

Role of Ultrasonography in Diagnosis of Pediatric Bowel Diseases

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ABSTRACT

Background: While conventional radiography remains a diagnostic option for pediatric intestinal disorders, non-invasive ultrasonography (US) provides a quick, dynamic, and radiation-free alternative. US is favored for its safety, reproducibility, and minimal need for anesthesia. **Objective:** was to outline the ultrasonographic criteria of different bowel diseases in pediatric age group and emphasize their role in evaluation of patients.

Patients and Methods: 31 children with clinically suspected bowel disease (18 males and 13 females; ages ranging from birth to 18 years) were recruited from the emergency rooms of Menoufia University and Al-Ahrar Teaching Hospitals for this prospective study (April 2023–December 2024). Standardized laboratory work-up, abdominal ultrasonography using linear and convex probes, and Doppler interrogation were performed on all patients. Surgery (22 patients), endoscopy, and histopathology (5 individuals) were used to reach final diagnosis.

Results: Among 31 patients, vomiting (77.4%) and abdominal pain (58.1%) were the most common symptoms. Ultrasonography mainly detected appendicitis (41.9%) and intussusception (16.1%). Final diagnoses were confirmed in 27 patients, with appendicitis being most frequent (40.7%). Ultrasound showed 100% sensitivity, 50% specificity, and 93.5% overall accuracy.

Conclusion: US is an exceptional, non-invasive first-line imaging method for children with gastrointestinal diseases, eliminating the disadvantage of ionizing radiation. It provides repeatable diagnosis and follow-up for a variety of disorders, notwithstanding the need for operator dependence.

Keywords: Ultrasonography, Pediatrics, Bowel diseases, Gastrointestinal disorders.

INTRODUCTION

For a long time, traditional radiography techniques have been essential in the diagnosis of intestinal disorders. Over the past few decades, the diagnosis of the GI tract has changed due to the introduction of non-invasive cross-sectional imaging techniques such as magnetic resonance imaging (MRI), computed tomography, positron-emission tomography, and ultrasound ⁽¹⁾. Bowel ultrasonography is affordable, somewhat fast, free of radiation, enables dynamic bowel exploration, is well-tolerated by patients, and permits repeat imaging ⁽²⁾. The absence of ionizing radiation and the brief examination duration, which avoids the need for sedation, are two obvious advantages of using ultrasonography to imaging children ⁽³⁾.

For almost ten years, children's intestinal disease, including intussusceptions, appendicitis, and hypertrophic pyloric stenosis, has been assessed using focused ultrasonography ⁽⁴⁾. MRI and ultrasonography (US) are increasingly being used as the first line investigation, even though CT and fluoroscopic studies are still the gold standard. This is especially true when imaging patients with inflammatory bowel disease, where repeat imaging to track disease activity is helpful, but the combined radiation dose from CT and fluoroscopic examinations is alarming ⁽⁵⁾. However, the diagnostic accuracy of the results depends on the operator ⁽⁶⁾. In contrast, ultrasonography enables dynamic evaluation of the stomach and can be employed in the acute context ⁽⁵⁾.

This study's aim was to outline the ultrasonographic criteria of different bowel diseases in pediatric age group and emphasize their role in evaluation of patients.

PATIENTS AND METHODS

This prospective clinical study was carried out on 31 children who were clinically suspected to have bowel pathology. The cohort included 18 boys and 13 girls, with ages ranging from the neonatal period up to 18 years. All participants were referred from the Emergency Department to the Radiodiagnosis and Interventional Imaging Units of Menoufia University and Al-Ahrar Teaching Hospital, Zagazig, during the period from April 2023 through December 2024.

Eligibility criteria: Children from birth to 18 years with clinical suspicion of bowel disease were recruited. Patients older than 18 years or those with a prior surgical history for bowel disease were excluded.

Every patient underwent the same diagnostic protocol, which included detailed clinical history, relevant laboratory investigations, and ultrasonography with Doppler assessment.

History and examination: Information was collected from medical records, covering demographic details, present and past illnesses, and clinical examination findings. For analysis, children were stratified into the

following age categories: newborn (birth to <1 month), infant (1 month–<1 year), toddler (1–<3 years), preschool (3–<6 years), school-age (6–<12 years), and adolescent (12–<18 years) ⁽⁷⁾.

Laboratory evaluation: Special attention was directed toward complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP).

Ultrasound technique:

All participants underwent abdominal ultrasonography with Doppler evaluation. No specific preparation was required for younger children, though parents were instructed to stop feeding prior to the examination. Adolescents, however, were asked to fast for 4–6 hours and to hydrate adequately with a full bladder to enhance visualization of the stomach and duodenum in the decubitus position, which allows better detection of gastric and duodenal wall lesions.

The scans were performed using GE Healthcare Logiq P7 (GE Healthcare, Chicago, IL, USA) and Toshiba Aplio 500 Platinum (Toshiba Medical Systems Corporation, Tokyo, Japan) ultrasound systems, equipped with linear (7–15 MHz) and convex (3.5–5 MHz) probes. A graded compression technique was applied to minimize the distance between probe and target by displacing gas- and fat-filled loops. Patients were examined in the supine position, with decubitus positioning added if upper gastrointestinal pathology was suspected.

Initial evaluation of abdominal solid organs was performed with the convex probe (3.5–5 MHz) to rule out alternative pathology. Thereafter, the small and large intestines were scanned in both longitudinal and transverse planes. A high-frequency linear probe (7–15 MHz) was then employed, beginning at the terminal ileum and ileocecal junction and following the bowel across to the left iliac fossa. The examination included assessment of bowel wall thickness, luminal diameter, motility, compressibility, intraluminal contents, and extraintestinal changes such as mesenteric fat stranding, lymphadenopathy, peritoneal involvement, and vascular alterations.

The cecum was identified in the right iliac fossa by the presence of fecal material, acoustic shadowing, and absent peristalsis. Scanning was extended distally to the proximal sigmoid colon, with rectal evaluation aided by bladder filling. The terminal ileum was traced from the cecum proximally, while the jejunum was recognized by its characteristic valvulae conniventes, in contrast to the smoother walls and reduced peristalsis of the ileum.

The mesentery was examined with the linear probe (7–15 MHz) to detect fluid collections, abscesses, and lymph node enlargement.

Finally, Color and Power Doppler techniques were utilized to assess vascularity within abnormal bowel

segments and to visualize mesenteric and intramural vessels. Settings were optimized for slow-flow detection in small vessels by applying low wall filters, the lowest possible pulse repetition frequency to avoid aliasing, and maximal gain.

Final diagnosis:

The diagnosis was finally made by surgery in 22 patients and by endoscopy, biopsy, and histopathology in 5 patients.

Ethical approval

Approval for the study was granted by the Ethical Committee of the Faculty of Medicine, Menoufia University. Written informed consent was obtained from the caregiver of each participants. The research complied with the ethical standards of the Declaration of Helsinki for human studies.

Statistical analysis

Data analysis was performed using SPSS version 26, with qualitative data presented as frequencies and percentages. Diagnostic validity measures including sensitivity, specificity, positive predictive value, negative predictive value, and accuracy were calculated.

RESULTS

We found that more than one presentation was present in the same patient. Vomiting was the most common presentation, it was found in 24 (77.4 %) patients, followed by abdominal pain that was found in eighteen (58.1%) patients. These data are summarized in the following **table1**.

Table 1: Clinical presentation of study population

Clinical presentation	Number (31)	Percentage%
Vomiting	24	77.4
Abdominal Pain	18	58.1
Fever	11	35.5
Blood in Stool	11	35.5
Delayed Meconium	4	12.9
Abdominal Distention	9	29.0

Ultrasonography and Doppler examination could diagnose mainly appendicitis in 13 (41.9%) patients and intussusception in 5 (16.1%) patients. The following **table 2** summarizes these data:

Table (2): Ultrasonographic and Doppler diagnoses in 31 patients:

US diagnoses	Number	percentage (%)
Positive		
Appendicitis	13	41.9%
Intussusception	5	16.1%
Duodenal atresia	2	6.5%
Inflammatory Bowel Disease (IBD)	2	6.5%
Malrotation / Midgut volvulus	2	6.5%
Necrotizing Enterocolitis (NEC)	1	3.2%
Intestinal lymphoma	1	3.2%
Terminal ileitis	3	9.7%
Negative	2	6.5%
Total	31	100%

The final diagnoses of the studied cases were established in 27 out of 31 patients (87.1%), while 4 cases showed no definitive diagnosis. Surgical exploration confirmed the diagnosis in 22 patients (81%), of whom 11 (50%) had appendicitis, 4 (18%) had intussusception, 3 (13.6%) had malrotation or midgut volvulus, 2 (9%) had duodenal atresia, and 2 (9%) had necrotizing enterocolitis. Endoscopic and histopathological evaluation confirmed diagnoses in 5 patients (18.5%), including inflammatory bowel disease in 2 (40%), terminal ileitis in 2 (40%), and intestinal lymphoma in 1 (20%). **Table (3)** summarizes these findings.

Table (3) Confirmed diagnoses and diagnostic methods in the studied patients:

Final Diagnosis	Surgical (n = 22, 81%)	Endoscopy / Histopathology (n = 5, 18.5%)	Total (n = 27)	% of Confirmed Cases
Appendicitis	11	—	11	40.7%
Intussusception	4	—	4	14.8%
Malrotation / Midgut Volvulus	3	—	3	11.1%
Duodenal Atresia	2	—	2	7.4%
Necrotizing Enterocolitis (NEC)	2	—	2	7.4%
Inflammatory Bowel Disease (IBD)	—	2	2	7.4%
Terminal Ileitis	—	2	2	7.4%
Intestinal Lymphoma	—	1	1	3.7%
Total (Positive)	22	5	27	100%
Negative Findings	—	—	4	—
Overall Total			31	

Table 4: summarizes the performance of ultrasound (US) in diagnosing a condition, showing strong sensitivity and high diagnostic accuracy. With 100% sensitivity, ultrasound correctly identified all confirmed positive cases, ensuring no false negatives. The 50% specificity indicates a higher rate of false positives, meaning some negative cases were incorrectly identified as positive.

The positive predictive value (PPV) of 93.1% means that when ultrasound results are positive, there is a high likelihood the patient actually has the condition. Additionally, the 100% NPV confirms that negative results are always accurate. Overall, the accuracy of 93.5% highlights that ultrasound performs well in diagnosing the condition, though improvements in specificity could reduce false positives.

Table (4) Validity of US in prediction of different bowel diseases in pediatric

	US Positive	US Negative	Total	Sensitivity	Specificity	PPV	NPV	Accuracy
Confirmed Positive	27	0	27	100%	50%	93.1%	100%	93.5%
Confirmed Negative	2	2	4					
Total	29	2	31					

US = Ultrasound; PPV = Positive Predictive Value; NPV = Negative Predictive Value.

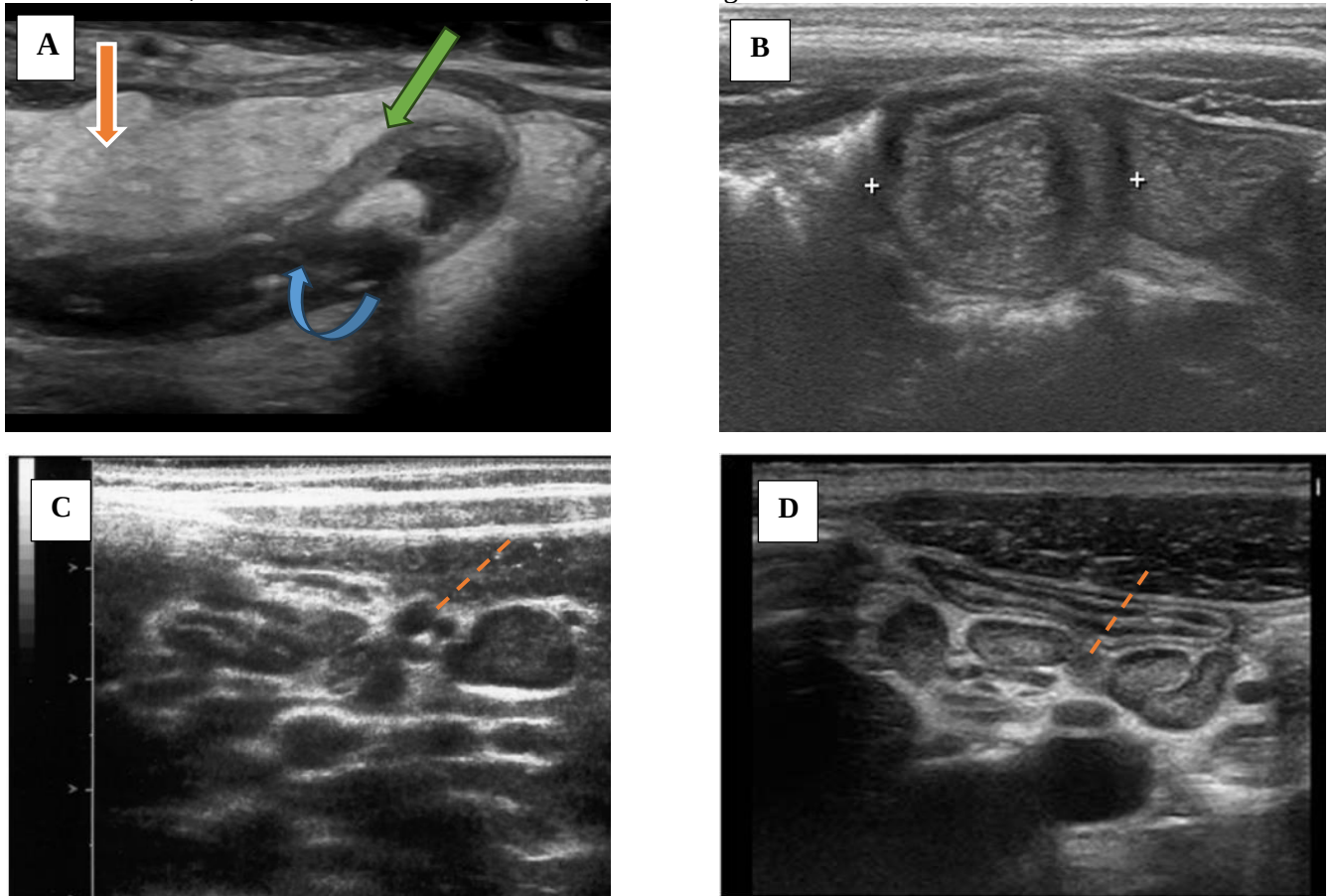


Figure (1) showing the inflamed appendix (green arrow), surrounded by echogenic fat (orange arrow) and hyper echoic focus seen at its tip representing appendicolith (curved blue arrow), reactive mesenteric Lymph Nodes (LNs)were also detected (C and D).

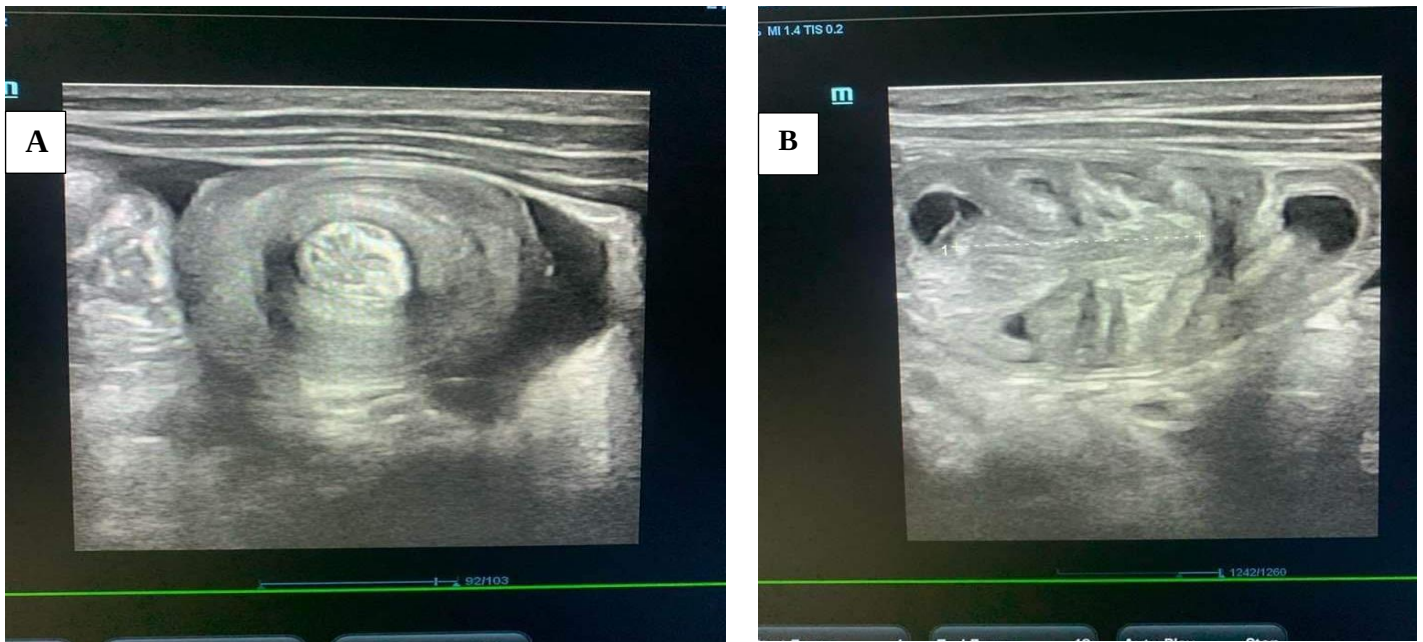


Figure (2): Ultrasound features of intussusception. Transverse section (A) demonstrates the characteristic “doughnut sign”, while longitudinal section (B) shows the “pseudokidney sign.”

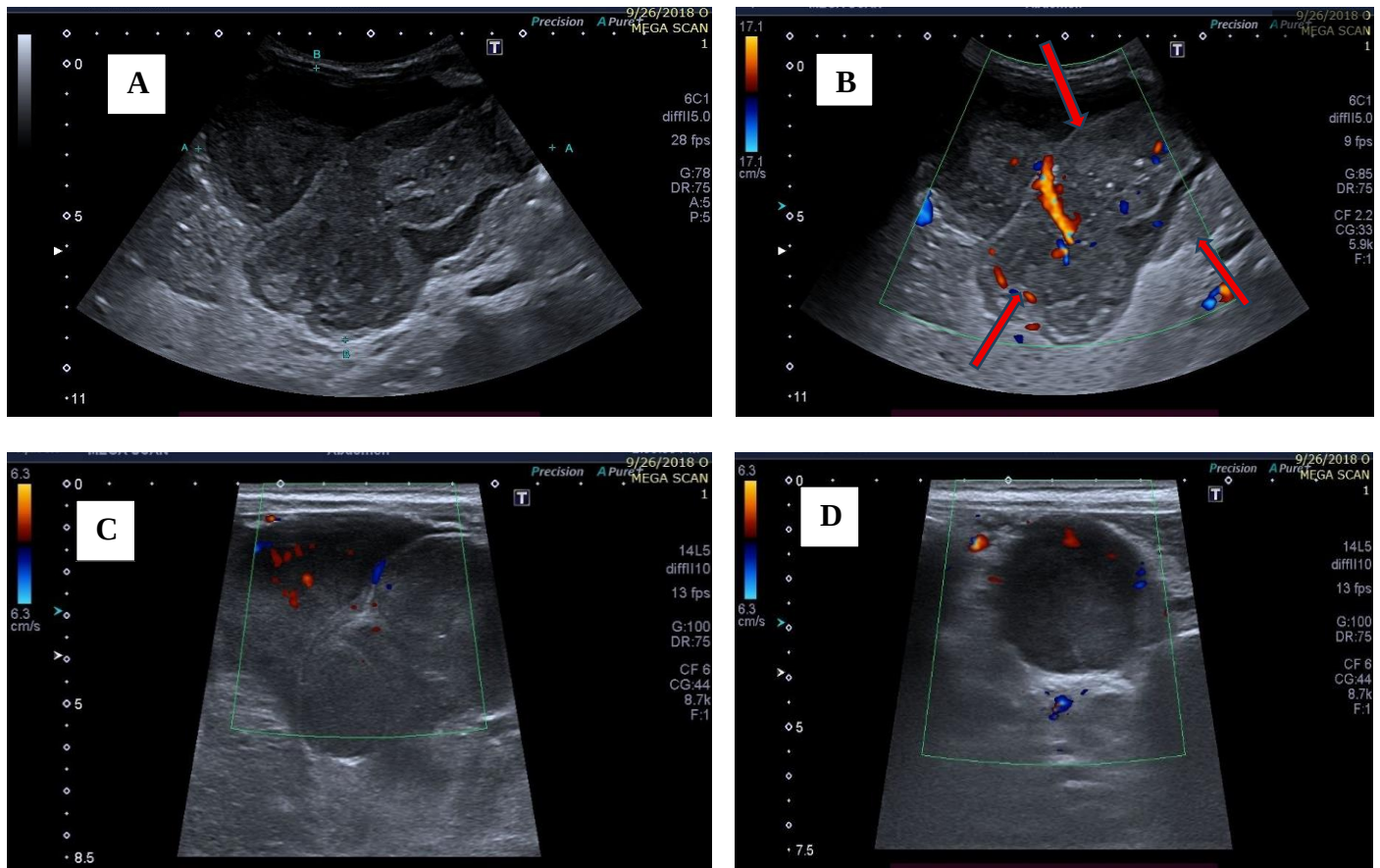


Figure (3) Gray scale US images with Doppler interrogation (A, B) show bowel wall thickening with intramural hypervascularity (red arrows), multiple enlarged amalgamated suspicious mesenteric LNs (C), rounded suspicious mesenteric LN with lost hilum (D), ultrasonographic diagnosis was intestinal lymphoma and the diagnosis was confirmed by endoscopy and histopathology.

DISCUSSION

Although non-invasive cross-sectional imaging techniques like ultrasound, CT, PET, and MRI have revolutionized gastrointestinal examination, traditional radiographic approaches have always been important in the diagnosis of bowel disorders. Bowel ultrasonography is one of these, with the benefits of being rapid, cheap, radiation-free, repeatable, and well-tolerated, particularly in children who are not subjected to anesthesia or ionizing radiation ⁽⁷⁾.

Targeted ultrasound has been used extensively for more than ten years to diagnose intestinal diseases in children, such as hypertrophic pyloric stenosis, appendicitis, and intussusception. Even while CT and fluoroscopy are still considered gold-standard procedures, MRI and ultrasound are becoming more and more popular as first-line methods due to the high radiation dose of CT and fluoroscopy, especially for inflammatory bowel disease that needs frequent monitoring. However, the diagnostic accuracy of ultrasound is still operator dependent, even with its advantages and dynamic assessment capacity in acute conditions ⁽⁸⁾.

In the present study, vomiting represented the predominant clinical feature, occurring in 77.4% of cases, followed by abdominal pain in 58.1% and either fever or the passage of red stool in 35.5% of patients. In contrast, **Khater et al.** ⁽⁹⁾ noted that abdominal pain was the most frequent symptom, affecting 95% of their cohort, while 37% developed ileus, 41% reported diarrhea, 17% presented with hematochezia, 63% experienced vomiting, 29% had fever, and 44% exhibited deterioration in their general condition. Similarly, **Banoub et al.** ⁽¹⁰⁾ found abdominal pain to be the leading manifestation, observed in 94.6% of cases, followed by right lower quadrant pain in 35.1%, ileus in 16.1%, diarrhea in 31.7%, hematochezia in 13.7%, vomiting in 69.8%, fever in 30.7%, and poor general condition in 49.8%.

Ultrasound was highly reliable in evaluating disease activity, with findings closely aligned with histopathological outcomes for active inflammation. When compared with CT enterography, ultrasound demonstrated greater sensitivity in identifying bowel wall thickening, subtle mesenteric hypervascularity, and minimal intraperitoneal fluid ⁽¹¹⁾.

In our analysis, 93.5% of patients had positive ultrasound results, with the most prevalent diagnosis being appendicitis (41.9%), followed by intussusception (16.1%) and terminal ileitis (9.7%).

With several benefits, including safety, non-invasiveness, good patient tolerance, and the capacity to do dynamic, real-time assessments at the site of symptoms, our study showed that ultrasound is a very useful tool in the evaluation of pediatric bowel illnesses. Ultrasound has several advantages, but one major drawback is that it is very operator-dependent; the

sonographer's expertise and experience have a big impact on the diagnostic accuracy ⁽¹³⁾.

However, when it came to diagnosing the presence, severity, and activity of inflammatory bowel disease (IBD) in children, ultrasound performed diagnostically equivalent to clinical evaluations, pathology findings, and CT enterography. Furthermore, it was successful in identifying a number of additional gastrointestinal disorders, all of which were surgically verified, including intussusception, appendicitis, and bowel obstruction ⁽¹²⁾.

Ultrasound was more successful than CT enterography in detecting modest but significant characteristics such as tiny fluid collections, enhanced mesenteric vascularity, and accurate measurements of the intestinal wall. Our findings are in line with past research that backs the use of intestinal wall thickness as a trustworthy indicator of disease activity, particularly in Crohn's disease. Thus, ultrasound provides a radiation-free, non-invasive way to assess children's health, which makes it particularly helpful for follow-up ⁽¹⁴⁾.

Furthermore, ultrasound-guided hydrostatic reduction was shown to be a simple, rapid, cost-effective, and highly successful treatment method, particularly when patients were carefully selected and complications were minimal. **Kelley-Quon et al.** ⁽¹⁵⁾ support these findings, reporting that intussusception often presents with abdominal pain, vomiting, and sometimes bloody stools, with ultrasound typically revealing a "target" or "doughnut" sign as the diagnostic hallmark.

Beyond inflammatory and acute conditions, ultrasound has also emerged as a valuable tool for diagnosing less common entities such as intestinal malrotation. This diagnosis often relies on assessing the relationship between the superior mesenteric artery (SMA) and vein (SMV), where the presence of the "whirlpool sign" in volvulus cases has been shown to provide high diagnostic sensitivity ⁽¹⁶⁾.

Our findings align with previous studies that emphasize the growing role of ultrasound in small bowel disease evaluation. Optimal sonographic technique, including adjustments to machine settings and the use of graded compression, enabled detailed examination of the entire bowel. Compared to CT and MRI, ultrasound offers several advantages including cost-effectiveness, superior spatial resolution, and real-time imaging capabilities. In pediatric patients and early pregnancy, ultrasound is often the preferred imaging modality due to the increasing need for radiation-free diagnostic techniques. Additional insights were gained through advanced applications such as color Doppler imaging, microbubble contrast agents, and newer methods to assess the mechanical properties of the bowel wall ⁽¹⁷⁾.

Ultrasound demonstrated excellent diagnostic performance in identifying pediatric bowel diseases, with 100% sensitivity and 100% negative predictive value, and an overall accuracy of 93.5%. These results highlight that ultrasound is a highly reliable tool for ruling out bowel pathology in children, supporting its use as a first-line diagnostic modality in this population.

Similarly, **Refaat et al.** ⁽¹⁸⁾ revealed that validity of US in prediction of different bowel diseases in pediatric as sensitivity of US is 85, specificity is 100 and accuracy is 88.3. Ultrasound was proven to have a major role in different bowel diseases diagnosis in children; especially that it is considered a safe procedure that does not cause non-ionizing radiation exposure. Also, it helps rapid diagnosis without the need for prolonged special preparations.

Khater et al. ⁽⁹⁾ confirmed that, ultrasonography is a key imaging tool for the evaluation of acute abdominal pain, especially in young patients, for whom a satisfactory examination is occasionally impossible

van Wassenae et al. ⁽¹²⁾ yielded 276 records of which 14 were included. The sensitivity and specificity of US ranged from 39-93% and 90–100% for diagnosing *de novo* IBD, and 48–93% and 83–93% for detecting active disease during follow-up, respectively.

Sanchez et al. ⁽¹⁹⁾ reviewed the sonographic characteristics of acute appendicitis, along with the sonographic features of other conditions that may mimic appendicitis, such as mesenteric adenitis/gastroenteritis, intussusception, Meckel diverticulum, and ovarian torsion. The study concluded that sonography is a safe imaging modality that can effectively distinguish between the common causes of abdominal pain in pediatric patients ⁽¹⁹⁾.

While ultrasound is a promising technology, its function can be influenced by factors such as operator experience, patient compliance, and obesity, which can interfere with ideal imaging. Additionally, ultrasound may be limited in the detection of deep or subtle lesions, particularly in the proximal small bowel or in early disease patients ⁽¹⁴⁾.

In **Hajalioghli et al.** ⁽²⁰⁾ study of 121 children, there were 54 (44.6%) true positive and 62 (51.2%) true negative based on sonographic findings. Based on the findings of ultrasound in this study, ultrasound sensitivity was 96.4%, specificity was 95.3%, positive predictive value was 94.7%, and negative predictive value was 96.8%.

However, **Pedram et al.** ⁽²¹⁾ included a total number of 230 children with clinical diagnosis of acute appendicitis. The sensitivity and specificity of ultrasound in these children were 58% and 68%, respectively. Positive and negative predictive values were 77% and 46%, respectively. The area under curve (AUC) was

0.853 (CI 95% 0.788-0.917) indicating a test with moderate accuracy.

The study had a sample of only 31 pediatric patients, which limits the power and generalizability of the findings, and was conducted at only two Egyptian hospitals that might not be representative of other patient populations or practices in other regions.

CONCLUSION

The study concluded that ultrasound is an extremely valuable, non-invasive, highly sensitive diagnostic modality in diagnosis of pediatric bowel diseases with high diagnostic accuracy. It was morphologically excellent in detecting different pathological features of different bowel diseases.

Ultrasonography with Doppler was very effective in detecting underlying bowel conditions, the most common of which were appendicitis and intussusception. Most diagnoses were validated by surgical or endoscopic evaluation. With the excellent ultrasound sensitivity in detecting most of the different conditions of different pediatric bowel diseases, thus ultrasound is a valuable first-line imaging modality in diagnosing bowel diseases and emergencies in children, however correlation with clinical and further diagnostic workup is required to confirm equivocal results.

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REFERENCES

1. **Acord M, Dennis R, Srinivasan A et al. (2023):** Radiologic evaluation of pediatric inflammatory bowel disease. *Pediatr Inflamm Bowel Dis.*, 255-266.
2. **Kellar A, Dolinger M, Novak K et al. (2023):** Intestinal ultrasound for the pediatric gastroenterologist: a guide for inflammatory bowel disease monitoring in children: expert consensus on behalf of the International Bowel Ultrasound Group (IBUS) Pediatric Committee. *J Pediatr Gastroenterol Nutr.*, 76 (2): 142-148.
3. **Dell'Era A, Cannatelli R, Ferretti F et al. (2023):** Relevance of sonographic parameters for inflammatory bowel disease in children. *J Ultrasound*, 26 (4): 815-822.
4. **Gilja O, Nylund K (2023):** Point-of-care ultrasound of the gastrointestinal tract. *J Med Ultrasound*, 31 (1): 1-7.
5. **Ponorac S, Dahmane Gošnjak R, Urlep D et al. (2023):** Diagnostic value of quantitative contrast-enhanced ultrasound in comparison to endoscopy in children with Crohn's disease. *J Ultrasound Med.*, 42 (1): 193-200.
6. **Cortellini F, Fichera A, Guarino A et al. (2025):** Abdominal and bowel ultrasound knowledge among young gastroenterologists: Results of an Italian survey. *J Clin Med.*, 14 (8): 2693.

7. **van Wassenae E, de Voogd F, van Rijn R et al. (2020):** Bowel ultrasound measurements in healthy children - systematic review and meta-analysis. *Pediatr Radiol.*, 50 (4): 501-508.
8. **Sun B, Liu J, Li S et al. (2023):** Imaging of gastrointestinal tract ailments. *J Imaging*, 9 (6): 115.
9. **Khater H, Tawfik M, Mansoor Z (2023):** Ultrasound of the pediatric gastrointestinal emergencies. *Benha J Appl Sci.*, 8 (6): 41-48.
10. **Banoub C, Sobhy T, Elsamak A et al. (2021):** Role of Ultrasound in the assessment of pediatric non-traumatic gastrointestinal emergencies. *EJHM.*, 83: 988-994.
11. **Yuksel I, Kilincalp S, Coskun Y et al. (2019):** Diagnostic accuracy of intestinal ultrasound and magnetic resonance enterography for the detection of endoscopy-based disease activity in ileocolonic Crohn's disease. *Eur J Gastroenterol Hepatol.*, 31 (7): 809-816.
12. **van Wassenae E, de Voogd F, van Rijn R et al. (2019):** Diagnostic accuracy of transabdominal ultrasound in detecting intestinal inflammation in paediatric IBD patients-a systematic review. *J Crohns Colitis*, 13 (12): 1501-1509.
13. **Hoerning A, Jüngert J, Siebenlist G et al. (2024).** Ultrasound in Pediatric Inflammatory Bowel Disease—A Review of the State of the Art and Future Perspectives. *Children*, 11(2): 156
14. **Yigit B, Sezgin O, Yorulmaz E et al. (2022):** Effectiveness and power of abdominal ultrasonography in the assessment of Crohn's disease activity: Comparison with clinical, endoscopic, and CT enterography findings. *Turk J Gastroenterol.*, 33 (4): 294-303.
15. **Kelley-Quon L, Arthur L, Williams R et al. (2021):** Management of intussusception in children: a systematic review. *J Pediatr Surg.*, 56 (3): 587-596.
16. **Nguyen H, Navarro O, Bloom D et al. (2022):** Ultrasound for midgut malrotation and midgut volvulus: AJR Expert Panel Narrative Review. *AJR Am J Roentgenol.*, 218 (6): 931-939.
17. **Steinsvik E, Hatlebakk J, Hausken T et al. (2021):** Ultrasound imaging for assessing functions of the GI tract. *Physiol Meas.*, 42 (2): 024002.
18. **Refaat M, Shalaan A, Mokhtar D (2021):** Ultrasound role in assessment of bowel diseases in pediatrics. *Benha Med J.*, 38 (Special Issue): 128-136.
19. **Sanchez T, Corwin M, Davoodian A et al. (2016):** Sonography of abdominal pain in children: Appendicitis and its common mimics. *J Ultrasound Med.*, 35: 627-635.
20. **Hajalioghli P, Mostafavi S, Mirza-Aghazadeh-Attari M (2020):** Ultrasonography in diagnosis of appendicitis and its complications in pediatric patients: a cross-sectional study. *Ann Pediatr Surg.*, 16 (1).
21. **Pedram A, Asadian F, Roshan N (2019):** Diagnostic accuracy of abdominal ultrasonography in pediatric acute appendicitis. *Bulletin of Emergency & Trauma*, 7(3): 278.