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Original Article

Accuracy of Ultrasonography for the Diagnosis of Intussusception in Children

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Abstract

Background: Intussusception is an important cause of intestinal obstruction in children. The diagnosis is primarily based on clinical findings; however, no universal diagnostic signs or symptoms are present in every patient. Preventing complications and fatalities caused by delayed diagnosis and surgery requires prompt medical attention. In this study, the accuracy of ultrasonography was investigated using per-operative findings as a gold standard.

Objective: To assess the accuracy of ultrasonography in detecting intussusception in children using per-operative findings as the gold standard.

Materials and Methods: This cross-sectional study was conducted from January 2022 to December 2023 at Sir Salimullah Medical College & Mitford Hospital in Dhaka, Bangladesh. A total of 42 patients were included in the study according to predefined inclusion and exclusion criteria. Statistical analysis was done by SPSS version 27.

Results: Among the study participants, 66.66% children were under 1 year of age with male predominance (69%). Ultrasonography accurately diagnosed intussusception in 37 cases (88.09%). The sensitivity, specificity, PPV, NPV, and accuracy of ultrasonography for the diagnosis of intussusception were 97.29%, 80 %, 97.29%, 80% and 95.23% respectively.

Conclusion: According to the study, ultrasonography has a satisfactory level of sensitivity, specificity, and accuracy to diagnose intussusception. Most crucially, ultrasonography can identify this condition with assessment of vascularity. Therefore, ultrasonography can be considered a reliable first-line imaging modality for diagnosing intussusception in children, as it avoids exposure to ionizing radiation from CT scans and X-rays.

Keywords: Intussusception, Ultrasonography, Child, Sensitivity and Specificity, Diagnosis

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Introduction

Intussusception is a surgical emergency in infants and an important cause of intestinal obstruction in children. It refers to the telescoping of one segment of intestine into

an adjacent distal segment. The invaginating part is called the intussusceptum, while the receiving segment is known as the intussuscipiens (1). The incidence of intussusception varies across regions, with a reported annual incidence of 34 per 100,000 live births in Africa and 90 per 100,000 live births in the Western Pacific region (2).

Intussusception most commonly affects infants between 5 and 9 months of age, although it may occur in other age groups as well (3). In most infants, the cause remains idiopathic. However, pathological lead points such as Meckel's diverticulum, lymphoma, and intestinal duplication cyst may be identified, particularly in older children (4).

The clinical presentation of intussusception is often variable and confusing. The classical triad of acute abdominal pain, red currant-jelly stool or hematochezia, and a palpable abdominal mass is present in fewer than half of the cases. Because of nonspecific symptoms, absence of rectal bleeding, and difficulty in obtaining a reliable history from nonverbal children, diagnosis is often delayed or missed (5,6). Untreated intussusception can lead to intestinal edema, gangrene, perforation, and generalized peritonitis, which may be life-threatening. Therefore, early diagnosis is essential (7).

Different imaging modalities are used in the diagnosis of intussusception. The diagnostic performance of abdominal x-ray varies considerably in previous studies, with reported sensitivity ranging from 74% to 90% and specificity from 42% to 90%. Enema x-ray can also be used both for diagnosis and therapeutic reduction, either by pneumatic or hydrostatic method. However, recurrence after enema reduction occurs in about 10% of cases, and the procedure carries a risk of perforation while also exposing infants to ionizing radiation (3,8). Computed tomography is used less frequently in children because it contributes little to management and raises concerns regarding unnecessary radiation exposure (9).

Ultrasonography is a safe, non-invasive, and readily available imaging modality for the diagnosis of intussusception. It can identify the lesion, assess vascular compromise, and detect associated findings such as free or trapped peritoneal fluid (4). It may also help in detecting pathological lead points in a small proportion of cases. Enlarged lymph nodes, which can be demonstrated by ultrasound, may hinder hydrostatic reduction and increase the likelihood of surgical intervention (6). Although ultrasonography is operator dependent, previous studies have reported sensitivity ranging from 87% to 92.5%, specificity from 50% to 96.2%, and overall accuracy from 84% to 94.4% (4,10).

Although surgery remains the mainstay of treatment, imaging plays a vital role in early diagnosis and timely management. Delayed diagnosis may adversely affect postoperative outcome and increase the complexity of surgical intervention. No study has yet been carried out in Bangladesh to determine the diagnostic accuracy of ultrasonography in children with suspected intussusception. Therefore, the aim of this study was to assess the accuracy of ultrasonography in diagnosing intussusception in children.

Materials and methods:

This cross-sectional study was conducted in the Department of Radiology and Imaging, Sir Salimullah Medical College & Mitford Hospital, Dhaka, from January 2022 to December 2023. A total of 42 pediatric patients who presented to the Pediatric Surgery Department with suspected intussusception and were referred to the Radiology and Imaging Department of the same centre for ultrasonography were included in the study. Purposive sampling was used, with inclusion criteria limited to children under 12 years of age presenting with intestinal obstruction due to suspected intussusception. Exclusion criteria included patients with previous abdominal surgery, prolapsed intussusception, and cases of spontaneous resolution of intussusception.

The study protocol received ethical approval from the Ethical Review Committee of Sir Salimullah Medical College & Mitford Hospital. Abdominal ultrasonography was performed by a radiologist, and the findings were documented accordingly. A Canon Xario-100 ultrasound machine was used, with both linear and convex transducers. The entire abdomen was scanned, with particular attention given to the ileocolic region in the right lower quadrant. Intussusception was diagnosed based on the characteristic sonographic features, including the target sign, doughnut sign, and pseudo-kidney sign. The presence of these specific signs was considered indicative of a positive result. Relevant data were collected and recorded in a master spreadsheet. Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 27.0 for Windows. Quantitative data were expressed as mean ± standard deviation, while qualitative data were presented as frequencies and percentages. Results were displayed in tables and graphs as appropriate. The diagnostic performance of ultrasonography for intussusception was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, using preoperative findings as the gold standard. These measures were then compared with findings from similar studies reported in the literature.

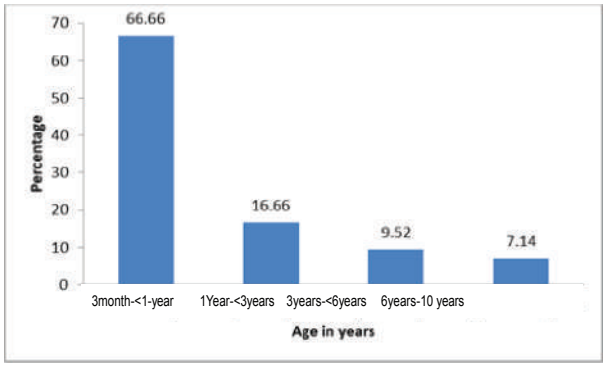

Figure 1: Bar diagram showing age distribution of the study population (n=42)

Among the 42 children included in the study, the majority, 28 (66.66%), were aged from 3 months to less than 1 year. The remaining patients were distributed as follows: 7 (16.66%) were aged 1 to less than 3 years, 4 (9.52%) were aged 3 to less than 6 years, and 3 (7.14%) were aged 6 to 10 years.

The figure indicates that intussusception was predominantly observed in infants under 1 year of age. This suggests that younger children, particularly infants, formed the most vulnerable age group in the present study population.

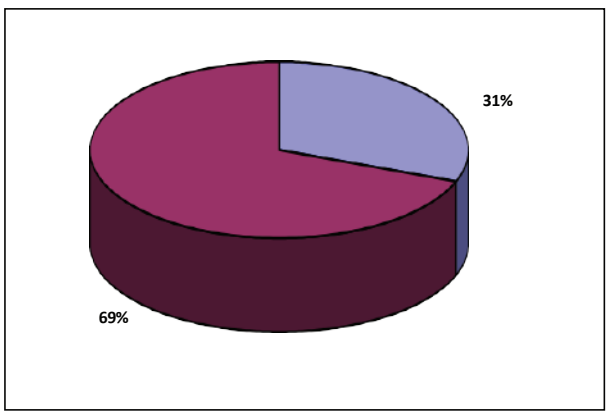

Figure 2: Pie chart showing sex distribution of the study population (n=42)

Out of the total 42 patients, 29 (69%) were male and 13 (31%) were female.

The figure demonstrates a clear male predominance among the study population. This finding suggests that intussusception was more frequently encountered in male children than in female children in this series.

Table 1: Clinical presentation of the study population (n=42)

Variable	Category	Number	Percentage (%)
Presenting complaints	Pain in the abdomen	34	80.95
	Vomiting	36	85.71
	Bloody stool	13	30.95
	Abdominal distension	15	35.71
	Palpable abdominal mass	11	26.19
Pattern of presentation	Classical symptoms (abdominal pain, vomiting, red-currant jelly stool)	8	19.04
	Non-classical symptoms	34	80.96

Table-1 shows that vomiting (85.71%) and abdominal pain (80.95%) were the most common presenting complaints. Bloody stool, abdominal distension, and palpable abdominal mass were less frequent. Only 8 (19.04%) patients presented with the classical triad of intussusception, whereas the majority, 34 (80.96%), had non-classical presentations. This indicates that most children did not present with the complete classical symptom complex, highlighting the importance of careful clinical suspicion even in atypical cases.

Table 2: Sonographic characteristics of the lesion in the study population (n=42)

Variable	Category	Number	Percentage (%)	Mean±SD / Range
Site of lesion	Right lower abdomen	16	38.09	—
	Right upper abdomen	11	26.19	—
	Left lower abdomen	4	9.52	—
	Left upper abdomen	6	14.28	—
	No identifiable mass	5	11.90	—
Type of intussusception	Ileocolic	28	66.66	—
	Ileoileal	9	21.42	—
	No identifiable mass	5	11.90	—
Size of lesion (cm)	1.0–3.0	11	26.19	—
	3.1–5.0	20	47.61	—
	5.1–8.0	6	14.28	—
	No identifiable mass	5	11.90	—
Wall thickness (cm)	Ileocolic	—	—	0.60±0.13 (0.3–1.0)
	Ileoileal	—	—	0.42±0.12 (0.3–0.8)

Table-2 shows that the lesion was most commonly located in the right lower abdomen (38.09%), followed by the right upper abdomen (26.19%). The most

frequent sonographic type was ileocolic intussusception, found in 28 (66.66%) cases, while ileoileal intussusception was observed in 9 (21.42%) cases. In most children, the lesion size ranged from 3.1 to 5.0 cm (47.61%). The mean wall thickness was greater in ileocolic lesions (0.60 ± 0.13 cm) than in ileoileal lesions (0.42 ± 0.12 cm). These findings indicate that ileocolic intussusception was the dominant pattern and that sonography was able to characterize lesion location, size, and wall thickness effectively in most patients.

Table 3: Associated ultrasonographic findings in the study population (n=42)

Variable	Category	Number	Percentage (%)
Sonographic signs	Target sign	37	88.09
	Pseudo-kidney sign	37	88.09
	No sign detected	5	11.90
Abdominal lymphadenopathy	Present	28	66.67
	Not present	14	33.33
Ascites	Present	23	54.76
	Absent	19	45.24
Vascularity of lesion	Normal	30	71.40
	Reduced	4	9.52
	Absent	3	7.14
	Not applicable	5	11.90

Table-3 demonstrates that the target sign and pseudo-kidney sign were the most common sonographic findings, each being present in 37 (88.09%) patients. Abdominal lymphadenopathy was noted in 28 (66.67%) cases, and ascites was present in 23 (54.76%) cases. Normal vascularity was preserved in most lesions (71.40%), whereas reduced or absent vascularity was found in 7 (16.66%) cases. These findings suggest that typical ultrasound signs were highly prevalent in confirmed cases, while associated features such as lymphadenopathy, ascites, and altered vascularity provided additional support in evaluation and may also reflect severity or progression of disease in some patients.

Table 4: Per-operative findings of the study population (n=42)

Variable	Category	Number	Percentage (%)
Type of lesion	Ileocolic	25	59.52
	Ileoileal	5	11.90
	Ileoileocolic	5	11.90
	Colocolic	1	2.38
	Jejuno-jejunal	1	2.38
	Other causes	5	11.90
Lymph node status	Enlarged	25	59.52
	Not enlarged	17	40.48
Peritoneal collection	Present	20	47.62
	Absent	22	52.38

Interpretation:

Table-4 shows that ileocolic intussusception was also the most common lesion type at surgery, found in 25 (59.52%) patients. Other varieties such as ileoileal and ileoileocolic intussusception were less frequent. Enlarged lymph nodes were present in 25 (59.52%) cases, and peritoneal collection was found in 20 (47.62%) cases. These operative findings support the sonographic pattern observed earlier and indicate that ileocolic intussusception was the predominant surgical diagnosis in the present study. The presence of lymph node enlargement and peritoneal collection may reflect inflammatory changes associated with the disease process.

Table5: Per-operative complications and final operative diagnosis of the study population (n=42)

Variable	Category	Number	Percentage (%)
Complications	Gangrene	7	16.67
	Perforation	3	7.14
	No complication	32	76.19
Final operative diagnosis	Intussusception	37	88.09
	Not intussusception	5	11.90

Table-5 shows that most patients, 32 (76.19%), had no per-operative complication. Gangrene was identified in 7 (16.67%) cases, while perforation was present in 3 (7.14%) cases. Final operative diagnosis confirmed

intussusception in 37 (88.09%) patients, whereas 5 (11.90%) patients were found to have other conditions. This indicates that although the majority of children did not develop complications, a clinically important proportion had serious operative complications such as gangrene and perforation, emphasizing the need for timely diagnosis and intervention.

Table 6: Diagnostic validity of ultrasonography compared with per-operative findings for intussusception (n=42)

A. Comparison of ultrasonographic and per-operative diagnosis

Variable	Category	Number	Percentage (%)
Complications	Gangrene	7	16.67
	Perforation	3	7.14
	No complication	32	76.19
Final operative diagnosis	Intussusception	37	88.09
	Not intussusception	5	11.90

Table-6 shows that ultrasonography correctly identified 36 true positive and 4 true negative cases. There was 1 false positive and 1 false negative result. The sensitivity of ultrasonography was 97.29%, specificity was 80.00%, and overall accuracy was 95.23%. The positive predictive value was 97.29%, while the negative predictive value was 80.00%. These findings indicate that ultrasonography was highly sensitive and accurate for diagnosing intussusception when compared with per-operative findings, making it a reliable diagnostic tool in the evaluation of suspected cases.

The present study showed that intussusception occurred predominantly in male infants under 1 year of age. Vomiting and abdominal pain were the commonest presenting complaints, while classical presentation was relatively uncommon. Sonographically, ileocolic intussusception was the most frequent type, usually located in the right side of the abdomen, with target sign and pseudo-kidney sign being the commonest imaging features. Operative findings closely matched sonographic findings, and ultrasonography demonstrated high sensitivity, good specificity, and high overall diagnostic accuracy in detecting intussusception.

Discussion:

The present study found that intussusception affected children from 3 months to 10 years of age, with the highest frequency occurring in infants aged 3 months to less than 1 year. In this study, 66.66% of the patients belonged to this age group. This finding agrees with the usual epidemiological pattern of childhood intussusception, which occurs predominantly in infants and young children. Chalya et al. reported a median age of 6 months and found that most of the patients were less than 1 year old (11). Standard clinical guidance also states that intussusception occurs most commonly between 2 months and 2 years of age (12). Therefore, the age distribution observed in the present study is consistent with the recognized peak incidence of this disease in infancy.

A male predominance was observed in the present study. Out of 42 patients, 29 (69%) were male and 13 (31%) were female, giving a male-to-female ratio of about 2.23:1. This result agrees with previous studies that also documented a higher frequency of intussusception among boys. Chalya et al. reported a male-to-female ratio of 3.3:1 (11), while Chukwubuike et al. also noted male predominance in their series (13). Thus, the sex distribution in the present study follows the general trend already described in earlier studies.

With regard to clinical presentation, vomiting and abdominal pain were the most common symptoms in the present study, being present in 85.71% and 80.95% of patients respectively. Bloody stool, abdominal distension, and palpable abdominal mass were less common. Only 19.04% of the patients presented with the classical symptom complex, whereas 80.96% had non-classical presentation. These findings are important because intussusception often presents with variable and non-specific manifestations. Mandeville et al. reported that clinical presentation is often diverse (14), and clinical guidelines state that the classical triad occurs in only one-third of children (12). Therefore, the low frequency of the classical symptom complex in the present study supports the need for careful clinical suspicion even when the full triad is absent.

In the sonographic evaluation, the lesion was most commonly located in the right lower abdomen, and the most frequent type was ileocolic intussusception. Similar findings were reported by Lioubashevsky et al., who demonstrated that ultrasonography can differentiate ileocolic from small-bowel intussusception based on lesion diameter, wall thickness, and associated sonographic features (15). These findings indicate that ileocolic intussusception was the dominant pattern in the present study.

The associated ultrasonographic findings were also noteworthy. Target sign and pseudo-kidney sign were present in the majority of patients. Abdominal lymphadenopathy and ascites were also observed in a considerable proportion of cases. Previous studies have reported that ileocolic intussusceptions are more frequently associated

with lymph nodes within the lesion and free peritoneal fluid (15). Since ileocolic intussusception was the predominant type in the present study, the frequent presence of lymphadenopathy and ascites is understandable.

Color Doppler assessment showed preserved vascularity in most lesions, whereas reduced or absent vascularity was observed in a smaller proportion of cases. However, operative findings revealed gangrene and perforation in a number of patients, indicating that some children had already developed bowel complications by the time of surgery. Similar complications related to delayed diagnosis have been reported in previous studies (7,11).

Per-operative findings in the present study corresponded closely with ultrasonographic findings. Ileocolic intussusception remained the most common operative diagnosis. Enlarged lymph nodes and peritoneal collection were also observed in a significant number of patients. These findings support the sonographic pattern observed earlier and indicate that ileocolic intussusception was the predominant type in the present series both on ultrasound and at surgery. Similar findings have been reported by Chalya et al. (11).

The present study also evaluated the diagnostic validity of ultrasonography by comparing ultrasound findings with per-operative diagnosis. The sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy were 97.29%, 80.00%, 97.29%, 80.00%, and 95.23% respectively. These findings indicate that ultrasonography is a highly effective diagnostic tool for intussusception. Riera et al. demonstrated that physician-performed ultrasound can achieve good sensitivity and specificity in the diagnosis of pediatric intussusception (16). Lin-Martore et al., in a systematic review and meta-analysis, also reported high pooled sensitivity and specificity for ultrasound in children with suspected intussusception (17).

Overall, the present study showed that intussusception occurred predominantly in male infants and usually presented with vomiting and abdominal pain rather than with the complete classical triad. Sonographically, ileocolic intussusception was the most frequent type and was commonly associated with target sign, pseudo-kidney sign, lymphadenopathy, and ascites. Operative findings closely matched the sonographic findings. The high sensitivity and good overall accuracy of ultrasonography observed in this study confirm that it is a dependable diagnostic tool for early evaluation of suspected intussusception in children.

Conclusion:

Ultrasonography is a highly accurate and useful imaging modality for diagnosing intussusception in children. Although occasional misdiagnosis may occur, the present study demonstrated an overall accuracy of 95.23%. Ultrasonography is a simple, safe, and non-invasive technique that avoids exposure to ionizing radiation, making it an effective first-line diagnostic tool for pediatric intussusception.

Limitations:

It was conducted in a single hospital, which may limit generalizability. The sample size was relatively small. In addition, ultrasonography was performed by more than one radiologist, which may have introduced operator variability.

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