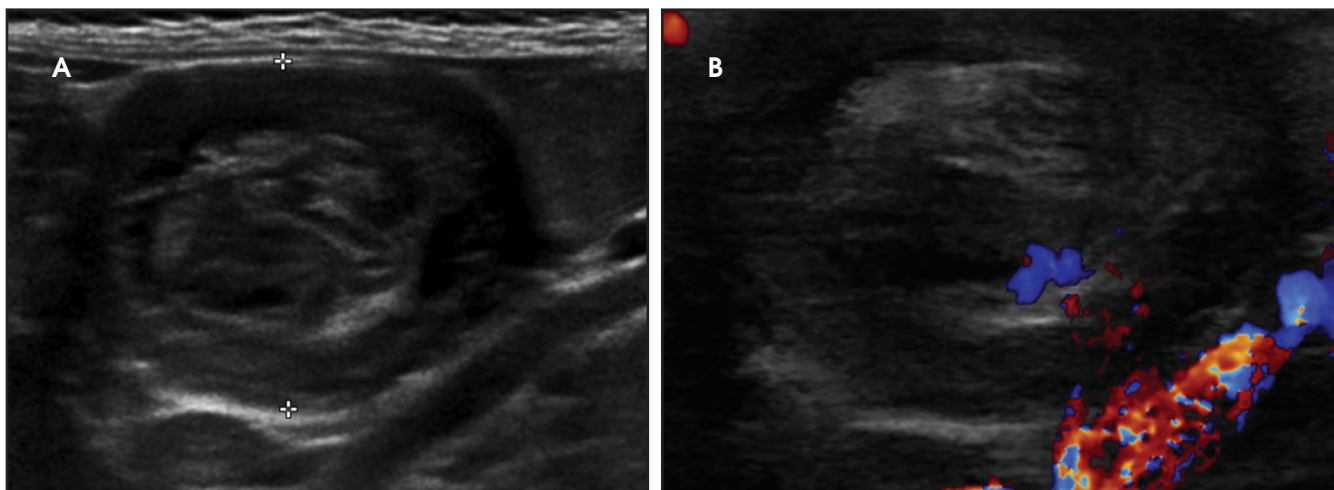


FIGURE 8. 8-month-old with emesis and decreased activity. (A) Ultrasound shows the target appearance of an ileocolic intussusception containing mesentery and small bowel. (B) There is a lack of color Doppler blood flow within the intussusciptum.

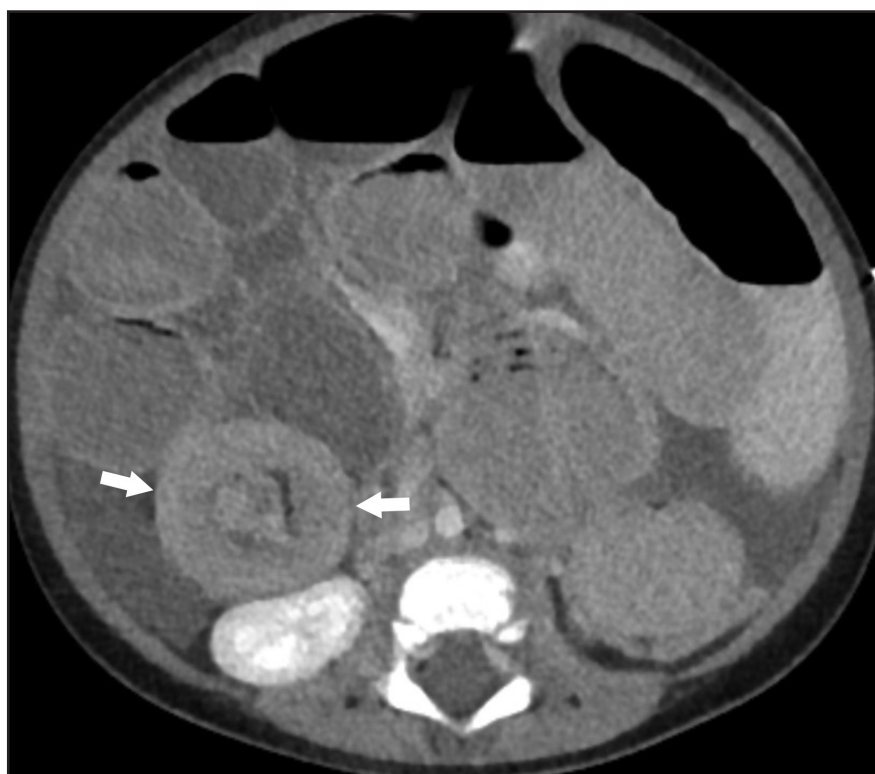


FIGURE 9. 9-month-old with emesis and concern for bowel obstruction. Axial CT image shows the target appearance of an ileocolic intussusception (arrows) with alternating layers of increased and decreased attenuation. There is associated upstream bowel dilation.

surgeon should be on standby and a large-gauge intravenous catheter should be available for decompression of the abdomen in the setting of a perforation with pneumatic reduction.

Formal, signed consent is not routinely obtained or required before intussusception reduction at many pediatric

radiology practices. A more informal consent process occurs in the radiology suite, where the details and risks of the procedure are discussed with the parent(s)/guardian. The reduction does not start until the child’s guardian fully acknowledges these details and verbally agree to the procedure.

Fluoroscopically Guided Air Reduction

A tight air seal using taping, manually squeezing the buttocks, or inflating a balloon is required for fluoroscopically guided air reduction. The patient can be placed in the prone or supine position. The advantage of prone positioning is that it permits access to the child’s buttocks to acquire a tight rectal seal. It is also important not to exceed a maximum pressure of 120 mmHg and to employ a pop off valve as a safety precaution. The endpoint of air reduction is to see air flood the small bowel (Figure 13). If there is concern that the intussusception has not reduced completely—an edematous ileocecal valve (ICV) can mimic residual intussusception—a targeted US can be performed immediately in the fluoroscopy suite for confirmation. Some may feel that bowel air in the aftermath of reduction can impair identification of a residual intussusception; however, this has not been true in our experience.

Fluoroscopically Guided Liquid Reduction

Liquid reduction is usually performed with an iso-osmolar, water-soluble contrast agent to ensure the highest level of safety, although recent surveys have found that 25% of pediatric radiologists use Gastrografin, and 16% report using barium, as their liquid contrast

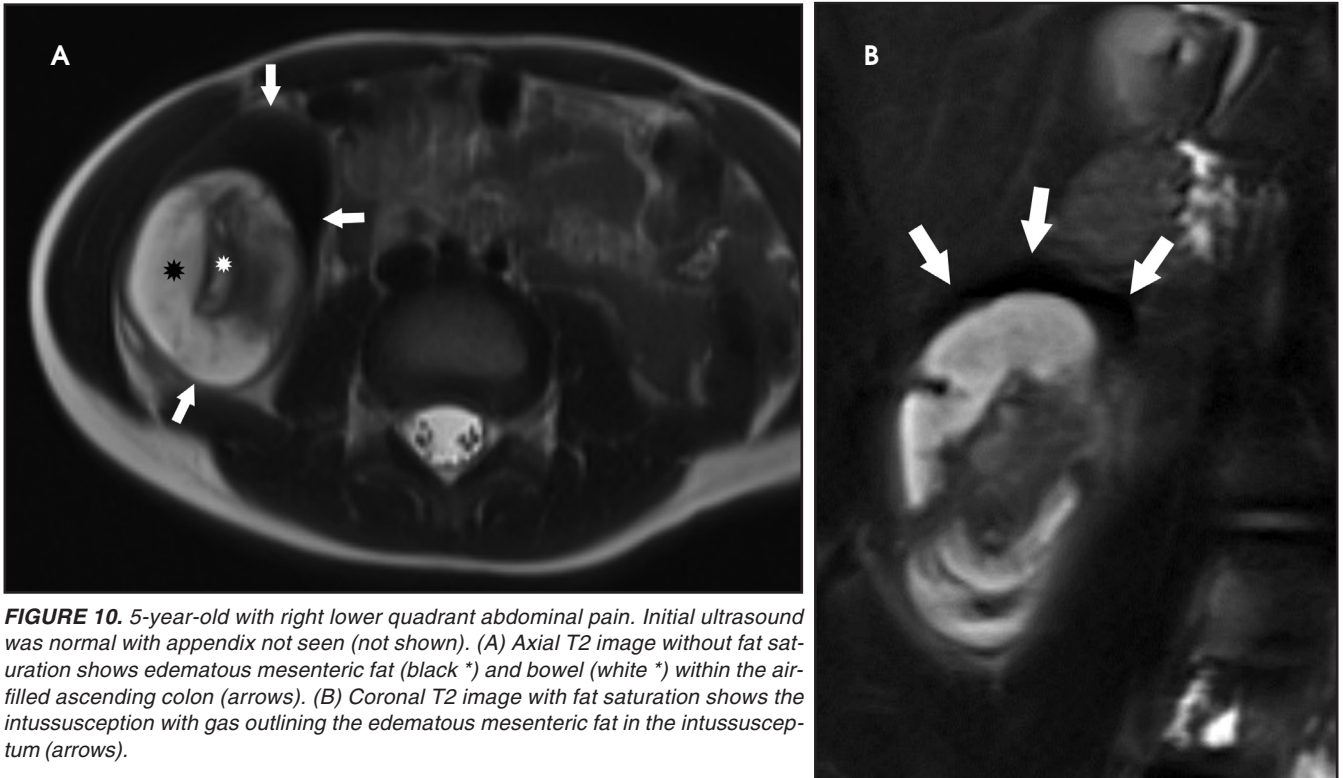


FIGURE 10. 5-year-old with right lower quadrant abdominal pain. Initial ultrasound was normal with appendix not seen (not shown). (A) Axial T2 image without fat saturation shows edematous mesenteric fat (black *) and bowel (white *) within the air-filled ascending colon (arrows). (B) Coronal T2 image with fat saturation shows the intussusception with gas outlining the edematous mesenteric fat in the intussusceptum (arrows).



FIGURE 11. 6-year-old with a GJ tube, abdominal pain and emesis. Ultrasound shows the target appearance of an intussusception. The GJ tube acts as a lead point for intussusception and can be seen here as parallel echogenic lines (arrows) within the intussusception.

of choice.²² Gastrografin is hyperosmolar and must be used with great caution; in our experience this agent should be avoided owing to its risk of causing electrolyte imbalance and possibly shock.

The general rule for using liquid contrast is to hold the enema bag three

feet above the table and to make three attempts to reduce the intussusception. However, situations may arise where this rule may be modified and the reduction attempt may be longer. The radiologist may consider this in the interest of the patient to attempt a longer reduction

to avoid surgery. Again, all safety precautions should be maintained throughout the procedure.

Ultrasound-guided Reduction

Ultrasound-guided reduction is employed by few pediatric radiologists. Based on 2015 data, only 4% of surveyed pediatric radiologists reported using US-guided hydrostatic reduction. In this method, a saline enema is hung and an US probe is used to follow the flow of saline as it pushes the intussusception to the ICV. The termination point occurs when the saline is seen traversing the ICV and flooding the small bowel. Ultrasound-guided hydrostatic reduction is advantageous in that no ionizing radiation is employed and any residual or incomplete reduction can be readily recognized.

Traditionally, a balloon has not been used during enema reduction—its use is controversial—but recent literature has shown a balloon can be effective.^{23,24} Proponents have argued the likelihood of successful reduction may increase with a balloon inflation; however, a higher rate of perforation has

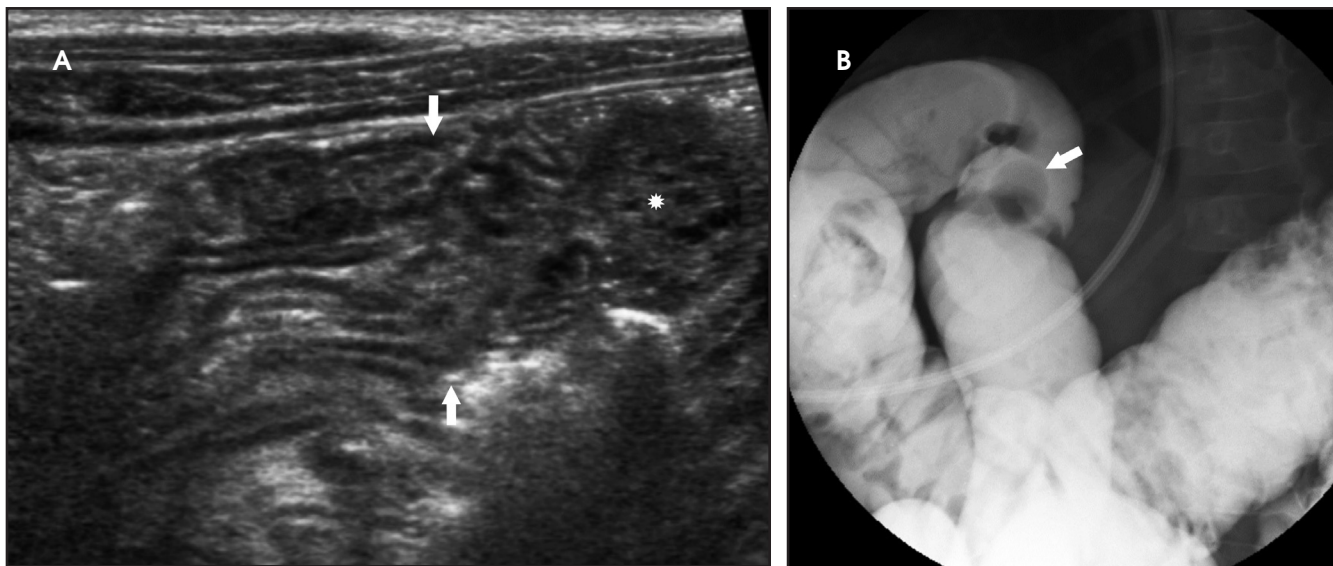


FIGURE 12. 6-year-old with intermittent abdominal pain and bloody stool. (A) Initial ultrasound shows a colocolic intussusception with alternating layers of hypo- and hyper-echogenicity (arrows). Within the intussusceptum, there is a round, pedunculated heterogeneous mass with internal cysts compatible with a polyp (*). (B) Water-soluble contrast enema reduction was successful and shows the intraluminal polypoid lesion within the splenic flexure of the colon (arrow), which acted as the lead point.

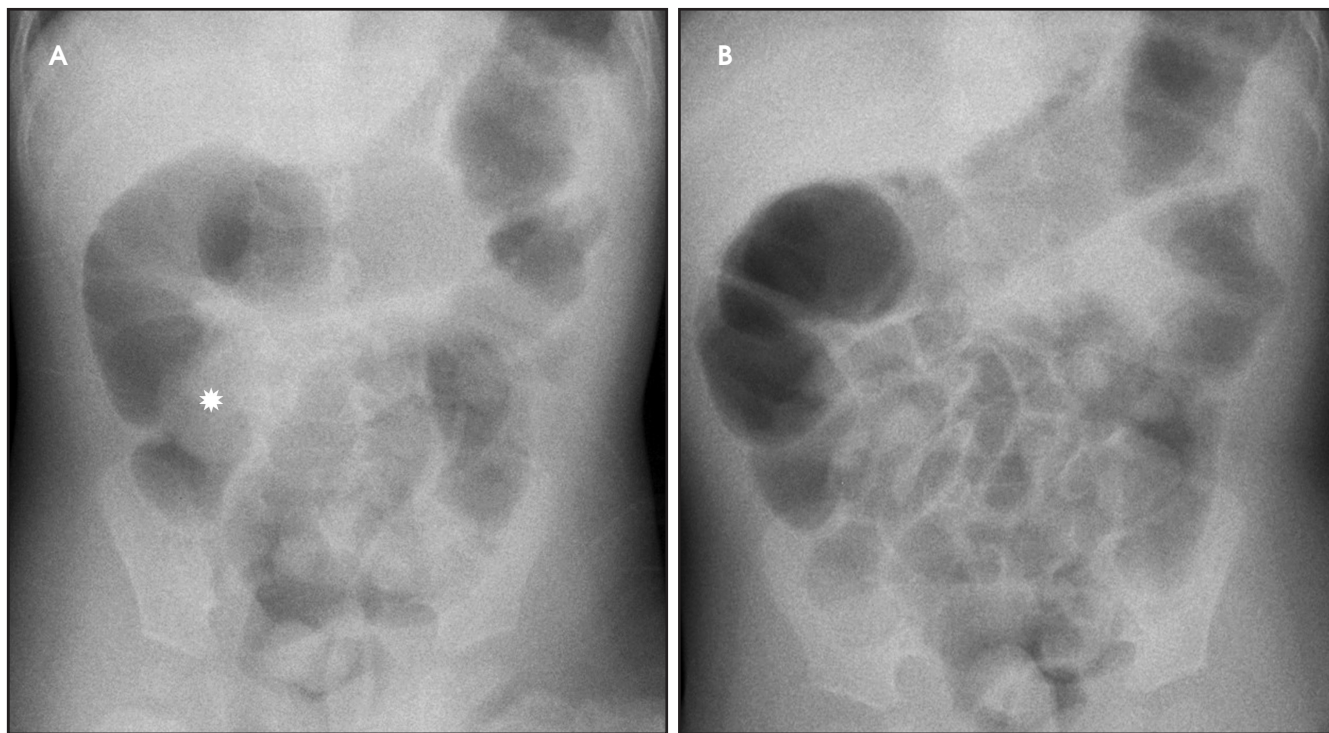


FIGURE 13. Air-contrast reduction. (A) Early image shows gas throughout the colon with a round soft-tissue density in the ascending colon (*). (B) Following successful reduction, the soft-tissue density is no longer present and there are numerous loops of small bowel now filled with gas.

been found in children younger than 9 months.²⁴ Overall, balloon inflation should be performed with caution and only by experienced radiologists.

Signs of unsuccessful reduction have been described on diagnostic US; however, two important signs must be

recognized. The first is frank perforation with free intraperitoneal air during reduction, or frank spillage of contrast or saline into the abdomen during liquid reduction. Free air is recognized as air outlining the bowel wall between loops of bowel, rapidly increasing

abdominal girth, and lucency over the liver and spleen. Regardless of liquid or pneumatic reduction, the procedure should immediately be terminated and the pediatric surgeon notified in the event of perforation. A large amount of air identified within the abdomen

and causing vascular compromise may require emergent needle decompression of the abdomen in the fluoroscopy suite.

The second important sign of unsuccessful reduction is the “dissection sign,” in which air traverses the intussusception and fills the small bowel as an air lock without generating sufficient pressure to retrogradely reduce the intussusception further.²⁵ As a result, air bypasses the intussusception and impedes further reduction. Reduction in this case is more likely to be unsuccessful, but some experienced radiologists may still be able to complete reduction.

Unsuccessful reduction does not always require surgery. Some radiologists will wait less than 30 minutes to a few hours after the first reduction and attempt a delayed reduction, as long as the patient remains stable. There are no guidelines on how long to wait, but significant success rates after a wait-and-watch period have been reported.^{26,27}

Conclusion

Intussusception is common in children and can be readily diagnosed by a combination of clinical symptoms and ultrasound findings. Upon diagnosis of ileocolic intussusception, several safe and effective radiologic methods of reduction are available. Small bowel-small bowel intussusceptions are often incidental and cannot be reduced, but they are typically self-limiting and resolve spontaneously. Identifying lead points can be challenging but is required in older children presenting with either ileocolic or small-bowel intussusception.

Finally, delayed reduction should be considered, as it can lead to greater success in avoiding unnecessary surgery.

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