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Non-Sonographic Hydrostatic Reduction of Intussusception in Children in Underdeveloped Pakistan

Majid Arshad [1], Anum Fatima [2], Rahmat Ali Khan [3], Khawar Saeed [4], Bakht Sarwar [5]

[1]Department of Pediatric Surgery, DHQ Teaching Hospital Timergara Lower Dir, KPK, Pakistan, [2]Department of Surgery, Al-Sehat Hospital Timergara Lower Dir, KPK, Pakistan, [3]Department of Peadiatric Surgery and Peadiatric Urology, PAQSJIMS Gambat, Sindh, Pakistan, [4]Department of Peadiatric Surgery, Northwest General Hospital Peshawar, KPK, Pakistan, [5]Department of Surgery, DHQ Teaching Hospital Timergara Lower Dir, KPK, Pakistan.

ABSTRACT

Background: Intussusception is a significant cause of pediatric intestinal obstruction that requires rapid intervention. While ultrasound-guided hydrostatic reduction is the standard treatment in developed healthcare systems, its availability is limited in resource-limited settings. This study evaluated the efficacy and safety of non-sonographic-guided hydrostatic reduction for the treatment of pediatric intussusception in a resource-limited setting in Pakistan.

Methods: A prospective descriptive case series study was conducted between January 2022 and January 2024 at Timergara Teaching Hospital involving 120 children aged 6 months to 3 years with ultrasound-confirmed acute ileocolic intussusception. A consecutive sampling technique was used to include all eligible patients during the study period. Success rates were analyzed for different age groups and symptom durations. Data analysis was conducted using IBM SPSS Statistics v20.0. Continuous variables were presented as mean ± SD or median (IQR), while categorical variables were shown as frequencies and percentages. Chi-square tests analyzed categorical data, and stratification by age, symptom onset, clinical signs, and vital signs minimized confounders. Statistical significance was set at $p < 0.05$.

Results: The overall success rate of hydrostatic reduction was 90.0% (n=108). Male patients accounted for 68 (56.7%) cases. The highest success rates were observed in children aged 7-12 months (n= 45; 91.8%) and in cases treated within 6-12 hours of symptom onset (n= 67; 95.7%). Success rates decreased significantly with increasing duration of symptoms, dropping to 10 (76.9%) cases treated after 24 hours (p=0.035). The most common symptoms were abdominal pain (n=112; 93%), fever (103; 86%), and a palpable abdominal mass (95; 79%).

Conclusion: Non-sonographic guided hydrostatic reduction is a highly effective treatment for uncomplicated pediatric intussusception in resource-limited settings, especially when performed within 12 hours of symptom onset. Early intervention is critical for optimal outcomes.

Keywords: Intussusception, Enema, Therapeutic, Non-Ultrasound Guided, Non-Imaging Guided, Pediatrics.

Corresponding Author:
Dr. Rehmat Ali Khan,
Department of Peadiatric Surgery and Peadiatric Urology,
Pir Abdul Qadir Shah Jeelani Institute of Medical Sciences,
Gambat, Sindh, Pakistan.
Email: rehmatalikhan146@gmail.com
ORCID: https://orcid.org/0009-0003-3403-5754
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INTRODUCTION

Intussusception is one of the leading causes of acute intestinal obstruction in the pediatric population, particularly in infants and young children[1,2]. The pathophysiologic process involves the extension of a proximal intestinal segment (intussusceptum) into an adjacent distal segment (intussuscipiens), which can lead to serious complications if not promptly diagnosed and treated[3,4]. Current epidemiological data suggest an incidence of 0.05% to 0.2% in infants and children, with a significant male preponderance and seasonal variation. Approximately 90% of cases are documented in children under the age of three. Among the anatomic variants, ileocolic intussusception predominates, accounting for more than 80% of cases, while other variants such as ileoileocolic, enter enteric, and colocolic intussusception are less common[5,6,7,8]. There is a distinct postoperative variant that mainly affects the small bowel after extensive surgery during a prolonged laparotomy.

The clinical presentation is highly variable, particularly in different age groups, although the disease usually affects healthy, well-nourished children. The classic presentation includes paroxysmal abdominal pain, a palpable abdominal mass, and hematochezia commonly described as "currant jelly" stools[9]. These symptoms typically occur in a cyclical pattern at 15–20-minute intervals, becoming progressively more severe. The progression from non-bilious to bilious vomiting often indicates progressive obstruction[10,11]. However, the diagnostic challenge lies in the fact that approximately 20% of infants may present without obvious pain, and a third of patients do not present with the classic signs of bloody stools or abdominal masses[11].

Treatment approaches have evolved considerably and include both surgical and non-surgical strategies. The choice of the appropriate intervention depends critically on the hemodynamic status of the patient and the absence of complications such as peritonitis or bowel perforation[12]. Modern non-surgical reduction techniques include fluoroscopically guided barium enema, pneumatic reduction under fluoroscopic guidance, and ultrasound-guided hydrostatic reduction (USGHR). Recent studies have shown varying success rates in different geographical regions. For example, an Ethiopian single-center study reported a success rate of 87.2% for hydrostatic reduction, while epidemiological data from Korea documented an incidence of 28.3 cases per 100,000 person-years between 2007-2017[13]. Despite the limited diagnostic accuracy of radiography (approximately 40%, including equivocal cases), it remains essential for the detection of complications such as pneumoperitoneum or high-grade bowel obstruction[13].

Given the potential morbidity associated with delayed diagnosis and the availability of various treatment options, the study aimed to evaluate the efficacy and safety of non-sonographically guided hydrostatic reduction in a resource-limited setting in the Dir Lower district. The objective of the study was to contribute to the existing body of literature by analysing treatment outcomes in a resource-limited setting where advanced diagnostic and therapeutic modalities were unavailable, thereby offering insights applicable to comparable healthcare environments.

METHODS

A prospective descriptive case series study was conducted between January 2022 and January 2024 at Timergara Teaching Hospital, Dir Lower, Pakistan. The facility serves as a regional center for pediatric surgery and performs approximately 60 procedures annually. The study protocol was approved by the ethics committee of the institution (Ref No: 6857).

The study population included consecutive pediatric patients aged 6 months to 3 years who presented with acute ileocolic intussusception confirmed by ultrasound. Inclusion criteria were that symptoms were present less than 48 hours before presentation and that all cases were initially treated by non-sonographic hydrostatic reduction. Patients were excluded if they had incomplete medical records, required immediate surgical intervention, had clinical or radiologic contraindications to hydrostatic reduction, or had previously undergone unsuccessful attempts at reduction. The sample size was calculated based on a previous study at DHQ Teaching Hospital, Timergara Lower Dir, KPK, Pakistan, which reported a 90% success rate for

non-sonographic hydrostatic reduction[14] with a failure rate of 10% as the primary outcome measure. A total of 120 patients were enrolled in the study.

The primary outcome variable was defined as the success or failure of non-sonographic hydrostatic reduction. Independent variables included demographic parameters (age, gender), clinical parameters (duration of symptoms, presence of vomiting, abdominal pain, bloody diarrhea, palpable abdominal mass, body temperature), and radiologic parameters (type of intussusception, presence of pathologic lead point, length of intussusception skeleton, trapped fluid within the intussusception, and dimensions of the concentric circle on ultrasound).

Clinical data were systematically collected using standardized data collection forms. Failed reduction was defined as incomplete reduction after two or more attempts, each lasting 5-10 minutes, requiring surgical intervention. Additional clinical data included patient demographics, primary symptoms, time of admission, and detailed ultrasound findings.

Data analysis was performed using IBM SPSS Statistics version 20.0. Descriptive statistics were presented as means ± standard deviation or median (IQR) for continuous variables and frequencies and percentages for categorical variables. Chi-square tests were used to analyze categorical variables. To minimize potential confounders, data were stratified by age groups, time of symptom onset, clinical signs, and vital signs. Statistical significance was set at $p < 0.05$. To ensure a comprehensive analysis, the data was stratified across multiple parameters. The stratified analysis examined the relationship between clinical presentations and outcomes across different age groups and symptom durations. This approach enabled the identification of potential age-specific and time-dependent factors influencing treatment success. The results are presented in a combination of tables, figures, and narrative text to provide a clear presentation of the results and their clinical significance.

RESULTS

The study included 120 children with intussusception who underwent hydrostatic reduction using a non-sonographic guided approach. Successful reduction was achieved in 108 patients, yielding an overall success rate of 90.0%.

Table 1: Gender Wise Distribution

Gender	Frequency (%)
Male	68 (56.7%)
Female	52 (43.3%)
Total	120 (100%)

The study included a total of 120 children with intussusception, of whom 68 (56.7%) were male and 52 (43.3%) were females. The gender distribution showed a slight preponderance of males with a male to female ratio of approximately 1.3:1. This finding suggests that intussusception was observed more frequently in male children compared to female children in our study population **(Table 1)**.

Table 2: Age Distribution and Success Rates of Hydrostatic Reduction In 120 Children with Intussusception

Age Group (months)	Successful	Unsuccessful	Total	Success Rate	P-value
3-6	18	2	20	90.0%	0.042
7-12	45	4	49	91.8%	
13-24	35	4	39	89.7%	
25-36	10	2	12	83.3%	
Total	108	12	120	90.0%	

Table 2 shows the results of hydrostatic reduction treatment in different age groups in 120 children with intussusception. The largest group of patients was aged 7-12 months, with 49 cases and a success rate of 91.8% (45 successful cases). The second largest group was children aged 13-24 months with 39 cases and a success rate of 89.7% (35 successful cases). The youngest group, 3-6 months old, included 20 patients with a success rate of 90 (18 successful cases). The smallest group was children aged 25-36 months, with only 12 cases and the lowest success rate of 83.3% (10 successful cases). Overall, the success rate across all age groups was 90%, with 108 successful cases out of a total of 120 patients. The differences in success rates between age groups were statistically significant, with a p-value of 0.042.

Table 3: Duration of Symptoms and Treatment Outcomes in Hydrostatic Reduction of Intussusception (n=120)

Categories of Duration	Successful	Unsuccessful	Total	Success Rate	P-value
6 to 12 hours	45	2	47	95.7%	0.035
13 to 24 hours	43	4	47	91.5%	
25 to 48 hours	20	6	26	76.9%	
Total	108	12	120	90.0%	

Table 3 analyzes the relationship between symptom duration and treatment success in the same 120 patients. The cases were divided into three categories. The 6-12 hour and 13–24-hour categories each included 47 patients, while the 25-48 hours category included 26 patients. The highest success rate was observed in patients treated within 6-12 hours of symptom onset, with 95.7% success (45 out of 47 cases). For patients treated between 13-24 hours, the success rate was slightly lower at 91.5% (43 out of 47 cases). The lowest success rate was observed in patients treated between 25-48 hours, at 76.9% (20 out of 26 cases). The overall success rate across all treatment duration categories was 90% (108 out of 120 cases). The association between symptom duration and treatment success was statistically significant, with a p-value of 0.035.

The distribution of symptoms among the 120 patients showed that abdominal pain predominated in 93% of cases and was thus the most common symptom. Pyrexia (fever) was the second most common manifestation, affecting 86% of patients. A palpable abdominal mass was noted in 79% of cases, which is an important clinical finding. Vomiting occurred in more than half of the patients, namely in 56% of cases. Bloody diarrhea was the least common of the major symptoms, occurring in 23% of patients. These results show a clear pattern of symptomatology, with abdominal symptoms and fever being the most common clinical manifestations in the population studied, as shown in **Figure 1**. Abdominal ultrasonography before the procedure showed that ileocolic intussusception was the predominant form in 85% of cases (n=102), while colocolic intussusception was observed in 5% of patients (n=6). Pathologic drainage points were identified in 4% of cases (n=5). The intussusceptum was most frequently located in the transverse colon (45%, n=54), with a mean length of intussusception of 4.8 cm. Ultrasonography revealed trapped lymph nodes in 52% of cases (n=62), while both trapped fluid and free peritoneal fluid were observed in 20% of cases (n=24).

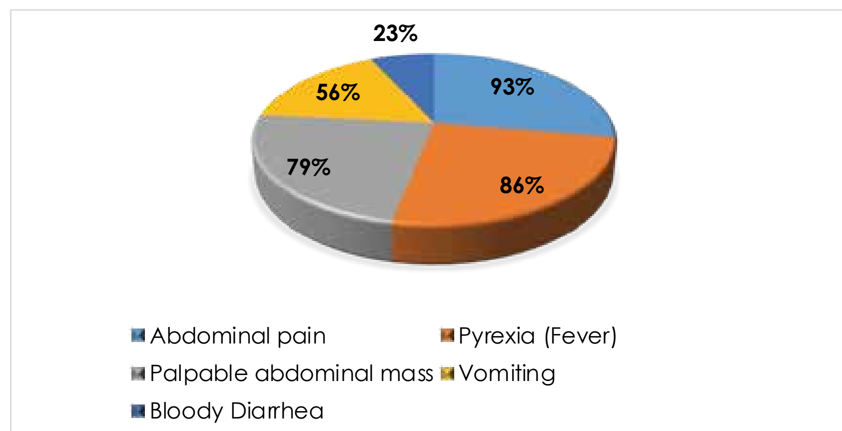

Figure 1. Distribution of Presenting Symptoms

DISCUSSION

The study demonstrated an overall success rate of 90.0% (n=108/120) for non-sonographic guided hydrostatic reduction. The highest success was observed in patients treated within 6–12 hours of symptom onset (n=45; 95.7%), emphasising the importance of early intervention. Success rates declined significantly with delayed treatment, dropping to 76.9% (n=20/26) for cases treated after 24 hours. Children aged 7–12 months exhibited the highest success rate (n=45/49; 91.8%), consistent with the peak incidence of intussusception reported in the literature. A slight male predominance was noted, with a male-to-female ratio of 1.3:1 (n=68; 56.7% males vs. n=52; 43.3% females). Abdominal pain (n=112; 93%), fever (n=103; 86%), and a palpable abdominal mass (n=95; 79%) were the most common presenting symptoms, aligning with typical clinical features of intussusception. Ultrasound findings revealed ileocolic intussusception as the predominant type (n=102; 85%), with trapped lymph nodes observed in more than half of the cases (n=62; 52%) and free or trapped fluid in 20% of cases (n=24).

These findings highlighted the efficacy of non-sonographic guided hydrostatic reduction as a viable treatment option in resource-limited settings, particularly when cases were identified and managed promptly. Intussusception occurs more frequently in children younger than 2 years, and it can result from a variety of underlying causes. The incidence of this condition decreases after the age of two[14,15,16]. In individuals experiencing intussusception, the swelling and reduced blood flow in the gastrointestinal tract progressively deteriorate over time, leading to an increased risk of perforation associated with enema treatment as time passes[17]. Research has indicated that the presence of bloody stool is a significant risk factor linked to the recurrence of pediatric intussusception and serves as an indicator of the condition's severity[18, 19].

The study evaluated the results of hydrostatic reduction in 120 children with intussusception, with an overall success rate of 90.0%. This success rate is comparable to or slightly higher than those reported in similar studies, which typically range from 75% to 95%[20, 21].

The gender distribution in the study showed a male preponderance (56.7% males versus 43.3% females) with a male to female ratio of 1.3:1. This finding is consistent with previous literature, which consistently reports a higher incidence of intestinal infarction in male[22, 23]. The exact reason for this male preponderance remains unclear and requires further investigation.

An age-related analysis revealed that most cases occurred in infants aged 7-12 months (40.8% of total cases), followed by children aged 13-24 months (32.5%). This age distribution pattern is consistent with worldwide epidemiologic data identifying the first year of life as the peak period for the occurrence of intestinal infarcts[24,25]. Success rates varied significantly between age groups (p=0.042), with the highest success rate observed in the 7-12 months group (91.8%) and the lowest in the 25-36 months group (83.3%). This variation may be due to anatomical differences and the potential for more complex pathology in older children.

An important finding of our study was the strong correlation between symptom duration and treatment success (p=0.035). Cases treated within 6-12 hours of symptom onset had the highest success rate (95.7%), while the success rate for cases treated after 24 hours was significantly lower (76.9%). This significant decrease in success rates with delayed presentation underscores the critical importance of early diagnosis and intervention for intussusception[26]. Similar time-dependent results have been reported in other studies[27], supporting the concept that early intervention is a key factor in successful non-surgical reduction. The symptom profile observed in our study population showed abdominal pain (93%) and fever (86%) as the predominant symptoms, followed by a palpable abdominal mass (79%). This clinical presentation largely corresponds to the classic triad of symptoms of intussusception. However, bloody diarrhea, which is often considered a characteristic sign, was present in only 23% of our cases, suggesting that its absence should not reduce the clinical suspicion of intussusception.

The ultrasound findings in our study showed that ileocolic intussusception was the most common type (85%), which is consistent with the established literature[28]. The predominant location in the transverse colon (45% of cases) and the presence of entrapped lymph nodes in 52% of cases provide valuable diagnostic information for clinicians. These results support the utility of ultrasound as a primary diagnostic tool in suspected intussusception.

The results have important clinical implications. The high success rate of hydrostatic reduction, especially when performed early, supports its use as a first-line treatment for uncomplicated intussusception. The significant impact of symptom duration on treatment success underlines the need for greater awareness among GPs and parents of the importance of early presentation and prompt referral.

Future research directions should include prospective multicenter studies to validate these findings and investigate factors that might predict unsuccessful reduction. In addition, studies investigating the role of different technical modifications in hydrostatic reduction could contribute to further optimization of the procedure.

CONCLUSION

This study shows that non-sonographic guided hydrostatic reduction is a highly effective treatment for pediatric intussusception, with a success rate of 90.0%. The success of the procedure was particularly influenced by early intervention, with optimal results observed within the first 12 hours of symptom onset. Our results confirm that this technique provides excellent results even without sonographic guidance, especially in infants aged 7-12 months. We conclude that non-sonographic guided hydrostatic reduction should be considered a safe and reliable initial treatment option for uncomplicated pediatric intussusception, provided it is performed early in the disease course.

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CONFLICT OF INTEREST

None

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ETHICAL APPROVAL

The study received ethical approval from the Institutional Ethical Review Committee of Timergara Teaching Hospital, Dir Lower, Pakistan under reference number (6857).

AUTHORS' CONTRIBUTIONS

All the authors contributed equally.

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