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Treatment Outcome of Hydrostatic Reduction of Intussusception and its Associated Factors Among Pediatric Patients in Tibebe Ghion Specialized Hospital, Bahir Dar, Ethiopia

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BAHIR DAR UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF MEDICINE

DEPARTMENT OF CLINICAL RADIOLOGY

TREATMENT OUTCOME OF HYDROSTATIC REDUCTION OF
INTUSSUSCEPTION AND ITS ASSOCIATED FACTORS AMONG
PEDIATRIC PATIENTS IN TIBEBE GHION SPECIALIZED HOSPITAL,
BAHIR DAR, ETHIOPIA

BY CHALA TAKELE (MD)

A THESIS REPORT SUBMITTED TO BAHIR DAR UNIVERSITY SCHOOL
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Abstract

BACKGROUND: Despite advances in non-invasive radiologic techniques for the treatment of intussusception, management of the entity remains exclusively surgical in many developing countries, including Ethiopia. Ultrasound-guided hydrostatic reduction (USGHR) was recently introduced to the main referral hospital in Ethiopia and subsequently has been adopted as the initial management option for intussusception. Knowing the treatment outcome of hydrostatic reduction of intussusception and its associated factors will reduce the workload of hospitals and also help the Radiologists and treating physicians to think of alternative treatments.

OBJECTIVE: The objective of the study was to assess the treatment outcome of hydrostatic reduction and its associated factors among pediatric patients with the diagnosis of intussusception in Tibebe Ghion Referral Hospital, Bahir Dar, Ethiopia 2022 GC.

Method: Institutional-based cross-sectional and a prospective study using systematic random sampling was conducted from Feb-August 2022 G.C on pediatric patients Tibebe Ghion Referral Hospital, Bahir Dar Ethiopia. The sample size was 145 and pediatric patients who underwent USGHR with US-confirmed intussusception who were clinically suspected of intussusception and sent to the Radiology department for ultrasound were selected. Data was entered using EpiData software and statistical analysis using SPSS version 26. Both simple and multiple binary logistic regression was employed to identify candidate variables for multiple binary logistic regression and factors associated with the treatment outcome of hydrostatic reduction. P-Values of less than 0.05 were considered statistically significant.

Results: From A total of 145 children who were diagnosed with intussusception, confirmed via ultrasound, 135 patients (93.1%) had successful reduction following exclusion criteria. The mean age of children who were diagnosed with intussusception was 24.27 months. Among independent variables, length of intussusception and duration of illness were significantly associated with hydrostatic reduction outcome. It was also found that the success rate increased in those patients with a shorter duration of symptoms and the length of the invaginated segment ($P < 0.05$).

Conclusion: Ultrasound-guided hydrostatic reduction of intussusception is a simple and effective method for the treatment of Intussusception and can be performed with high success rate. This study resulted in a success rate of 93.1%. The short duration of symptoms and length of the invaginated segment may have positive effects on the success of the procedure.

Keywords: Intussusception, Pediatrics, Hydrostatic reduction.

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Acronyms

US Ultrasound

ESCH EthioSwedish child health

TSRH TibebeGhio Specialized Hospital

USGHR Ultrasound Guided Hydrostatic Reduction

TASHTikurAnbessa Specialized Hospital

COR crude odds ratio

AOR adjusted odds ratio

1. INTRODUCTION

1.1 Background

Intussusception is the most common cause of acute intestinal obstruction in infants and young children. It occurs when a segment of the bowel invaginates into the distal bowel, resulting in venous congestion and bowel wall edema. The classical clinical triad, consisting of abdominal colic, red jelly stools and a palpable mass, is only present in approximately 50% of cases, 20% of patients are asymptomatic at clinical presentation (1).

Intussusception was first described by Paul Barbette of Amsterdam in 1692. In 1876, Harald Hirschsprung made the first attempt at hydrostatic reduction of intussusception using water. The sonographic features of intussusception were described in (2,19) Kim and his colleagues described the first successful sonography-guided hydrostatic reduction in 1982 (3).

But there remains considerable variability regarding both its diagnosis and treatment; non-operative treatment includes reduction with barium, air, or saline enema under fluoroscopic or ultrasound (US) guidance (4).

USGHR has gained widespread acceptance as a tool for intussusception (ISN) reduction, with extensive literature documenting high success rates comparable to or better than fluoroscopic air reduction (6). Despite advances in non-invasive radiological techniques for the treatment of intussusception, management of the entity remains exclusively surgical in developing countries, including Ethiopia. Ultrasound-guided hydrostatic reduction (USGHR) was recently introduced to the main referral hospital in Ethiopia and subsequently has been adopted as the initial management option for intussusception (7).

Despite this widespread acceptance, ultrasound-guided hydrostatic reduction is not used in many parts of the world, particularly in developing countries. This has been attributed to various reasons highlighting lack of resources as well as lack of expertise (8).

Sonography can demonstrate intussusception, is widely available, easily performed, does not produce radiation, and can be used to screen suspected cases (9).

Ultrasound is a reliable imaging modality for the diagnosis of intussusception, which enables the diagnosis or exclusion of intussusception with a sensitivity of 98-100%, specificity of 88% and a negative predictive value of 100% (9).

Intussusception has a characteristic sonographic appearance. This is described as an abdominal mass with a target sign, doughnut sign, concentric ring sign on the transverse section and a pseudo kidney or sandwich sign on the longitudinal section. Abdominal ultrasound may assist in the definition of a pathologic lead point and monitor the success of enema reduction without the need for radiation exposure. A lack of Color Doppler flow in the bowel wall has been reported to assist in the prediction of the irreducibility of the intussusception by enema (10).

Once the diagnosis of intussusception is established, surgical reduction (NSR) is used. Non-operative management is indicated in hemodynamically and clinically stable children, with high clinical suspicion of intussusception or radiological evidence of intussusception, but without any evidence of bowel perforation. A surgical approach is chosen in patients with signs of perforation, shock or peritonitis. Depending on the choice of guiding imaging technique, different contrast media are used for NSR. Barium suspension or air with fluoroscopic guidance, or saline only or mixed with water-soluble contrast under sonographic guidance, has to be used. Regardless of the used contrast medium, NSR is an effective technique, being successfully employed in more than 90% of cases (11).

Besides previously described suggestions to explain this variation in rates, some authors also noted the presence of factors that predisposed to lower reduction rates. Those risk factors include; the younger age, the presence of rectal bleeding on the clinical exam, the presence of radiographic signs of bowel obstruction, a longer duration of symptoms (usually more than 24 hours), early recurrence and an ileoileal or ileocolic type of intussusceptions. These factors could be considered when decision making towards the optimal treatment for a specific patient (12).

Failure to make a prompt diagnosis and initiate appropriate treatment may lead to bowel ischemia, perforation, peritonitis, shock and even death. The clinician, therefore, may have to rely on imaging procedures to diagnose or exclude the presence of intussusception promptly and accurately (13).

Hence, the need for early medical advice, diagnosis and intervention should reduce the mortality due to intussusception in children (14).

1.2 Statement of the problem

It is mentioned that intussusception is the most common cause of acute intestinal obstruction in infants and young children. If intussusception progresses and is not treated, it can eventually become fatal. Mortality caused by intussusception has become rare in developed countries through timely diagnosis and treatment with enema or surgery. In developing countries, patients might present with more serious illnesses, and mortality rates are higher because of limited access to health care (15). Mortality rates from intussusception in developed countries are less than 0.5%, while studies from developing countries report mortality rates up to 18%. This high rate of mortality underscores the need to treat intussusception in a timely and efficient manner (7).

In a retrospective study on treatment outcome in the University of Port Harcourt Teaching Hospital, Nigeria conducted from October 1985 to September 1992 on infants and children whose diagnosis was made clinically and confirmed at operation, Mortality was 11.6%. The high mortality rate appears to be related to the long interval between the onset of symptoms and the commencement of definitive treatment (16).

When it comes to our country, Ethiopia, few studies were done on adolescents and adults as well as children in Black Lion Hospital, the magnitude of mortality due to intussusceptions, showed an increased mortality trend in a ten-year review (14, 17). A study done in TASH on pediatric patients over a three-year review showed a mortality of 9.5% obtained as the surgery was the only means of treatment in the hospital due to apart from lack of facilities, the majority of the children presented late, >24 hours from the onset of symptoms (18). But the study did not include the treatment outcome of patients managed by hydrostatic reduction. This study will try to fill this gap.

There is no study done in Bahir Dar regarding treatment outcome and its associated factors among pediatric patients diagnosed with intussusception. So, this study will help develop local guidelines based on the experience in our setup and a baseline for future studies.

1.3 Significance of the study.

The purpose of this study is to assess the treatment outcome of hydrostatic reduction and its associated factors among pediatric patients with the diagnosis of intussusception TGS. As there is little study regarding the factors which affect treatment outcome of hydrostatic reduction of intussusceptions among pediatric patients in Ethiopia, this study will be used as initial input in the field. The importance of knowing the treatment outcome of hydrostatic reduction and its associated factors will improve physicians' confidence in treating intussusception and will reduce the workload of hospitals and postoperative complications, and it will also decrease the delay in intervention and complications.

This study helps to know factors associated with treatment outcome of hydrostatic reduction and will help the Radiologists and the treating physicians to think of alternative treatments. This study can also prompt those who are interested to conduct further research on this area, thereby identifying where the gap is and giving recommendations on how to improve it.

2. Literature review

2.1 Treatment Outcome

Intussusception is a common cause of bowel obstruction in young children in a pediatric emergency department. Delay or even misdiagnosis or indigestion can lead to significant morbidity and mortality. Hence, the diagnosis of intussusception should be suspected in all children, under the age of 3 years, with an acute colicky abdominal pain (1, 19)

The incidence of intussusception in infants and children is reported to be between 0.3 and 2.5 cases per 1,000 live births in North America, Europe, and Australasia. Although mortality resulting from intussusception is uncommon in developed countries, case fatality rates up to 50% have been reported in some developing countries (20).

A retrospective study done, in Germany (2009), revealed idiopathic intussusception in 95% of the cases. The remaining patients presented with Meckel's diverticulum and schwannoma of the small bowel. They used ultrasound as the primary modality for diagnosis in all the patients, with a diagnostic accuracy of 100% in the study. Conservative treatment using an air enema was successful in 79.5% of cases. A higher rate of surgical intervention was found in patients who had symptoms for more than 24 h and in referred patients (21)

Although lead points can be detected with a contrast enema study, they can easily be missed or even reduced with this technique. The US allows better detection and characterization of lead points than does a contrast enema study. One would be in error to wait for the classical triad presentation before beginning the appropriate diagnostic testing (22).

A record review study of infancy and childhood intussusception at King Fahad National Guard Hospital in the Kingdom of Saudi Arabia from January 1984 through December 2000 showed that 4 recurrences in 3 children had successful enema reduction. Since most intussusceptions were already in the cecum at surgery after failed enema reduction, a repeat or delayed enema reduction was considered in stable cases. Recurrent intussusception occurred in 3 operated cases and adhesive intestinal obstruction in 3 Laparotomy cases. The 4 recurrences in 3 children had successful enema reduction. There was no mortality but 3 operative cases required late surgery for adhesive intestinal obstruction including one requiring bowel resection (23)

A prospective study done on Presentation and management outcome of childhood intussusception in Lagos, Nigeria showed Surgical exploration was the mainstay of treatment in 169 (97.1%) patients. Ileocolic intussusception was seen in 133 (78.7%) of all cases that had laparotomy, the colocolic variety was recorded in 28 (16.6%) cases, whereas the ileoileal type was seen in eight (4.7%). 119 (70.4%) patients the manual reduction was attempted the surgery. Forty seven (27.8%) of these attempts were successful. A total of 119 (70.4%) (Comprising the 75 unsuccessful reductions and another 44 deemed outright unfit for manual reduction at laparotomy) underwent bowel resection and end-end anastomosis. Nine six (56.8%) of these patients had right hemicolectomy whereas in 23 (13.6%) others, limited ileal resection was performed. The hydrostatic reduction was not attempted in this series (21).

In a well-designed comparative study of management outcome of intussusception between a rural African setup and an American metropolis hospital, Mechal, attributed the 18% mortality rate in the Africans to delayed presentation and consequent gangrene and opined that non-operative reduction would have achieved little in this group of moribund late presenter (24).

A retrospective study on treatment outcome on the University of Port Harcourt Teaching Hospital, Nigeria conducted from October 1985 to September 1992 on infant children whose diagnosis was not clinically and confirmed at operation, All 69 patients had laparotomy as reduction using barium enema was not attempted. Of the 35 patients who required resection, 27 (77.1%) had gangrenous bowel and 2 (2.8%) had perforation. Mortality was 11.6%. The high mortality rate appears to be related to the long interval between the onset of symptoms and the commencement of definitive treatment (16).

Even though there is inadequate available study or data on infancy and childhood intussusceptions in Ethiopia, a three year retrospective review of adolescent and adult patients' records with an intraoperative diagnosis of intussusception in three teaching Hospitals in Addis Ababa, Ethiopia, i.e. TikurAnbassa (TAH), Princess Zewditu Memorial (ZMH) and St. Paul's Hospitals (SPH), shows the magnitude of mortality due to intussusception.

In this study, the median duration of illness was 144 hours with a range of 16 hours. The Ileocolic type was identified in 14 (56%) of the cases. Fifteen (60%) cases were primary

(Idiopathic). Benign conditions represented the majority (67%) of the identified lead points. Intraoperative reduction was successful in only 6 (24%) of the cases, all of which were idiopathic. Four of their patients died giving an overall mortality rate of 16%. All of the deaths were from the idiopathic variety. Irreversible septic shock with multiorgan failure was the cause of death (14).

A study done in TAH on pediatric intussusception over a three-year review showed that a normal bowel wall was found in 27 (64.3%) and successful surgical reduction of the intussusceptions was possible. 14 (33.3%) children had devitalized bowel, and one perforated required bowel resection (18).

In a study done on implementing the ultrasound-guided hydrostatic reduction of intussusception in a low-resource country in Sub-Saharan Africa: our initial experience in TAH, Ethiopia 2017, the reduction was successful in 41 of the 47 (87.2%) patients. Twenty of 25 patients (88%) with symptoms for less than 24 h had successful reduction. The highest percentage, 88.9% success rate, was noted in the patients who presented within 24 h of symptom duration. Similar percentages were noted for the remaining patients, even in those with symptom duration greater than 72 h (83.3% success rate). Intussusception recurrence was seen in 11 (23.4%) of the patients who underwent USGHR. All the recurrences occurred within 24 h and were treated successfully with repeat USGHR. Six of the 47 (12.8%) patients failed USGHR and underwent surgery immediately after the failed reduction (10).

2.2 associated factors

A retrospective, case-based study of all patients with intussusception presenting to the Royal Children's Hospital, Brisbane, Australia between 1 April 1994 and 31 March 2004 showed the median age of presentation was 9 months, with a ratio of male to female of 1. Three or more of the four classic features of intussusception (vomiting, abdominal pain, bloody/red currant jelly stool, or abdominal mass) were reported in only 46% of presentations. The median time to confirmation of diagnosis was 19 h from onset of symptoms. Ultrasound was the most commonly employed method used to confirm the diagnosis. Air enema had a success rate of 80%, with a reduced success rate beyond the first attempt (25).

Although intussusception-associated infant deaths in the United States have declined substantially over the past 2 decades, some deaths seem to be related to reduced access to or

delays in seeking health care and are potentially preventable intussusceptions. Intussusception associated hospitalizations were uncommon in the first 2 months of life, peaked from 5 to 7 months of life, and showed no consistent seasonality. Intussusception associated infant mortality rates declined from 6.4 per 1,000,000 live births during 1971 to 2.3 per 1,000,000 live births during 1995-1997 (relative risk = 2.8, 95% CI = 1.8-4.3). Infants whose mothers were <20 years old, nonwhite, unmarried, and had an education level below grade 12 years were at an increased risk for intussusception associated death. Studies on the time of presentation after the onset of symptoms indicated late presentation (26).

A record review study of Point-of-care ultrasound may be useful for detecting pediatric intussusception at an early stage in University of Ulsan College of Medicine, Seoul, Republic of Korea done in 2020 showed presenting symptoms were intermittent abdominal pain/irritability or bloody stool, or the 2 symptoms among nonspecific abdominal pain/mass/distension, vomiting, or lethargy with a mean symptom duration of 11 (27).

A record review study of infancy and childhood intussusception at King Fahad National Guard Hospital in the Kingdom of Saudi Arabia from January 1984 through December 2000 showed the clinical features included rectal bleeding (81%), vomiting (78%), abdominal pain (65%) and abdominal mass (62%). All cases were ileocolic intussusception with no leading point. Seventy percent of the cases presented within 24 hours of the onset of symptoms (23).

The prospective study was carried out on 116 consecutive patients under two years of age, at the Pediatric Center of Hue Central Hospital (Hue City, Vietnam) showed Clinical presentation included abdominal pain (100%), vomiting (82.2%), bloody stool (11.9%), and a palpable mass (43.2%). Patients hospitalized with the symptoms and signs for less than 24 hours accounted for 80.5% of the cases. The overall success rate of pneumatic reduction was 98.3%. Late hospital admission (> 24 hours from illness onset), bloody stool, and not presenting with the classic triad of symptoms of intussusception were found as the factors that correlated to the surgical management outcome. All patients recovered well without any complications. The median postoperative hospital stay of two days for the pneumatic reduction group and six days for the operation group (28).

In a study on Intussusception in children studied at Muhimbili National Hospital, Dares Salaam, the majority of the children presented late, >48 hours from the onset of symptoms and the diagnosis was mainly based on clinical symptoms and signs of intestinal obstruction and confirmed with the presence of multiple fluid levels on a plain erect abdominal x-ray. All children were then managed by surgery, 11(39.3%) underwent bowel resection. Histopathology reports of those available did not show the cause of intussusception. Seven patients died postoperatively with a hospital mortality of 25 % (29).

Rectal bleeding was reported in a higher proportion of patients in studies from developing countries (median, 79%; range, 17-100%) compared with developed countries (median, 53%; range 14-72%) ($P < 0.001$) Rectal bleeding occurs commonly in young infants with intussusception occurring in 96% of infants less than 4 months of age (20).

Regarding the mortality rate of intussusception in Ethiopia, in 1993 a year review showed an increased mortality trend. Sixty six cases of intussusception were admitted to ESCH, Addis Ababa over 10 years. Males dominated in the series. Age distribution showed that 69.7% of the cases were < or = 1 year old, and 85% were < or = 2 years old. The mortality was high probably because the majority of cases presented late for medical attention. The need for early medical advice, diagnosis and interventions should reduce mortality (17).

A study done in TAH on pediatric intussusception over a three year review showed, at operation, 18 (47.4%) children had ileocolic, ileocolocolic 16(42.1%), and 2 (5.3%) ileoileal and ileoileocolic intussusceptions each. Four (9.5%) children had Meckel's diverticulum, one (2.4%) appendix was found which acted as a lead point, In 18(42.9%) cases, there was no identifiable pathology in the intestines, while 20 (47.6%) children had mesenteric lymphadenopathy and inflamed Peyer's patches and the majority of the children presented late, >24 hours from the onset of symptoms (18).

A study done in Enugu State University Teaching Hospital, Enugu, Nigeria, 2021 Intussusception in children: effect of symptom duration on the outcome of hydrostatic reduction stated that Children with intussusception who present early (within 48 h of onset of symptoms) had a more successful hydrostatic reduction when compared with patients who present after 48 hours (30).

A study done at Van Yuzuncuyil University, Faculty of Medicine, Pediatric Surgery Department, Van, Turkey, 2018 showed that reduction was successful in 83.9% of the patients with a history of rectal bleeding and 94.7% of the patients with no history of rectal bleeding (5). The mean duration of symptoms was 2.74 days in the patients with successful reduction and 4.33 days in the patients with failed reduction. The mean diameter and length of the invaginated segments measured on USG were 3.5 cm and 5.12 cm in the patients with successful reduction and 4.27 cm and 9.23 cm in the patients with failed reduction, respectively. No significant difference was observed between the patients with successful and failed reduction in terms of rectal bleeding, vomiting, gender, age, and body weight ($P > 0.05$). It was also found that the success rate increased as the number of reduction attempts increased and the success rate decreased as the duration of symptoms and the diameter and the length of the invaginated segment increased ($P < 0.05$) (31).

3. Conceptual framework

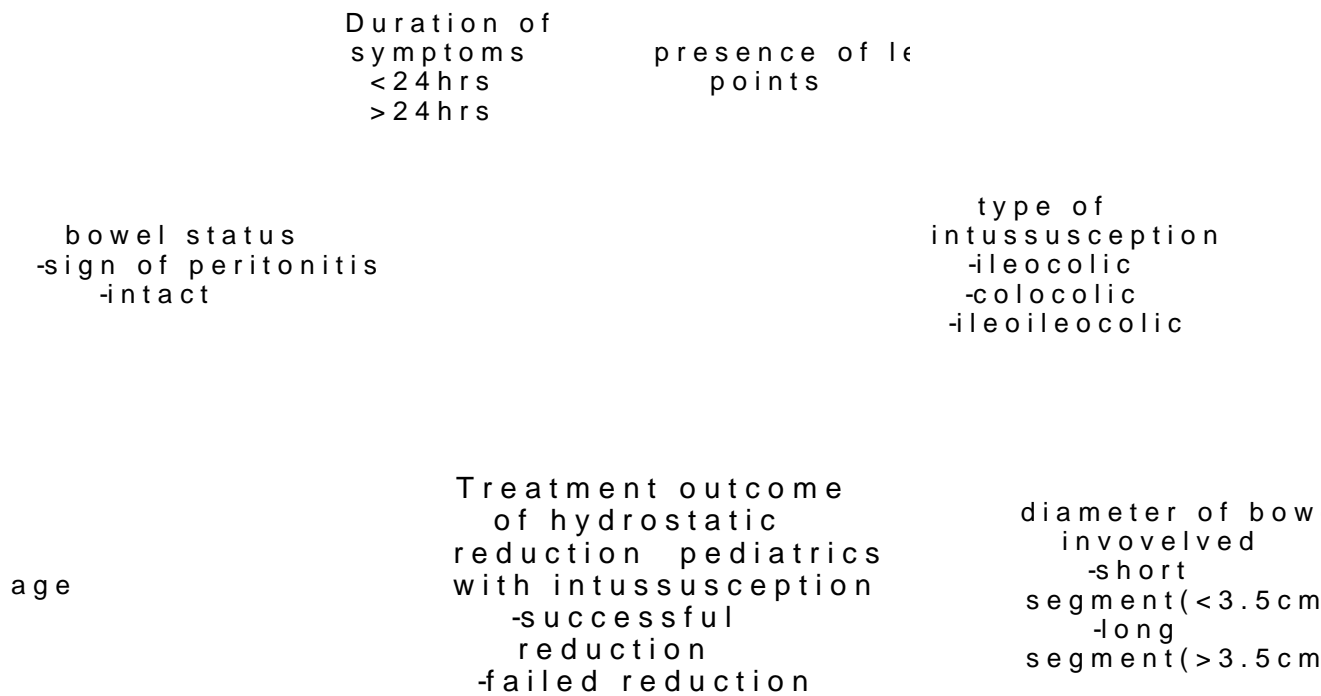


Figure 1: - conceptual framework of hydrostatic reduction and its associated factors among pediatric patients undergoing UGHR at TGSH, in Bahir Dar, Ethiopia, 2022.

4. Objectives of the study

4.1 General objectives

- To assess treatment outcome of hydrostatic reduction and its associated factors among pediatric patients with the diagnosis of intussusception in Tibebe Ghion Referral Hospital Bahir Dar, Ethiopia.

4.2 Specific objectives

- To determine the proportion of treatment outcome of hydrostatic reduction among pediatric patients with the diagnosis of intussusception.
- To identify factors associated with treatment outcome of hydrostatic reduction among pediatric patients with the diagnosis of intussusception.

5. Methods and materials

5.1 Study area and period

The study was conducted at Tibebe Ghion Specialized Hospital (TGSH), which is found in Bahir Dar which is the capital city of Amhara region and 578km northwest of Addis Ababa. The city has 3 sub-cities and 16 Kebeles. The total population of the city is 750,991 populations (2016). The city has two referrals, one district hospital, 4 private hospitals, six higher, and five health centers owned by the government and private sectors. TGSH is a teaching university hospital established in 2018 and has more than 350 beds for inpatient management and serves more than 8 million people from parts of Amhara and Benshangul Gumuz for patient and outpatient treatment. It is a training center for undergraduates and a wide spectrum of postgraduate studies. The radiology department has 7 radiologists, 26 residents, and 6 radiology technicians. The study was conducted from February to August 2022 G.C.

5.2 Study design

The study was an institution-based prospective cross-sectional study design.

5.3 Source population

All pediatric patients with intussusception in Tibebe Ghion Specialized Hospital, TGSH.

5.4 Study population

Pediatric patients with a confirmed case of intussusception underwent hydrostatic reduction during the study period.

5.5 Inclusion and exclusion criteria

5.5.1 Inclusion criteria

Pediatric patients who had a confirmed case of intussusception, multiple concentric rings of layers of bowel walls, classically described as the target or crescent-in-doughnut signs in the axial plane, and the sandwich, or pseudokidney signs in the longitudinal plane, who undergoes hydrostatic reduction.

5.5.2 Exclusion criteria

Those patients with clinical signs of perforation and peritonitis, complex intraperitoneal fluid, lack of color flow of bowel within the intussusception on color Doppler US, and duration of symptoms > 4 days.

Patient diagnosis miscoded, history lost and insufficient clinical data recorded to allow assessment of the clinical case definition

5.6 Sample size determination

The sample size was calculated using the formula $n = \frac{z^2 pq}{d^2}$, using a p-value of 0.895 (18)

$n = \frac{z^2 pq}{d^2}$ where

z is CI of 95% which is 1.96

P is the proportion of patients having positive ultrasound result of intussusception

d is the margin of error which is 5%

$$n = 1.96^2 \times 0.895 \times 0.105 / 0.05^2 = 1444 = 145$$

Hence in this study a total of 145 subjects should be

Sample size calculation for the second objective

From the previous, the believed estimated segment of intussusception associated with the outcome of hydrostatic reduction of ileocolic intussusception using CI of 95% margin the sample size was calculated using the formula $n = \frac{z^2 pq}{d^2}$, using p value (0.008) (31). And the sample size became 122.

The sample size calculation using the proportion of patients having positive ultrasound result of intussusception was larger than the factor. So, the final sample size was 145.

5.7 Sampling procedures

A systematic random sampling technique was used to select the study participants. All the patients with the diagnosis of intussusception during the study period were given a serial number. By using a constant interval, k , which was calculated by dividing the total population size by the desired sample size it became $k=2$. So the sample was taken in every other patient to obtain a total sample size of 145. The first sample size was selected using the lottery method.

5.8 Study variables

5.8.1 Independent variables

- age
- Duration of symptoms
- Rectal bleeding
- Lead point
- Type of intussusception
- Length of intussusception

5.8.2 Dependent variables

- Treatment outcome of hydrostatic reduction

5.9 Operational definitions

Reduction: the progression of intussusception both on longitudinal and transverse sections until it is completely reduced or perforation is suspected

Successful Reduction: when the progression of intussusception is completely reduced or disappeared during (3-5x) attempts.

5.10 Data collection tools and procedures

A structured questionnaire was developed based on study objectives and available literature. Data that were extracted from the medical records included patient age, gender, duration of symptoms, presenting symptoms, and results of treatment. The ultrasound finding which was done by the hospital-allocated radiologic resident or radiologist was collected. Finally the treatment outcome of hydrostatic reduction was recorded.

5.11 Data quality control

The data entry and cleaning were made by the principal investigator. Frequency output was used to check missing values and cleaning was done using the original code number. Data collection was performed using Radiology Residents to improve the quality of data collection. The completeness and consistency of the collected data were checked on daily bases during data collection by the principal investigator. Whenever there appears incompleteness and ambiguity in recording, the filled information formats were crosschecked with source data soon. Individual records with incomplete data were excluded.

5.12 Data processing and analysis

The data was cleaned, stored, checked its completeness and entered using Epi-Info version 4.6 software. It was cleaned and edited accordingly and was exported to the SPSS version 26 statistical package for analysis and was checked for missing values before analysis. Descriptive statistics were used to generate and summarize frequencies. Both simple and multiple binary logistic regression was employed to identify candidate variables for multiple binary logistic regression and factors associated with the treatment outcome of hydrostatic reduction. In simple binary logistic regression variables with a p-value, of less than 0.25 were selected for multiple logistic regression analysis, and in multiple logistic regression analysis variables with a p-value, of less than 0.05 were considered statistically significant. Multi-collinearity was checked among independent variables through the variance inflation factor (VIF) and the observations in the dataset are independent of each other. Fisher's exact test were used to measure the strength of association between the factors considered and the dependent variable. A p-value less than 0.05 was considered for statistical significance.

5.13 Ethical considerations

Before conducting the study, permission and approval letter from TGSH hospital management and the research review committee of Bahir Dar University College of medicine and health science was received. Informed consent was obtained from the family or adoptee before the imaging. The participants of the study were told they could discontinue whenever they want. During the data collection procedure, patient privacy and confidentiality were kept to the maximum.

5.14 Dissemination of research findings

Based on the findings, after conclusion and recommendation, one soft copy and two hard copies of the research paper will be submitted to Bahir Dar University College of medicine and health science and Radiology Department and shared with the scientific community on CMEs or annual society meetings.

6 . Result

6.1 Sociodemographic characteristics

During the study period a total of 145 pediatric patients with the diagnosis of intussusception who met the inclusion criteria were analyzed studied with a response rate of 100%. Males accounted for 96 (66.2%) and females accounted for 49 (33.8) of the subjects. The study subjects were in the age group of -168 months with a mean age of 24.27 months. Table 1 shows the distribution of the age of occurrence of intussusception among patients undergone hydrostatic reduction. There were no statistical differences between the groups in terms of age and gender distribution ($P > 0.05$).

Age distribution was done according to NICHD, Eunice Kennedy Shriver National Institute of Child Health and Human Development (32).

6.2. Patient clinical presentation

The clinical features of the patients with the most common symptoms being colicky abdominal pain which accounted for 79 (54.5%), vomiting, diarrhea and abdominal distension. The least clinical presentation was abdominal distension which accounted for 3 (2.1%). There were no statistical differences between those patients whose hydrostatic reduction failed and those whose hydrostatic reduction was successful in terms of clinical presentation ($p > 0.05$).

6.3 Duration of illness

As the duration of illness is mentioned in table 1, most of the patients presented within 24 hrs of clinical presentation accounting for 123 (84.8%). The duration of symptoms was less than 24 hrs in those patients hydrostatic reduction were successful than those hydrostatic reduction that failed ($p = 0.021$). This P value is statistically significant.

6.4 Length of intussusception

The length of intussusception of the majority of the patients was short segment (3.5cm) accounting for 118 (81.4%) and peritoneal in a position which accounted for 101 (69%). Those patients with successful hydrostatic reduction had short segment in terms of length of intussusception than those patients with failed hydrostatic reduction ($p = 0.031$). This p-value is statistically significant.

In the majority of patients leading points were not identified which accounted for 126 (86.9%). Those patients leading points not identified had more successful hydrostatic reduction than those

patients leading points of intussusception identified (p=0.365). But this p-value is not statistically significant.

6.5 Types of intussusceptions

One hundred thirty two of the intussusceptions 135 (93.1%) were ileocolic, 3 (2.2%) were colocolic, and 7 (4.8%) were ileoileocolic intussusception.

6.6 outcome of hydrostatic reduction

One hundred thirty-five (93.1%) cases were successfully reduced under ultrasound guidance while 10 (6.9%) cases had failed reduction of intussusception. Of the failed cases five cases had mesenteric lymphadenopathies as the lead point and another five cases had a long segment (>3.5cm) length of intussusception. Successful reduction was defined as disappearance of the intussusceptum and reflux of saline into the ileum. A maximum of three attempts were made each reduction lasting approximately 35 minutes. The majority of reduction was done with the first attempt. All patients who had undergone successful USGHR were kept under observation for at least 24 hours to evaluate for recurrence and procedural complications. Ultrasound was performed on these patients and none of the patients had a recurrence. All patients whose intussusception did not respond to USGHR were treated subsequently by surgery. The spontaneous reduction was found in 1 patient, manual reduction was performed in 4 patients and bowel resection and anastomosis were performed in 5 patients because of irreducibility or gangrenous changes. No complication occurred during and after reduction in the two groups.

Table1 Distribution of Socio-demographic characteristics and factors associated with hydrostatic reduction in pediatric patients in TGSH, Baddi, Ethiopia, 2022 GC (n=145).

Variable	category	Frequency	Percent
Sex	Male	96	66.2
	Female	49	33.8
Age	Infancy	47	32.4
	Toddler	32	22.1
	Childhood	66	45.5
Clinical presentation			
	Abdominal pain	79	54.5
	Abdominal distension	3	2.1
	Vomiting	28	19.3
	Diarrhea	35	24.1
Duration of illness			
	Less than 24hrs	123	84.8
	More than 24hrs	22	15.2
Mean length of intussusception			
	>3.5cm	27	18.6
	<3.5cm	118	81.4
Location			
	Periumblical	101	69.7
	Right upper and lower quadrant	44	30.3
Lead point			
	Identified	19	13.1
	Not identified	126	86.9
Type of intussusception			
	Ileocolic	135	93.1
	Ileoileocolic	7	4.8
	Colocolic	3	2.1
Hydrostatic reduction outcom			
	Successful	135	93.1
	Failed	10	6.9
	Total	145	100

7. Association factors

In binary logistic regression: lead point, mean length of intussusception, duration of illness and location of intussusception were statistically significant at a p-value of 0.05

Significant variables in the bivariate logistic regression were entered into a multivariate logistic regression. The length of intussusception and duration of illness were significantly associated with hydrostatic reduction outcome at the p-value of 0.05.

Those pediatric patients with intussusception in whom the length of intussusception was short segment (3.5cm) were 7.434 times more likely to have a successful outcome of hydrostatic reduction than those patients with long segment (3.5cm) of intussusception. (AOR=7.434, 95% CI: 1.201-46.02, p-value 0.031).

Those pediatric patients with intussusception who presented within 24hrs of onset of their symptoms were 7.452 times more likely to have a successful outcome of hydrostatic reduction than those patients who presented after 24hrs of their onset of symptoms (AOR=7.452, 95% CI: 1.35-40.99, p-value 0.021).

Those pediatric patients with intussusception in which lead point was not identified (which in our cases were all mesenteric lymph nodes) were 2.171 times more likely to have a successful outcome of hydrostatic reduction than those patients in which lead point was identified (AOR=2.171, 95% CI: 0.405-11.63, p-value 0.365).

Table 2 Bi-variate and Multi-variate logistic regression showing the association of independent variables on hydrostatic reduction in pediatric patients seen at TGSB Bahir Dar, 2022 GC.

Variables	Hydrostatic reduction		COR(95%CI)	AOR(95%CI)	p-value
	Successful	Failed			
Patient age					
<12month	56	5	1		
>12month	79	5	1.411(0.395-104)	1.117(2.544-907)	0.600
Leading point					
Yes	14	5	1	1	
No	121	5	8.64(2.22-33.58)	2.17(0.405-11.63)	0.365
Length of intussusception					
>3.5cm	22	5	1	1	
<3.5cm	113	5	5.14(1.37-19.23)	7.43(1.201-46.02)	0.031
Duration of illness					
>24hr	17	5	1	1	
<24hr	118	5	6.94(1.82-26.5)	7.453(1.354-0.99)	0.021
Location of intussusception					
Right upper and lower quadrant	39	5	1	1	
Periumbilical	96	5	2.462(0.675-8.98)	2.845(0.626-12.983)	0.176

8. Discussion

The management of intussusception in children has changed in recent times with the transition from surgery to nonoperative reduction and from hydrostatic to pneumatic reduction. Hydrostatic reduction using normal saline is still favored as the means of operative treatment in many parts of the world (11, 33) US-guided hydrostatic reduction is an easy, radiation-free, cost-effective method with high success rates. Its success rate ranges from 67% to 100% when compared to fluoroscopy-pneumatic reduction (34).

While hydrostatic reduction of intussusception is well established in developed countries, its practice in developing countries is shaky due to late presentation, lack of facilities, and well-trained expertise (35).

Intussusception is one of the most common causes of acute abdomen in infants and children less than 2 years of age (36). Bowel infarction and perforation may develop if the entity is not diagnosed and treated promptly. Unfortunately, children do not always present with the classic signs and symptoms of abdominal pain, vomiting, red currant jelly stool, and a palpable mass. The US has proven to be a highly valuable tool in intussusception diagnosis, with improved diagnostic accuracy than plain radiograph (37).

The peak age of presentation (8 months), male to female ratio ~2:1 and the male dominance recorded in the current study are consistently observed in many other reports (7, 38) It is also comparable with the study done at Royal Children's Hospital, Brisbane, Australia between 1 April 1994 and 31 March 2004, which showed the median age of presentation was 9 months, with a ratio of male to female of 2:1.

In this study the finding of abdominal pain as the most common presenting symptom of intussusception is in line with the reports of other studies (7, 39, 40) In the present study the ileocolic type of intussusception was the most common. This is consistent with the observation

of most series In a prospective study done the presentation and management outcome of childhood intussusception in Lagos, Nigeria and colic intussusception was seen in (73.7%) of all cases Other types of intussusception such as ileoileal and colocolic can also occur in children but they are less common than the ileocolic type (39, 41)

In the current study, the majority of the patients leading point was not identified and the identified leading points were mesenteric lymphadenopathies, unlike done in TAH on pediatrics over a three year review that showed that four (9.5%) children had Meckel's diverticulum, one (2.4%) appendix was found which acted as lead point

In terms of symptom duration and USGHR outcome, the highest percentage of success rate was noted in the patients who presented within 24hrs (84.8%) of onset of symptom, and this study is comparable to other authors have described a lower success rate in prolonged duration of symptom (42).

This study result is also consistent with the study done in Peshawar, Pakistan, 2020 on the outcome of ultrasound guided reduction of intussusception using normal saline which showed success rate for patients presented within the first day was 96.2% (n=5/26) as compared to 85.7% (n=24/28) in patients presented 1-2 days and 65.3% (17/26) in patients presented after two days (43). But some reports recommended reduction as the first line treatment in all children with intussusception regardless of length of symptom (44).

According to our study, among associated factors, length of intussusception, short segment and duration of illness of 24hrs were significantly associated with hydrostatic reduction success. The majority of our cases with successful hydrostatic reduction had short segment of intussusception as compared to failed. No significant difference was observed between the patients with successful and failed reduction in terms of gender and age. This is a comparative study as compared to previous report (31).

The overall success rate of USGHR in our study was 93.1%, which falls within the range of previously reported studies in both developed and developing countries. Collective review in 2004, Daneman and Navarro found that the success rate of hydrostatic reduction was 125%

95.5% (11). Additional articles from other developing countries including India, Turkey, and Egypt reported success rates ranging from 67 to 95% (45, 46)

The overall success rate in our study was higher compared with local and regional reports. According to Kevin Emeka Chukwubuike Hydrostatic reduction of intussusception in children in a single center done in Nigeria, 2020, the success rate was 65%. Lack of expertise was found to be the primary reason for the low rate of utilization of USGHR in Nigerian hospitals (47). Another group in Ghana reported a positive experience instituting USGHR with 75% success rate of reduction (66). Also as compared to a study done on ultrasound-guided hydrostatic reduction of intussusception in TAH, in our country Ethiopia, 2017, which reduction was successful in 41 of the 47 (87.2%) patients, this current study has a higher success rate (7).

9 .Strengths and Limitations of the study

9.1 Limitation of the study

The limitation of the present study is the relatively small sample size. A larger number of cases would have availed better analysis. The sample size is not representative of the general population as it was derived from a single institution, hence, the actual result for the general population cannot be extrapolated.

9.2 strength of the study

The strength of the study was being prospective study.

10 Conclusion and Recommendation

10.1.conclusion

Hydrostatic reduction of intussusception is a simple and effective method for the treatment of Intussusception can be performed with a high success rate and also be a good modality of choice for the treatment of intussusception. A short duration of symptoms and a short length of the invaginated segment may have a positive outcome on the success of the procedure. Therefore, early presentation and proper patient selection are necessary for optimal outcomes. And, we

believe USGHR should be fully implemented in our hospital and recommend that this study serves as an example to other institutions

10.2 Recommendation

To hospital staff and both radiology and surgery departments

- We recommend the surgical department strongly consider hydrostatic reduction as the first line of treatment for intussusception before the unnecessary trial of open reduction. We recommend a multidisciplinary approach between Radiologists, Pediatric surgeons, and clinicians for the treatment of intussusception.

To regional and federal administrative

- We recommend the regional health bureau and ministry of health facilitate diagnostic ultrasound facilities and equipment to the level of primary hospital to avoid unnecessary operations for intussusception.

To the researchers

- We recommend further research with a large population and a long study period to conduct multicenter prospective studies with large samples and further study on risk factors of hydrostatic reduction outcome

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