Ultrasonographic Evaluation of Non-Traumatic Gastrointestinal Disorders in Pediatrics

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ABSTRACT
Background: Non-traumatic gastrointestinal (GI) disorders in children are common causes of pediatric hospital visits. Accurate and rapid diagnosis is essential to guide timely intervention. Ultrasound (US) offers a non-invasive, radiation-free, and widely available diagnostic option.
Objectives: To evaluate the role of ultrasonography in the diagnosis of pediatric non-traumatic gastrointestinal disorders.
Methods: This cross-sectional study included 100 pediatric patients (0–16 years) presenting with acute non-traumatic abdominal pain or other GI symptoms. All underwent gray-scale and color Doppler US using curvilinear (3–5 MHz) and linear (8–12 MHz) probes. Diagnostic accuracy metrics were calculated for key conditions.
Results: The cohort comprised 48 males and 52 females (mean age 6.7 ± 5.05 years). Common presentations included abdominal pain (100%), vomiting (46%), and fever (26%). Frequent US findings were free fluid collection (46%) and enlarged mesenteric lymph nodes (28%). Diagnoses included appendicitis (18%), intussusception (12%), hypertrophic pyloric stenosis (12%), small bowel obstruction (4%), mesenteric lymphadenitis (8%), necrotizing enterocolitis (6%), and malrotation with volvulus (4%). US sensitivity, specificity, and accuracy were: appendicitis 90%, 100%, 96.8% (κ = 0.94); intussusception 100%, 100%, 100% (κ = 1.00); hypertrophic pyloric stenosis 100%, 100%, 100% (κ = 1.00); malrotation 100%, 100%, 100% (κ = 1.00). Overall diagnostic performance was 96% sensitivity, 100% specificity, and 93% accuracy (κ = 0.834). Findings were correlated with surgical, laboratory, therapeutic, or further imaging results.
Conclusions: Ultrasonography is a highly accurate, non-invasive diagnostic tool for pediatric non-traumatic gastrointestinal disorders, providing rapid and reliable evaluation that supports timely clinical decision-making.
Keywords: Ultrasonography, Non-Traumatic Gastrointestinal Disorders, Acute Abdomen, Diagnostic Accuracy.

INTRODUCTION

Gastrointestinal (GI) disorders in children are broadly categorized as traumatic and non-traumatic categories. Among these, non-traumatic acute GI disorders are the most frequent reason for visits to Pediatric Emergency Departments. Unlike adults, pediatric patients exhibit a diverse array of possible diagnoses, encompassing both congenital abnormalities and acquired conditions. The causes of acute abdominal presentations vary significantly according to the child's age [1, 2]. Abdominal pain or related abdominal symptoms are among the most common complaints leading children to hospital evaluation. The underlying etiology is influenced partly by age and partly by whether there is a history of prior surgical intervention. Differential diagnoses are wide-ranging and may include acute surgical pathology, intra-abdominal medical disorders, extra-abdominal disease, systemic illness, and functional abdominal pain. The most frequently encountered emergencies include acute appendicitis, intussusception, hypertrophic pyloric stenosis, incarcerated hernia, congenital bowel obstruction, and midgut volvulus due to malrotation [3, 4]. Traditionally, diagnostic evaluation of pediatric GI disorders relied on radiographic modalities such as plain films and contrast examinations. These methods, however, pose certain limitations, including radiation exposure and the need for contrast administration, which may not be suitable in all patients. By contrast, ultrasound (US) is a non-invasive modality that avoids radiation and is widely available in most healthcare systems [5, 6].

For these reasons, the present study focuses on assessing the role of US in diagnosing pediatric non-traumatic GI disorders.

MATERIALS AND METHODS

Design and population:

This cross-sectional study was conducted on one hundred pediatric patients who presented with acute abdomen or other gastrointestinal (GI) symptoms such as diarrhea, vomiting, or bloody stool. The study was carried out in the Diagnostic and Interventional Radiology Department, Menoufia University Hospital, and the Diagnostic Radiology Department at Shibin Elkom Teaching Hospital, over a one-year period from April 2024 to March 2025.

Patient Selection:

The inclusion criteria comprised pediatric patients aged 0–16 years presenting with acute non-traumatic abdominal pain or other gastrointestinal symptoms, including diarrhea, vomiting, or bloody stool. Exclusion criteria included patients older than 16 years and those with abdominal pain secondary to trauma or accident.

METHODS

Clinical and Laboratory Assessment:

All patients underwent a comprehensive clinical evaluation, which included detailed history taking, full physical examination, and relevant routine laboratory investigations.

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Ultrasound Equipment and Examination Protocol:

Ultrasound examinations were performed using a GE LOGIQ P9 or GE Versana Premier ultrasound system, equipped with a curvilinear probe (3–5 MHz) and a multifrequency linear probe (8–12 MHz). Scans were obtained in both longitudinal and transverse orientations. Color Doppler ultrasound was routinely utilized to assess organ perfusion and detect inflammatory changes.

Patient Preparation:

Preparation varied according to the clinical scenario. For suspected acute abdomen, such as acute appendicitis, no specific preparation was required. In cases of suspected hypertrophic pyloric stenosis, breastfeeding or administration of oral sugar-containing water was given to displace gastric air; water was preferred for its superior acoustic window. In non-acute cases with vague abdominal symptoms, fasting was advised for 4–6 hours in children aged 6 months–5 years and for 6–8 hours in older children, to reduce bowel gas and improve visualization.

Patient Positioning:

Patients were examined in the supine position with extended legs as the standard approach. In selected cases, right or left lateral decubitus positioning was employed to improve visualization of abdominal organs by displacing bowel gas.

Examination Technique:

A systematic gray-scale ultrasound examination of the entire abdomen was performed using both curvilinear and linear transducers. The graded compression technique was applied for bowel loop evaluation, effectively reducing overlying bowel gas, improving visualization, and distinguishing abnormal from normal bowel segments. At the start of the scan, patients were asked to indicate the site of maximal tenderness, which was examined first.

Color Doppler assessment was performed for evaluation of vascular structures and inflammatory hyperemia. In suspected midgut volvulus, special attention was given to identifying the superior mesenteric artery (SMA)–superior mesenteric vein (SMV) relationship and the "whirlpool" sign. Pediatric Doppler settings included low wall filter, low pulse repetition frequency (PRF) for low-velocity flow detection, optimized color gain, and minimizing the color box size to maintain frame rate.

Reference Standards for Diagnosis:

The provisional sonographic findings were correlated with final diagnoses, which were established based on operative and surgical findings, clinical therapeutic response, laboratory results, and additional imaging modalities when available.

Ethical approval:

The study protocol was reviewed and approved by the institutional ethics committee. Informed oral consent was obtained from the legal guardians of all participants after explaining the details of the procedure. Patient privacy and confidentiality of data were maintained throughout all phases of the study. Throughout its implementation, the study complied with the Helsinki Declaration.

Statistical analysis:

All collected data were subjected to rigorous statistical analysis using the Statistical Package for Social Sciences (SPSS), version 27 (Armonk, NY: IBM Corp.). Descriptive statistics were used to summarize the characteristics of the study cohort. Specifically, qualitative variables were expressed as frequencies and percentages, whereas the distribution of quantitative variables was assessed. For data that were normally distributed, the summary measure was the mean ± standard deviation (SD). Conversely, for non-normally distributed data, the median with the interquartile range (IQR) was reported. The inferential statistical analyses included the use of the Chi-square test (χ^2) to assess for associations between qualitative variables. Additionally, Cohen's kappa coefficient (κ) was employed to quantify and measure the level of inter-rater reliability. For the purpose of establishing significance, a p-value of less than 0.05 ($p<0.05$) was considered statistically significant, and a p-value of less than 0.001 ($p<0.001$) was considered to indicate a highly significant finding for all two-tailed tests conducted.

RESULTS

This cross-sectional study included 100 patients with suspected pediatric non-traumatic gastrointestinal disorders. The included patients were 48 males and 52 females. The age of patients ranged from 5 days to 16 years, with a mean age of 6.7±5.05 years. Clinical and ultrasound data were presented **(Table 1&2).**

Table (1): Clinical presentation of the patients included in the study.

Clinical presentation	No.	%
Abdominal pain:	100	100.0
Right lower	43	43.0
Non localized pain	57	57.0
Fever	26	26.0
Constipation	22	22.0
Vomiting	46	46.0
Diarrhea	18	18.0
Abdominal Distension	18	18.0
Heamatochezia	18	18.0
Poor weight gain	18	18.0
Tenderness & Rigidity	38	38.0
Palpable mass	28	28.0
TLC:		
Normal	56	56.0
High	40	40.0
Low	4	4.0

TLC: Total leukocyte count.

Table (2): Ultrasound findings in the studied patients

Ultrasound findings		No.	%
Non compressible blind ended tubular structure	Absent	76	76.0
	6-8 mm	10	10.0
	Above 8 mm	10	10.0
	Perforated	4	4.0
Dilated bowel loops		12	12.0
Sluggish peristalsis		14	14.0
Target sign		16	16.0
Cervix sign		12	12.0
Doughnut sign		12	12.0
Free fluid collection		46	46.0
Elongated pyloric canal		12	12.0
Enlarged mesenteric LNs		28	28.0
Whirlpool sign		4	4.0
Reversed SMA-SMV		4	4.0
Portal venous gas		6	6.0
Intramural gas		4	4.0
Thickened bowel wall		22	22.0
Bowel wall hyperemia on color Doppler		20	20.0
Mesenteric sonographic findings	Iso-echoic	30	30.0
	Hyper-echoic	58	58.0
	Hyper vascularization	12	12.0

LNs: Lymph nodes, SMA: Superior mesenteric artery, SMV: Superior mesenteric vein.

The Site of pathology was not determined in 22 (22%) patients, while the site was pyloric canal in 12 (12%) patients, duodenum in 6 (6%) patients, ilium in 30 (30%) patients, appendix in 18 (18%) patients, and ileo-colic in 12 (12%) patients.

Diagnosis by US in the studied patients showed that there was appendicitis in 18 (18%) patients, intussusception in 12 (12%) patients, Hypertrophic Pyloric Stenosis (HPS) in 12 (12%) patients, small bowel obstruction in 4 (4%) patients, mesenteric lymphadenitis in 8 (8%) patients, inflammatory bowel disease (IBD) 8 (8%) patients, necrotizing enterocolitis (NEC) in 6 (6%) patients, malrotation with volvulus in 4 (4%) patients, Meckel's diverticulitis in 4 (4%) patients, duplication cyst in 4 (4%) patients, acute typhlitis in 2 (2%) patients, intestinal bezoar in 2 (2%) patients **(Figure 1)**.

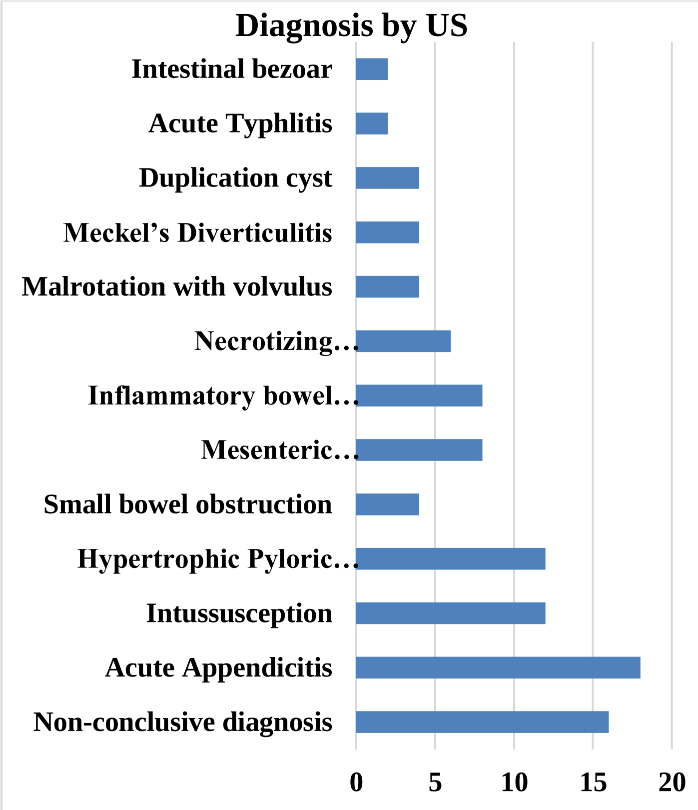

Figure (1): Ultrasound diagnosis of the included patients.

There were 20 cases diagnosed as acute appendicitis. 16 of 20 (80%) patients with appendicitis had non-complicated disease; and 4 patients had complicated appendicitis (20%). 18 of 20 patients with acute appendicitis were correctly diagnosed by US (sensitivity, 90%). In the other two cases, US was negative for appendicitis which was confirmed by surgery. Complicated appendicitis was diagnosed by US in 4 cases (20%). The 4 patients had perforated appendicitis **(Table 3)**.

Table (3): The sonographic signs of appendicitis.

Sonographic signs of appendicitis	No.	%
Antero-posterior diameter of 6 mm or more	18	90.0
Target sign	15	75.0
Free fluid collection	12	60.0
Enlarged mesenteric LNs	6	30.0
Hyper-echoic peri-appendiceal fat	18	90.0

LNs: Lymph nodes.

Concerning the correlation between the diagnostic accuracy of ultrasound compared to the final diagnosis of appendicitis according to pediatric surgery, the sensitivity of ultrasound was 90%, positive predictive value (PPV) was 100%, negative predictive value (NPV) was 100%,) false negativeFN(was 2% and accuracy was 96.8% and Kappa agreement (κ=0.94) showing excellent agreement **(Table 4)**.

Table (4): Diagnostic accuracy of ultrasound compared to the final diagnosis of appendicitis according to pediatric surgery.

Final diagnosis		**Diagnosis by ultrasound**				**Total**	
		Negative		**Positive**			
		N	**%**	**N**	**%**	**N**	**%**
Appendicitis	**Negative**	80	80%	0	0.0%	80	80%
	Positive	2	2%	18	18%	20	20%
Total		82	82%	18	18%	100	100.0%
κ (P)		0.94 (<**0.001****)					
Sensitivity		90%					
Specificity		100%					
PPV		100%					
NPV		97.6%					
Accuracy		96.8%					

κ: Kappa coefficient, P: Probability, PPV: Positive predictive value, NPV: Negative predictive value.

There were 12 cases of intussusception, and the 12 cases were correctly diagnosed by ultrasound (sensitivity 100%). Ilio-colic intussusception was diagnosed in 8 cases, ileoileal intussusception in the remaining 4 cases. The typical sonographic signs of intussusception were visible in all patients. Lesions appeared as heterogeneous masses with a "dougnut sign", with telescoping of proximal segment of bowel (intussusceptum) into the lumen of the distal segment (intussuscepiens) in all cases. There were 10 cases recovered after Hydrostatic reduction, and 2 cases recovered spontaneously. Concerning the correlation between the diagnostic accuracy of ultrasound compared to the final diagnosis of intussusception according to pediatric surgery, the sensitivity of ultrasound was 100%, PPV was 100%, NPV was 100%, FN was 0% and accuracy was 100% and Kappa agreement (κ=1) showing excellent agreement **(Table 5)**.

Table (5): Diagnostic accuracy of ultrasound compared to the final diagnosis of intussusception according to results after Hydrostatic reduction & spontaneous recovery.

Final diagnosis		**Diagnosis by ultrasound**				**Total**	
		Negative		**Positive**			
		N	**%**	**N**	**%**	**N**	**%**
Intussusception	**Negative**	88	88%	0	0.0%	88	88%
	Positive	0	0.0%	12	12%	12	12%
Total		88	100.0%	12	100.0%	100	100.0%
κ (P)		1.00 (<0.001**)					
Sensitivity		100%					
Specificity		100%					
PPV		100%					
NPV		100%					
Accuracy		100%					

κ: Kappa coefficient, P: Probability, PPV: Positive predictive value, NPV: Negative predictive value.

There were 4 cases diagnosed as midgut volvulus. All cases were diagnosed by ultrasound (sensitivity 100%). In all 4 patients, a "whirlpool" pattern of SMV and mesentery was detected by US and color Doppler examination. This sign corresponds to Reversed SMA-SMV, i.e., a clockwise wrapping of the SMV and the mesentery around the SMA. Concerning the correlation between the diagnostic accuracy of ultrasound compared to the final diagnosis of intestinal malrotation according to pediatric surgery, the sensitivity of ultrasound was 100%, PPV was 100%, FN was 0%, and accuracy was 100% and Kappa agreement (κ=1.000) showing excellent agreement **(Table 6)**.

Table (6): Diagnostic accuracy of ultrasound compared to the final diagnosis of intestinal malrotation according to pediatric surgery (Ladd's procedure)

Final diagnosis		**Diagnosis by ultrasound**				**Total**	
		Negative		**Positive**			
		No.	**%**	**No.**	**%**	**No.**	**%**
Intestinal malrotation	**Negative**	96	80	0	0.0	96	80
	Positive	0	0.0	4	20	4	20
Total		96	100.0	4	100.0	100	100.0
κ (P)		1.00 (<0.001**)					
Sensitivity		100%					
Specificity		100%					
PPV		100%					
NPV		100%					
Accuracy		100%					

κ: Kappa coefficient, P: Probability, PPV: Positive predictive value, NPV: Negative predictive value.

There were 12 cases correctly diagnosed by ultrasound examination as hypertrophic pyloric stenosis. The sonographic criteria were pyloric single muscle wall thickness > 3 mm, pyloric canal length >15 mm, pylorus transverse diameter > 13 mm, and cervix sign which describes the indentation of the pylorus into the fluid-filled antrum. Concerning the correlation between the diagnostic accuracy of ultrasound compared to the final diagnosis of hypertrophic pyloric stenosis according to pediatric surgery, the sensitivity of ultrasound was 100%, PPV was 100%, FN was 0%, and accuracy was 100% and Kappa agreement (κ=1.000) showing excellent agreement **(Table 7)**.

Table (7): Diagnostic accuracy of ultrasound compared to the final diagnosis of hypertrophic pyloric stenosis according to pediatric surgery

Final diagnosis		**Diagnosis by ultrasound**				**Total**	
		Negative		**Positive**			
		No.	**%**	**No.**	**%**	**No.**	**%**
Hypertrophic pyloric stenosis	**Negative**	88	88	0	0.0	88	88.0
	Positive	0	0.0	12	12.0	12	12.0
Total		88	100.0	12	100.0	100	100.0
κ (P)		1.00 (<0.001**)					
Sensitivity		100%					
Specificity		100%					
PPV		100%					
NPV		100%					
Accuracy		100%					

κ: Kappa coefficient, P: Probability, PPV: Positive predictive value, NPV: Negative predictive value.

All the correlations between the final diagnosis and the diagnosis by ultrasound, showed highly statistically significant relationship with p-value (p<0.001). Concerning the correlation between the diagnostic accuracy of ultrasound of all the patients included in the study presented with non-traumatic gastrointestinal emergencies compared to the final diagnosis according to pediatric surgery, the sensitivity of ultrasound was 96%, Specificity was 100%, PPV was 100%, NPV was 75%, FN was 25% and accuracy was 93% and Kappa agreement (κ=0.84) showing excellent agreement **(Table 8)**.

Table (8): Diagnostic accuracy of ultrasound of all the patients included in the study presented with non-traumatic GIT disorders compared to the final diagnosis.

Final diagnosis		**Diagnosis by ultrasound**				**Total**	
		Negative		**Positive**			
		No.	**%**	**No.**	**%**	**No.**	**%**
Patients included in the study	**Negative**	12	75	0	0.0	12	12
	Positive	4	25	84	100	88	88
Total		88	100.0	12	100.0	100	100.0
κ (P)		0.834 (<0.001**)					
Sensitivity		96%					
Specificity		100%					
PPV		100%					
NPV		75%					
Accuracy		93%					

κ: Kappa coefficient, P: Probability, PPV: Positive predictive value, NPV: Negative predictive value.

CASE PRESENTATION

<u>CASE 1</u>

History: A 7-year-old male presented to the emergency room complaining of abdominal pain for 1 day and vomiting, on examination; Abdominal rigidity, tenderness with maximum point at right iliac fossa & rebound tenderness.

US Findings (Figure 2):

Grey scale US transverse plane on right iliac fossa revealed (Figure 2): Non compressible blind ended structure, with target sign (white arrow), which measures (11mm) at maximum diameter, with thickened edematous wall and surrounded by echogenic omentum (yellow arrow) and free fluid (star*).

Grey scale US longitudinal plane revealed (Figure 2C): a dilated, blind ended non-peristaltic, tubular structure, surrounded by free fluid (star *).

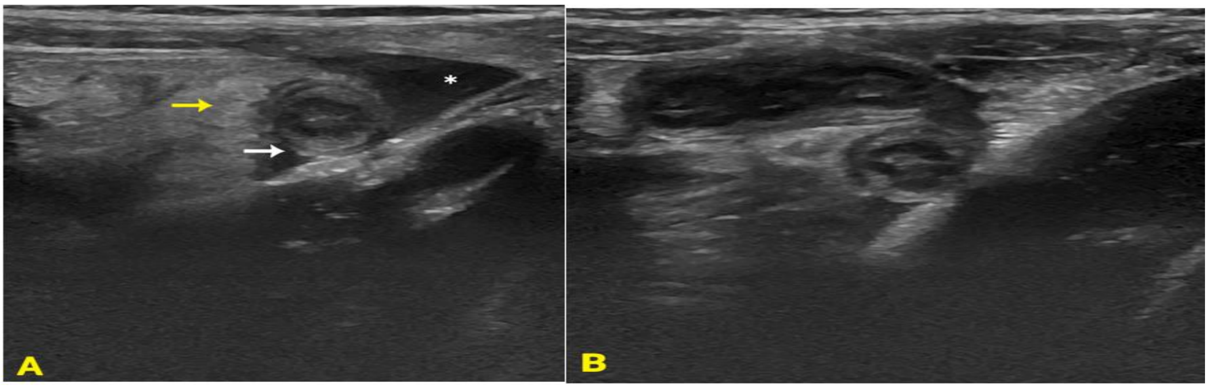

Figure (2): Grey scale US transverse plane shows; target sign of appendicitis (white arrow), surrounded by free fluid (star*) and echogenic omentum (yellow arrow).

(A) before compression, (B) after compression.

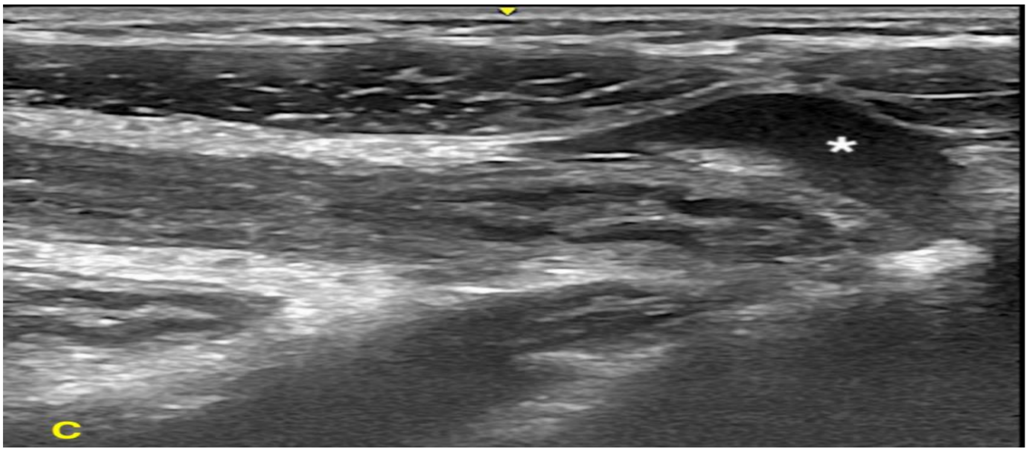

Figure (2C): Longitudinal plane shows; blind ended tubular structure, with thickened edematous wall and surrounded by free fluid (star*).

Laboratory investigations: Total Leucocytic count (TLC) of 12000 cell/ uL.

Final Diagnosis:

Acute non-complicated appendicitis, which was confirmed by pediatric surgeons after appendectomy.

CASE 2

History: A 6-year-old male presented to the emergency room complaining of abdominal pain and bloody stool.

Clinical Examination: Abdominal distension, with palpable mass at right upper quadrant.

US Finding (Figure 3):

Grey scale US transverse plane on right lower quadrant region: Evidence of target sign of intussusception (doughnut sign) measuring (3.2 X 2.5 cm) (Figure 3C), with multiple LNs seen within the core (Figure 3A).

Grey scale US longitudinal plane on right lower quadrant region (Figure 3B): Shows telescoping of proximal segment of bowel (intussusceptum, yellow arrow) into the lumen of the distal segment (intussuscepiens, white arrow) with preserved vascularity.

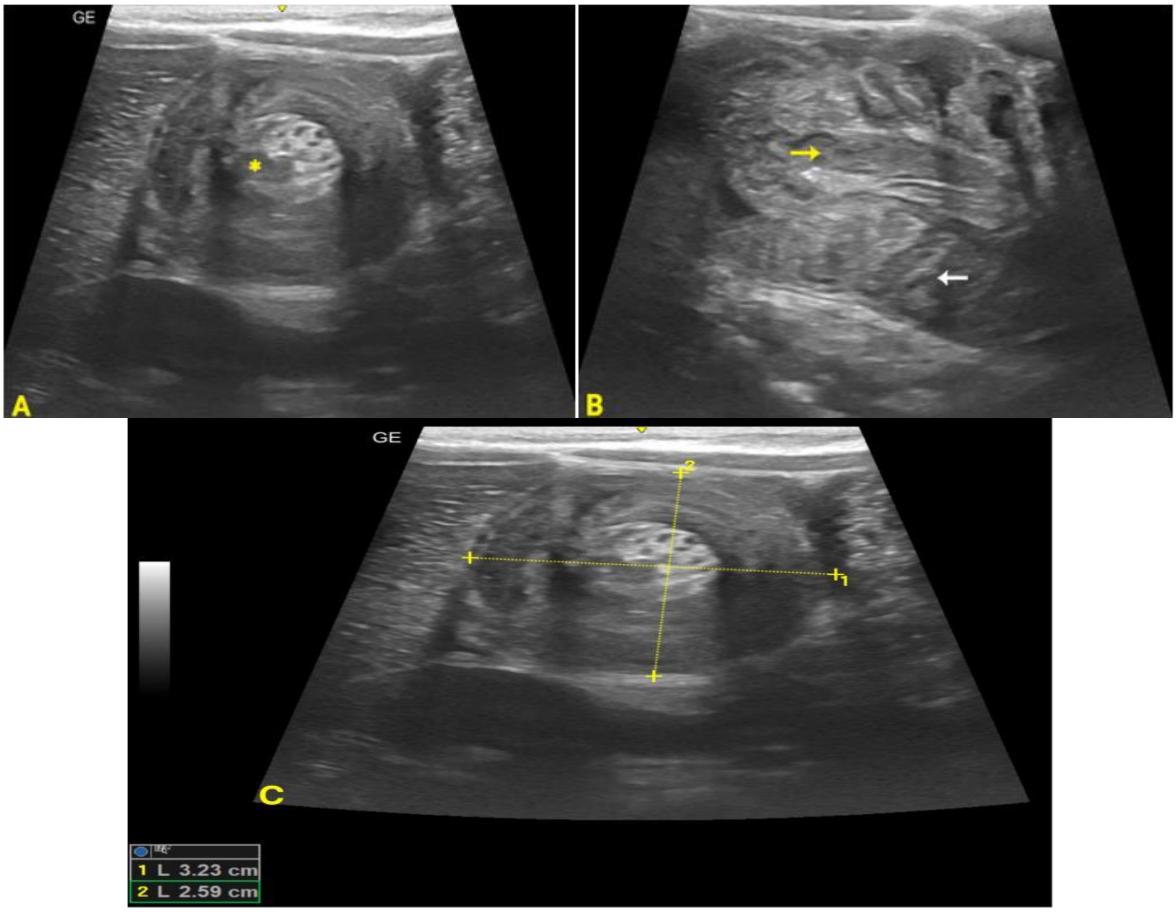

Figure (3): (A) axial image shows (Doughnut sign), with multiple L.Ns seen within the core (yellow star *). (B) longitudinal image showing telescoping of proximal segment of bowel (intussusceptum, yellow arrow) into the lumen of the distal segment (intussusceptions, white arrow). (C) Target sign of intussusception (doughnut sign) in axial US image measuring (3.2.4x2.6 cm).

Final Diagnosis:

Ileo-colic intussusception which was confirmed by pediatric surgeons after Hydrostatic reduction.

CASE 3

History: A 4-week-old male patient with persistent non-bilious projectile vomiting.

Clinical Examination: A palpable mass (olive size) at the right hypochondrial region.

US Findings (Figure 4):

Grey scale US scan on the epigastric region longitudinal plane demonstrates: Elongated pyloric canal measures (17.8 mm) with increased pyloric muscle thickness (4.2 mm) and pyloric width measures (12.8mm) (**Figure 4A**). The indentation of the elongated pyloric canal (yellow arrow) into fluid filled gastric antrum (star*) gives the (cervix sign) (**Figure 4B**).

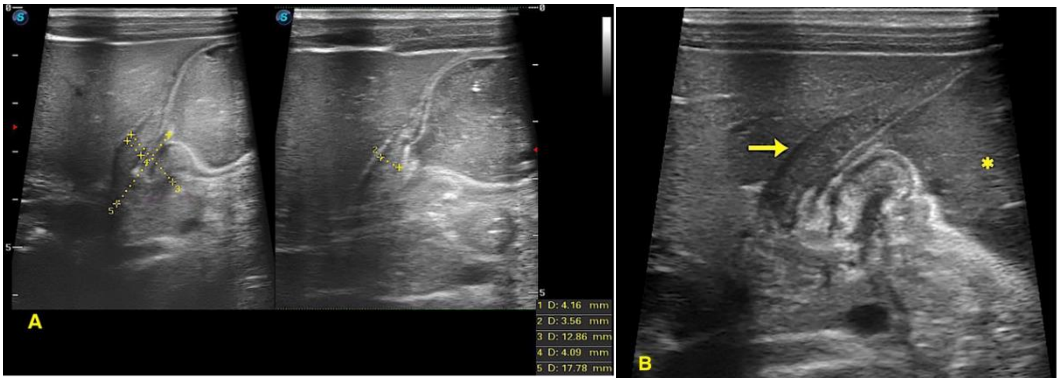

Figure (4): (A) Longitudinal axis: US image showing an elongated pyloric canal (18 mm) with increased pyloric muscle thickness (4.1 mm), pyloric width measuring (12.8mm). (B) "Cervix sign" the indentation of the elongated pyloric canal (yellow arrow) into the fluid filled antrum (star*).

Final Diagnosis:

Hypertrophic pyloric stenosis, which was confirmed after surgery (Pyloromyotomy).

CASE 4

History: A 5-year-old girl complains of abdominal pain and intermittent constipation.

US Findings (Figure 5):

Grey scale US scan transverse midline plane shows: clockwise swirling of SMV (yellow arrow) and small bowel (white arrow) around SMA (star*) (**Figure 5A**).

Color Doppler scan shows: a whirlpool sign of the superior mesenteric vessels, with inversion of the normal relationship between the SMV and the SMA, with the vein seen on the left side of the artery (**Figure 5B**).

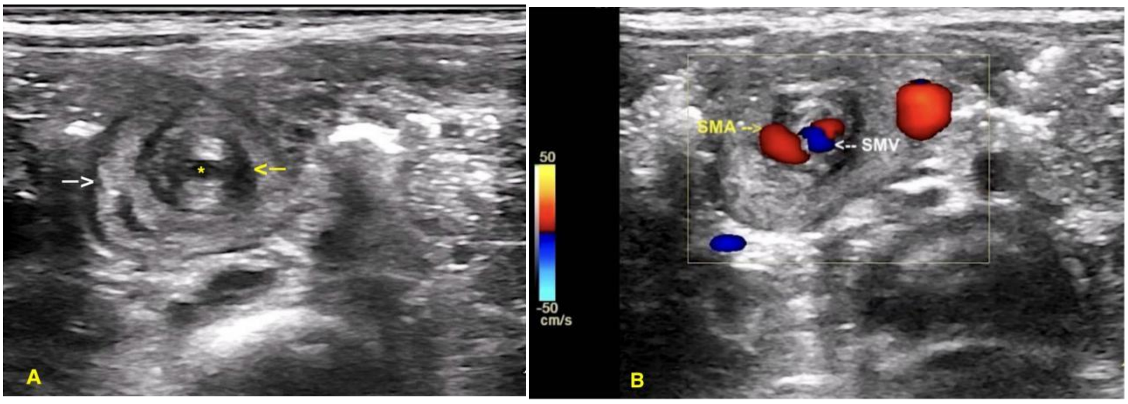

Figure (5): (A) Grey scale US shows clockwise swirling of SMV (yellow arrow) and small bowel (white arrow) around SMA (star*) in central abdomen. (B) Color Doppler image shows a (whirlpool sign) with inversion of the normal relationship between the SMV on the left and SMA on the right.

Final diagnosis:

Intestinal malrotation with midgut volvulus which was confirmed after surgery.

DISCUSSION

Non-traumatic GI emergencies account for a major share of pediatric acute care visits, where rapid and precise diagnosis is essential to limit morbidity and avoid complications **(7)**. Conventional imaging approaches, including plain radiographs and contrast-based examinations, have recognized drawbacks such as ionizing radiation and risks related to contrast use. By contrast, US is widely available, non-invasive, free of radiation, and is therefore considered the preferred initial imaging tool in children **(8)**. The present work systematically examined the diagnostic value of US across a range of pediatric non-traumatic GI disorders, correlating sonographic findings with surgical, laboratory, therapeutic, and other imaging outcomes to determine diagnostic performance.

In this study, vomiting was identified in 46% of patients, while fever, constipation, diarrhea, abdominal distension, hematochezia, and poor weight gain were each observed in 18%–26% of cases. Khater and co-authors reported higher vomiting rates (63%), with fever and diarrhea occurring in 29% and 41% of patients, respectively **(6)**.

The most frequent US finding in our cohort was free peritoneal fluid, seen in 46% of cases. Matz and co-authors documented that among non-traumatic pediatric abdominal pain cases evaluated with imaging, 33% demonstrated free fluid, and 57% of those were linked to surgical pathology; these patients had a markedly greater likelihood of requiring operative intervention [9].

The classic "target sign" was present in 16% of patients and was significantly associated with appendicitis ($p < 0.001$). This concurs with **Bekiaridou *et al.*** **(10)**, who demonstrated that US reliably distinguished between uncomplicated and complicated appendicitis; 63.8% of children with uncomplicated disease showed the target sign compared to 36% with complicated cases ($p < 0.001$).

A significant relationship was also observed between the cause of pediatric GI emergencies and the presence of the "doughnut sign" ($p < 0.001$). Our results mirror those of Banoub et al., who confirmed that all intussusception cases exhibited the doughnut sign (100%), while no such finding occurred in non-intussusception cases (0%) [4].

Enlarged mesenteric lymph nodes (MLN) were detected in 28% of our patients. Similarly, Karmazyn et al., using abdominal CT, noted enlarged MLN (short axis ≥ 5 mm) in 54% of children with a low probability of mesenteric lymphadenopathy, with 28% demonstrating three or more enlarged nodes in the right lower quadrant [11].

Appendicitis was diagnosed by US in 18 cases, yielding a sensitivity of 90%, specificity of 100%, and an overall accuracy of 96.8%. This aligns with Mittal et al., who evaluated US performance for appendicitis in children. They reported overall sensitivity of 72.5% and specificity of 97.0%; however, when the appendix was clearly visualized, sensitivity increased to 97.9% with specificity of 91.7% [12].

Hypertrophic pyloric stenosis (HPS) was identified with 100% sensitivity, specificity, PPV, NPV, and diagnostic accuracy ($\kappa = 1.00$, $p < 0.001$). Comparable results were reported by **Sivitz *et al.*** **(13)**, where pediatric emergency physicians accurately recognized all 10 positive HPS cases, producing sensitivity and specificity of 100% (95% CI: 62–100% and 92–100%, respectively). Niedzielski and co-authors also confirmed US as the preferred diagnostic test in suspected HPS, achieving sensitivity of 98% and specificity of 100% [14].

All 12 intussusception cases in our cohort were correctly diagnosed by US, resulting in 100% sensitivity, specificity, PPV, NPV, and accuracy. Rahmani and co-authors similarly demonstrated high diagnostic yield of US, reporting sensitivity and specificity of 0.96 (95% CI: 0.95–0.97) and 0.97 (95% CI: 0.97–0.98), respectively, while comparing point-of-care ultrasound (POCUS) with radiologist-performed US (RADUS) [15].

Intestinal malrotation was also diagnosed with perfect diagnostic indices (100% sensitivity, specificity, PPV, NPV, accuracy; $\kappa = 1.00$, $p < 0.001$). Nguyen and co-authors reported comparable results, showing US sensitivity of 94% (95% CI: 89–97%) and specificity of 100% (95% CI: 97–100%) in children and adolescents assessed for malrotation and volvulus [16].

Across all non-traumatic GI cases, US achieved overall diagnostic accuracy of 93%, with sensitivity of 96%, specificity of 100%, and a κ value of 0.834 ($p < 0.001$). Fonio *et al.* **(17)** provided similar evidence, citing accuracy of 90.6% for appendicitis and nearly 93% accuracy for other acute pediatric abdominal disorders, with excellent sensitivity and specificity values.

CONCLUSIONS

Ultrasonography is a highly effective diagnostic tool for pediatric non-traumatic GI emergencies. Throughout the analysis, US consistently demonstrated high sensitivity, specificity, and overall diagnostic accuracy, particularly for appendicitis, intussusception, HPS, and malrotation. These results support US as a reliable, non-invasive, and radiation-free alternative to conventional imaging modalities, facilitating early recognition and appropriate management of acute abdominal conditions in children.

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