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A brief review of diagnostic properties of point-of-care ultrasound for adult bowel intussusception: Making the case for ultrasound

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Abstract

Undifferentiated abdominal pain in adults is a common chief complaint in acute care clinics and emergency departments worldwide, representing up to 10% of visits to emergency departments. Many patients have a non-specific presentation and an initial workup with labwork, urine analysis or X-ray might not reveal a specific diagnosis. Although bowel intussusception is a primarily pediatric disease, adult intussusception is a recognized but rare cause of bowel obstruction often requiring surgical intervention. However, recent data from advanced multi-detector computed tomography imaging shows that milder or recurring cases in adults have been underrecognized. Multi-detector computed tomography is still the imaging gold standard for detecting intussusception in adults, but new data showed that sonographers with basic training using the point-of-care ultrasound approach have a reasonable accuracy in detecting this pathology. As the point-of-care ultrasound for undifferentiated abdominal pain is an emerging core skill in the acute care setting, knowledge of sonographic signs of intestinal intussusception should be included in the skill set of physicians. Sonographic findings in adults mimic pediatric cases, but different location patterns and higher malignancy rates exist in adults. In this manuscript, we will review the current literature on adult intussusception and summarize key knowledge of intestinal intussusception in adults. We will present four adult patients diagnosed with different types of adult acute bowel intussusception using the point-of-care ultrasound and describe a focused scanning approach with typical sonographic findings.

Introduction

Although intestinal intussusception is thought of as a classic pediatric condition, new research utilizing more advanced multidetector computed tomography imaging showed incidence rates in adults with acute abdominal pain as high as 16.6%. It is thought to be responsible for 1–5% of all adult bowel obstructions and commonly requires surgical intervention^(1–4). Intussusception results from an invagination of a segment of the gastrointestinal tract along its length described as “telescoping”. Usually a proximal segment of the bowel slides into the adjacent distal segment. When this occurs, circulation might be impaired and intestinal edema can develop, potentially leading to ischemia, necrosis, or even perforation⁽⁵⁾. In adults, approximately 90% of the intussusceptions occur in large or small bowel. Less frequent locations are ostomies or the upper gastrointestinal tract, such as gastro-duodenal, GJ-tube related, or postoperative intussusceptions^(6–9). In gastro-duodenal intussusceptions, usually a pedunculated benign or malignant intestinal wall lesion prolapses into the duodenum⁽⁷⁾. GJ-tube

intussusceptions are associated with the use of inflated balloons or a distal pigtail, or incorrect insertion depths⁽⁸⁾. Postoperative intussusceptions can develop after bowel resection, anastomosis or reconstruction surgery (i.e. Roux-en-Y)⁽⁹⁾.

The most common locations are in the lower gastrointestinal tract and can be classified as 1) entero-enteric, 2) ileo-colic, 3) ileo-cecal and 4) colo-colonic. Small intestines are more often involved than large intestines⁽¹⁰⁾. The etiology is strongly dependent on location. About 2/3 of entero-enteric intussusceptions have a benign etiology. About 20% of all lower GI intussusceptions are colo-colonic and frequently caused by malignancy.

Hong *et al.* showed in a systematic review of 40 studies and 1,229 patients that the pooled rates of enteric, ileocolic, and colonic location types in adults were 49.5%, 29.1%, and 19.9%, respectively⁽¹¹⁾. A study of 745 patients diagnosed intraoperatively with intussusception revealed 52% of small intestine (39% enteroenteric, 13% ileocolic) and 38% of large intestine (17% ileocecal, 17% colocolic, 4% appendiceal) intussusceptions⁽¹²⁾. Adults have a pathological leading

point in almost 80–90% of cases, with malignancy rates varying with anatomic location^(10–13). Transient intussusceptions in adults are thought to be mainly idiopathic, and have been associated with celiac and Crohn's disease or cystic fibrosis. Some case reports have been published describing chronic intermittent symptoms over months or even up to 5 years, finally resulting in an intussusception diagnosis^(14–19). However, similar to intussusception in children, adult intussusception will most likely present as a predominantly obstructive clinical picture. Atypical cases may require a high clinical suspicion index and highly sensitive imaging. Indeed, advancements in multi-detector computed tomography (MDCT) technology allowed improved diagnostic capacity of CT imaging for intussusception and suggest that the incidence of milder spectrum cases of adult intussusception may be higher than previously thought. Patients with transient presentations or evaluated early in their clinical course may not have been identified by older and less sophisticated imaging⁽²⁰⁾.

There are several imaging modalities to consider when evaluating for intussusception. Plain film X-ray has poor sensitivity and specificity, but may show an elongated mass with evidence of proximal dilation⁽²⁰⁾. MDCT is the imaging modality of choice for adult intussusception, although not 100% accurate. Findings can show a heterogeneous “target” or elongated “sausage-shaped” mass depicting the outer intussusciens and central intussusceptum^(20–23). However, MDCT exposes patients to a relatively large amount of radiation, may not be readily available in a resource-limited environment, and is not easily repeatable if clinical circumstances change or the patient presents with chronic or intermittent symptoms. This is also of consideration if a patient already accumulated a large number of abdominal MDCTs.

Ultrasound is the standard imaging modality for the pediatric population^(24,25) given the lack of radiation exposure and predictable anatomical location, with the vast majority of cases being ileo-colic. Classic findings on ultrasound include the target sign, the pseudo kidney sign and the crescent in a donut sign. These signs depict the outer intussusciens and central intussusceptum in different planes, whereby the often edematous and thickened outer layer of bowel appears hypoechoic and contains a collapsed hyperechoic inner layer of bowel^(21,22,24,25). Interestingly, sonographic findings for

pediatric and adult cases are alike, but there is a difference in the use of ultrasound for adults and still a paucity of literature with regard to ultrasound accuracy in adults^(26–29). This may be caused by the adult body habitus that limits bowel ultrasound, by different diagnostic approaches to abdominal pain evaluation for adults, or due to the lack of a critical mass of skilled sonographers. Some investigators reported that ultrasound was found to be less reliable in two adult patient case series and suggested bowel edema, air-fluid levels, and larger fecal loads as potential reasons⁽³⁰⁾. However, in a European retrospective multicenter case series, sonographers with ‘basic skill sets’ detected 63.6% of intussusceptions in adults on initial evaluation, while experts detected 91.7%⁽³¹⁾.

Regarding treatment, pneumatic decompression is sufficient to treat about 80% of pediatric cases with no further intervention. For adults, surgical intervention is often needed because of the frequency of malignancies, but also because benign neoplasms or adhesions causing intussusception have a tendency to cause persistent symptoms such as obstruction, vascular compression and bowel ischemia, especially if the length of the intussusciens is greater than 3.5 cm⁽²⁰⁾. Up to 20% of adult intussusceptions are idiopathic and often transient, frequently resolving spontaneously without intervention^(10,11,20,21).

Sonographic approach

Ultrasound examination for pediatric intussusception is a well-established technique. The majority of pediatric intussusceptions are ileocolic and can usually be localized using a high frequency linear probe due to less required depth. In adults, the location might be highly variable and at a greater depth. Therefore, most investigators recommend that the entire abdomen is systematically imaged with a curvilinear probe first, followed by a linear probe and graded compression^(23,32). In our institution, adult gastrointestinal PoCUS can be performed using either a comprehensive anatomical 4-step approach or a symptom-based abbreviated exam. These approaches are modified versions of previously described scanning protocols by Hollerweger *et al.* and Puylaert (Fig. 1) and tailored to the point-of-care setting^(32,33).

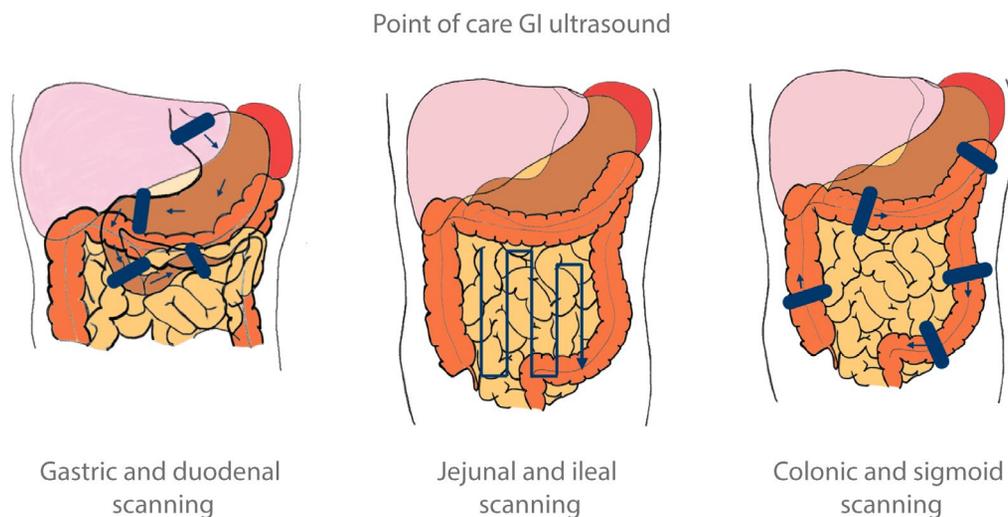


Fig. 1. Transducer positions and scanning concept (arrows) for gastrointestinal ultrasound. Modified after Hollerweger *et al.*⁽³³⁾

The telescoped bowel is typically visualized with a hypoechoic (dark) outer layer and a hyperechoic (bright) inner layer. This finding has been described as the “target sign” and “crescent in a donut sign” in transverse or short axis views, and the “pseudo kidney sign” in long axis views (Fig. 2, Fig. 3, Fig. 4, Fig. 5).

Systematic anatomical approach

Using the systematic anatomical approach, a four-part examination starts with the curvilinear transducer and quickly screens the gastroesophageal junction, the gastrum including cardia, antrum, pylorus and the segments of the duodenum through the ligament of Treitz region. Transducers are oriented transversely and longitudinally to the axis of the viscous structure. In the second step, jejunum and

ileum are scanned in a systematic “up and down” pattern, covering the area of the abdomen. Third, the large bowel, including cecum, colon and sigmoid are scanned following their anatomical location (Fig. 1). As the final step, a high frequency transducer is applied over the area of interest or maximum pain, and scanning should include graded compression techniques as originally described by Puyleart to maximize visualization of intestines over specific areas of interest⁽³²⁾. For trained operators, this type of gastrointestinal point-of-care exam should not take more than 5–10 minutes, depending on the presence of pathology. Trained operators with basic experience had detection rates of over 64%, and experienced operators had excellent detection rates in adults of 91%⁽³¹⁾. However, given the variety of potential pathologies such as ileus, colitis, diverticulitis or appendicitis, we recommend PoCUS training, including these common pathologies as well following suggested education practices⁽³⁴⁾.

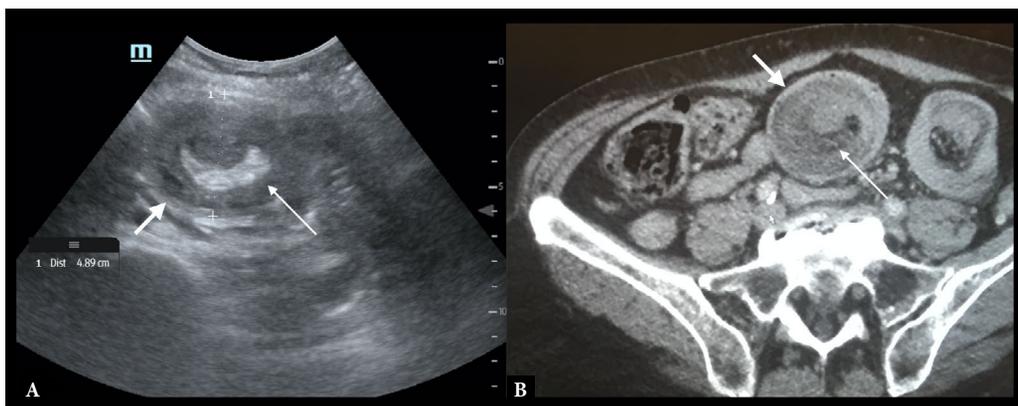


Fig. 2. A. Sonographic image and corresponding CT image B. with jejunal intussusception in transverse view showing outer intussusciens (thick arrow) and central intussusceptum (thin arrow)

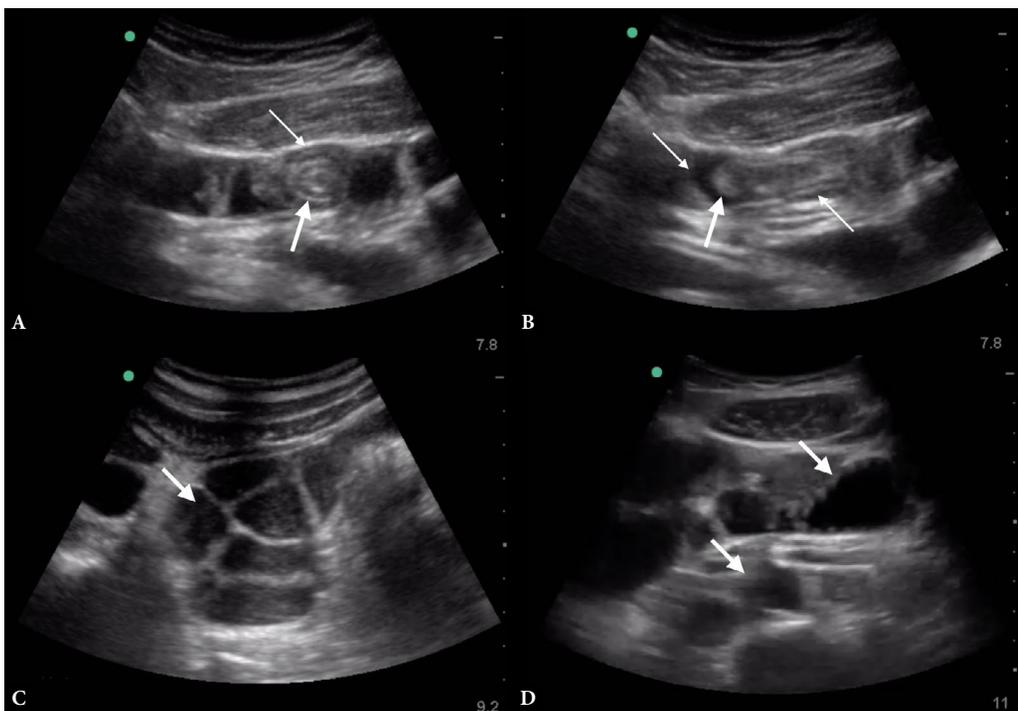


Fig. 3. A. Ileo-ileal intussusception in transverse and B. longitudinal view with outer intussusciens (thin arrow) and central intussusceptum (thick arrow). C, D. Mildly dilated bowel loops with very early sonographic ileus (arrows)

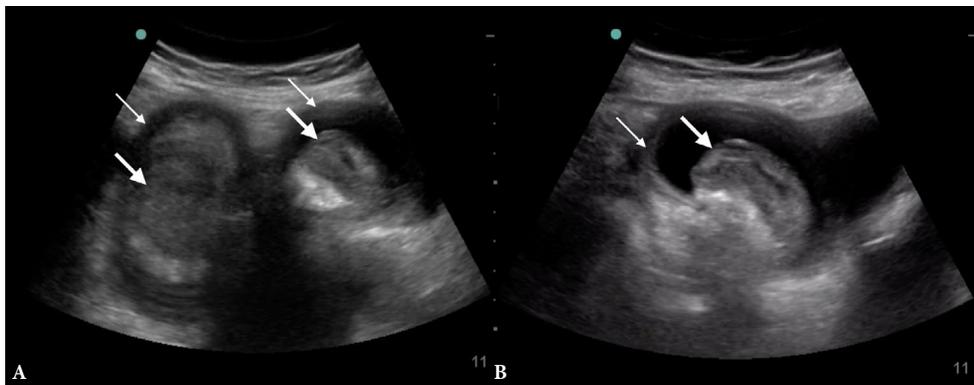


Fig. 4. Showing the ileo-colic intussusception site with outer intussusciptions (thin arrow) and central intussusceptum (thick arrow)

Symptom-based approach

For the symptom-based approach, the operator usually shortens the exam and focuses on the specific area of abdominal tenderness, thereby only identifying anatomical structures in the area of pain or symptoms rather than the entire abdominal intestinal tract. The patient can be asked to “self-localize” the area of initial or maximum symptoms, and curvilinear followed by additional high frequency transducers are used. This technique might be perceived as faster and more in tune with the rapid rhythm of acute care and emergency medicine practice. However, we believe that the abbreviated approach can only be successful if the comprehensive approach is already mastered. We recommend to start training in the systematic approach as it provides greater overview and hindsight, and utilize the focused approach with progressing skill level. However, further research is required to substantiate our approach.

Common clinical presentations and sonographic findings

We present four cases of adult intussusception in which the initial diagnosis was made by trained emergency physicians using PoCUS. This case series was approved by the local IRB.

Case 1

A 61-year-old female with a past medical history significant for a remote Roux-en-Y and chronic back pain on opiates, presented to the emergency department with acute onset of diffuse abdominal pain and nausea. The pain started that morning. It was diffuse and crampy, and she had not experienced similar pain in the past. On exam, her abdomen was soft with diffuse mild tenderness, but she reported out-of-proportion abdominal pain in comparison with her exam tenderness. PoCUS was performed by an emergency physician and showed a target sign in the periumbilical region with an outside diameter approaching 5 centimeters, suggesting intestinal intussusception (Fig. 2). A CT scan was obtained to further evaluate this finding and confirmed a long segment intussusception at the jejunojunction anastomosis. Surgery was consulted and the patient was transferred to a facility that performed her Roux-en-Y. Following transfer, the patient was brought to the operating room for laparoscopic evaluation. The intussusception was identified 20 centimeters distal to the jeju-

nojejunostomy anastomosis, found to be 8 centimeters long, and was reduced surgically with ensuing partial small bowel resection. The patient recovered well and was discharged 4 days postoperatively.

Case 2

A 38-year-old male with no significant past medical history presented with three hours of mid-abdominal crampy pain and nausea. PoCUS was performed by an emergency physician (EP) and revealed a small bowel segment with a target sign in the periumbilical region at the exact location of the patient’s pain, suggesting ileo-ileal intussusception (Fig. 3). Abdominal and pelvic CT scans confirmed the diagnosis. Surgery was consulted, and while the patient was under observation, all symptoms resolved. A repeat ED PoCUS ultrasound confirmed the resolution of the intussusception (Fig. 3). After further monitoring in the emergency department and serial exams, the patient remained asymptomatic and was deemed stable for discharge to close outpatient follow-up with the clinical diagnosis of transient small bowel intussusception.

Case 3

A 71-year-old female with a past medical history significant for hypertension presented with 12 hours of intermittent left lower quadrant abdominal pain and nausea. She had been evaluated at an outside hospital for abdominal pain the day before. She was discharged after her symptoms had improved and an abdominal and pelvic CT showed no acute findings. Interestingly, the patient reported that by the time she had her CT scan, her symptoms had improved. Her abdominal pain recurred shortly after she got back home. After 12 hours of recurrent persistent pain she presented to our facility for “a second opinion”. The patient was afebrile and had stable vital signs. Her exam revealed a soft abdomen but with significant tenderness of her right lower abdomen with guarding and rebound tenderness. PoCUS was performed by the emergency physician (EP) and showed a prominent ileocecal intussusception with significant bowel wall edema, sedimentation of bowel content with concern for bowel ischemia (Fig. 4). The patient was started on intravenous fluids, and surgery was emergently consulted. After reviewing the ultrasound images at bedside, the patient was directly taken to the operating room for exploratory surgery and a partial resection of the ileocecal junction with end-to-end anastomosis was performed after intra-

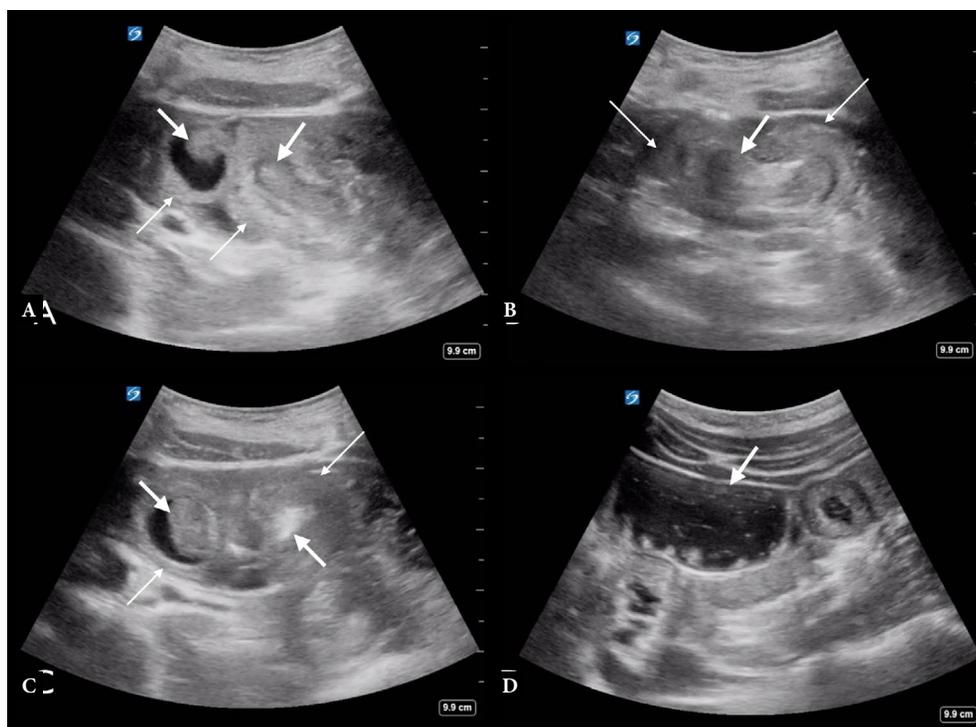


Fig. 5. A–C. Showing intussusception site with outer intussusciens (thin arrow) and central intussusceptum (thick arrow). D. with dilated bowel loops (arrow) and early sonographic ileus

operative confirmation of her ileocecal intussusception with bowel necrosis. Interestingly, no malignancy, masses or other pathologic changes were identified. The patient had an uneventful postoperative course and was eventually discharged to outpatient management.

Case 4

A 31-year-old female with a complex bariatric surgical history including a sleeve gastrectomy converted to RYGB and hiatal hernia repair one year prior, presented to the ED with two hours of acute-onset severe “twisting” epigastric abdominal pain radiating to her back. This pain woke her from sleep and was constant with nausea, but no vomiting. A week prior she reported a two-day inpatient admission for an episode of left lower abdominal pain and one event of a bloody stool. All symptoms resolved and she was discharged with a diagnosis of gastroenteritis. Now she reported not being able to pass flatus and no stool for four days. The patient was significantly tender over her epigastric and mid-abdomen with guarding and rebound tenderness indicating acute abdomen. PoCUS performed by the EP showed intestinal obstruction and small bowel jejunal intussusception in the upper abdomen (Fig. 5). The patient was started on intravenous fluids and pain management. Pre-operative labwork was obtained. An emergent surgery consult was initiated for suspected bowel obstruction due to high-grade intussusception. Subsequent CT imaging revealed a long segment of ileo-ileal intussusception with the jejuno-jejunostomy anastomotic site acting as the leading point. She underwent an exploratory laparotomy the following day, at which time the intussusception had spontaneously reduced. No abnormal intra-operative findings were noted. Her diet was advanced and she had an uneventful post-op course and was discharged several days later.

Discussion

In recent years, gastrointestinal point-of-care ultrasound has been introduced into the training repertoire of acute care and emergency medicine specialists⁽³⁴⁾. This launched an expansion of PoCUS into diagnoses such as ileus, colitis, appendicitis, evaluating pathways to complement or substitute the common approach of diagnostic MDCT use and radiation exposure. Still, an estimated 25–40% of patients presenting to emergency departments with acute abdominal pain are discharged without a diagnosis, but not every patient presenting should or will receive diagnostic CT imaging^(35,36). This could present an opportunity for PoCUS use.

Furthermore, recent advancements in CT technology have resulted in an upsurge in the detection of adult intussusception, including cases that are asymptomatic, intermittent, or without an identifiable leading point⁽²⁵⁾. The increase in CT sensitivity suggests that adult intussusception may be more common than we typically think. Until recently, our epidemiology knowledge of adult intussusception has been based primarily on older generation CT studies and/or studies based on surgical evidence. Now, with more sensitive cross-sectional imaging available, it is likely that milder cases or even asymptomatic or transient cases will be detected more frequently.

Many adult patients may still require surgery, but some may be candidates for expectant management and serial exams, making these patients ideal candidates for sonographic monitoring. When developing management approaches for this wide spectrum of diseases, incorporating point of care ultrasound should be considered, especially for a patient cohort that includes previously undetected cases of mild or transient intestinal intussusception. PoCUS could bring additional diagnostic value to patient management. This was

highlighted in case two, where PoCUS was able to demonstrate the resolution of the intussusception, supporting serial clinical exams.

Conclusion

New research suggests that adult intussusception is an under-recognized condition that may present with vague symptoms and may be intermittent and transient, making it a difficult diagnosis. In adults, sonographers with basic skills have been shown to detect nearly 2/3 of cases in a prospective multicenter study, while experts detected more than 91%⁽³¹⁾. The typical ultrasound signs found in pediatric patients are the same as those found in adults. While sonographic sensitivity has not been established to be high enough to reliably rule out intussusception, a positive ultrasound in an adult patient should be highly suggestive of this diagnosis.

PoCUS for diagnosis of bowel abnormalities such as suspected ileus, colitis, appendicitis, or perforated viscous has become a core emergency ultrasound application. Its use will likely continue to increase, and intussusception diagnosis should be incorporated into training. Although an uncommon diagnosis, it might be more common

than currently thought. Further research is needed to establish the true frequency of use and accuracy of PoCUS for adult intussusception. PoCUS should be considered as an initial imaging modality in any patient who presents with vague or undifferentiated abdominal symptoms.

Conflict of interest

The authors do not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

Author contributions

Original concept of study: BH. Writing of manuscript: DGT, DSB, BH. Analysis and interpretation of data: DGT, DSB, JMS, BH. Final acceptance of manuscript: DGT, JMS, BH. Collection, recording and/or compilation of data: DSB, BH. Critical review of manuscript: DGT, DSB, JMS, BH.

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