Section: Miscellaneous

Original Research Article

# EFFICACY OF ULTRASOUND-GUIDED HYDROSTATIC REDUCTION IN RECURRENT INFANTILE INTUSSUSCEPTION: A CLINICAL OUTCOME STUDY

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ABSTRACT

**Background:** Intussusception is a common, potentially life-threatening surgical emergency that primarily affects infants and young children. While the management of primary intussusception is well established, recurrent intussusception poses unique challenges that require further investigation and refined treatment strategies. Treatment options for recurrent intussusception may be either non-operative or operative, with non-operative approaches increasingly utilized even for recurrences. **Objectives:** The study aimed to evaluate the efficacy of sonography guided hydrostatic reduction in cases of recurrent intussusception in babies, and to look for epidemiological and clinical characteristics of babies with recurrent intussusception.

**Methods and Materials:** A Prospective study was conducted over a period of 2 years in children under the age of 8 years with ultrasound confirmed intussusception, with a previous documented history of intussusception managed by hydrostatic reduction. All the children excluding those with signs of peritonitis, complete intestinal obstruction, small gut intussusception, radiologically proven internal volvulus and radiologically proven internal volvulus were selected for ultrasound guided hydrostatic reduction. Maximum of three attempts at reduction were allowed.

**Results:** sonography guided hydrostatic reduction was successful in 90% of the patients in the study. The patient characteristics such as age and gender did not influence successful reduction. Clinical features of constipation, bleeding per rectum, abdominal distention were statically significant in patients with failed reduction ($p < 0.05$). Success rate decreased with increased symptom duration.

**Conclusion:** Our study found that ultrasound guided hydrostatic reduction is highly effective even in recurrent episodes of gut intussusceptions, with comparable success rates to reduction of first-time intussusceptions.

**Keywords:** Ultrasound, Ultrasound-Guided Hydrostatic Reduction, Infantile Intussusception.

## INTRODUCTION

Intussusception is a serious gastrointestinal condition characterized by one segment of the intestine telescoping into an adjacent segment. The invaginating segment is referred to as the intussusceptum, while the receiving segment is termed the intussuscipiens. This telescoping effect leads to obstruction, ischemia, and if left untreated, can result in necrosis of the bowel tissue, making timely diagnosis and treatment crucial. Intussusception is particularly common in infants and young children, with the highest incidence observed between 5 and 10 months of age. Although the treatment of primary intussusception is well-established, recurrent cases present distinct challenges that require further investigation and

optimization of treatment protocols. The global incidence of intussusception is estimated at 1 to 4 cases per 1,000 live births, with males more frequently affected. Recurrence rates range from 8% to 15%, adding complexity to management. Hsu et al. (2012) highlighted that recurrent cases often involve distinct contributing factors compared to primary cases. Recognizing these epidemiological trends is crucial for clinicians seeking to improve prevention and treatment strategies.

The etiology of intussusception is multifactorial, with most infant cases classified as idiopathic. A leading theory suggests hypertrophied lymphoid tissue in the terminal ileum, often triggered by viral infections, serves as a lead point. Seasonal peaks during viral gastroenteritis outbreaks support this hypothesis. Recurrent cases are more often associated with pathological lead points, such as Meckel's diverticulum, intestinal polyps, or lymphomas, which are less common in primary episodes. Identifying these lead points is critical, as they lower the success rate of non-operative reductions and increase the likelihood of surgical intervention.

Recurrent intussusception poses distinct diagnostic challenges. In primary cases, the classic triad of abdominal pain, vomiting, and bloody stools aids clinicians in making a prompt diagnosis. However, in recurrent episodes, these symptoms may be less pronounced or absent, increasing the risk of delayed diagnosis and treatment. Ultrasonography remains the gold standard for diagnosing intussusception, with characteristic features like the "target sign" or the "pseudo-kidney sign" being definitive indicators. However, previous interventions or anatomical changes resulting from earlier episodes may complicate the ultrasound interpretation in recurrent cases, necessitating a higher index of suspicion and vigilance from clinicians.

Historically, surgical intervention was the standard treatment for intussusception, particularly in recurrent cases. In recent years, however, non-operative techniques have gained popularity due to their lower risk of complications and better outcomes. Hydrostatic reduction has become the method of choice for many clinicians managing both primary and recurrent intussusception. This technique involves the use of either saline or air to reduce the intussusception and is performed under ultrasound or fluoroscopic guidance.

Ultrasound-guided hydrostatic reduction has emerged as a promising non-operative approach, offering real-time visualization that enables precise control during the reduction process while minimizing radiation exposure risks, particularly important for pediatric patients. The success rate ranges from 75% to 95%, influenced by case specifics and the medical team's experience. Although it demonstrates a high success rate in primary intussusception, its effectiveness in recurrent cases is still the subject of ongoing research and debate.

Ultrasound-guided hydrostatic reduction has shown favorable results in managing recurrent intussusception. Several advantages make it an attractive option for clinicians:

**No Radiation Exposure:** Unlike fluoroscopy-guided reduction, ultrasound-guided procedures eliminate the risk of radiation exposure.

Real-Time Monitoring: The process can be observed in real-time, allowing for immediate feedback on the success of the reduction or the need for further intervention.

**Reduced Risk of Complications:** Due to better visualization, the risk of bowel perforation is lower compared to other methods.

The clinical efficacy of this technique in recurrent cases, however, has produced mixed results. Some studies report success rates comparable to those seen in primary intussusception, while others suggest that recurrent episodes are more resistant to non-operative reduction, potentially due to underlying anatomical abnormalities or scar tissue from previous interventions.

Choubey et al. (2021) evaluated the effectiveness of ultrasound-guided hydrostatic reduction (UGHR) in recurrent intussusception, reporting a success rate of 83.3%. They concluded that UGHR is both safe and effective, though its success may be influenced by factors such as time since the previous episode and the presence of pathological lead points. This thesis aims to assess the safety and efficacy of Ultrasound guided hydrostatic reduction in managing recurrent intussusception in infants. Identify key factors that influence successful reduction and reduced recurrence rates. Propose evidence-based guidelines for optimal treatment strategies.

Through this research, we seek to fill gaps in existing knowledge, enhance treatment protocols, and provide insights into the pathophysiology of recurrent intussusception, with the goal of improving long-term outcomes for affected infants.

## MATERIALS AND METHODS

This study was a prospective observational investigation conducted over two years at Sheri-Kashmir Institute of Medical Sciences (SKIMS), aimed at evaluating the efficacy and safety of ultrasound-guided hydrostatic reduction in infants with recurrent intussusception in collaboration between the Departments of Radiology and Pediatric Surgery, the study focused on a cohort of infants under 8 years old with a documented history of intussusception followed by recurrence. Patients meeting the inclusion criteria—those without peritonitis, complete intestinal obstruction, volvulus, or pathological lead points—were selected for detailed evaluation.

Each patient underwent a comprehensive clinical assessment, including a general examination to gauge the severity of illness, a thorough abdominal examination to detect signs of distention or

tenderness, and systemic evaluations to rule out concurrent conditions. Radiological investigations, primarily abdominal X-rays and ultrasounds, were used to confirm the diagnosis and guide treatment. The procedure involved hydrostatic reduction using warm saline and a Foley catheter, with real-time ultrasound guidance to monitor the gradual retraction of the intussusceptum. Successful reduction was confirmed by the complete resolution of the intussusception and the passage of fluid and air through the ileocecal valve.

**Procedure:** The hydrostatic reduction was performed under sterile conditions in the radiology suite with continuous vital sign monitoring. Informed consent was obtained from parents or caregivers after explaining the procedure, risks, and potential outcomes. An intravenous line was established pre-procedure for fluid administration and prophylactic antibiotics. The hydrostatic reduction involved using warm normal saline, introduced into the colon via a Foley catheter (20 French), which was inserted rectally and secured with an inflated balloon to prevent leakage. A 1-liter saline container was suspended 100 cm above the patient to allow gravity-driven flow into the colon, and the progress of the intussuscepted bowel was monitored in real-time using ultrasound. Procedure success was confirmed by the complete resolution of the intussusception along with fluid and air passing through the ileocecal valve and distension of the ileum. If successful, the saline was drained, and a follow-up ultrasound was conducted to confirm that no recurrence had occurred. Post-procedure, patients were closely observed for 12-24 hours, with regular assessments of vital signs and abdominal exams, before gradually reintroducing oral feeds once the patient was stable and showed no signs of recurrence.

Post-procedure, patients were closely monitored for 12 to 24 hours, with regular assessments of their clinical condition. In cases where the reduction was unsuccessful or complications like perforation arose, immediate surgical intervention was arranged. Data collected during the study—including patient demographics, clinical presentations, and treatment outcomes—were analyzed to identify factors associated with successful reductions and to provide evidence-based recommendations for improving the management of recurrent intussusception in infants.

## RESULTS

The mean age of patients with reduced intussusception was 24.02 months (±14.24), compared to 19.50 months (±9.32) for those not reduced, yielding a p-value of 0.54, indicating no statistical significance. Gender distribution did not show significant differences, with 50% of reduced patients being male versus 75% in the not reduced group (p = 0.60). Among patients with gastrointestinal infections, all 11 (30.6%) had successful reductions; however, only 30.6% of those with upper respiratory tract infections (URTIs) had reductions, while 75% of non-reduced patients presented with URTIs. The overall p-value was 0.165, suggesting no significant association between infection type and reduction outcomes. Significant clinical features included abdominal distention (p = 0.046) and bleeding per rectum (p = 0.011), with 30.56% and 22.22% of reduced patients exhibiting these symptoms, respectively. The duration of symptoms was crucial, as 52.8% of patients with symptoms lasting less than 24 hours achieved reduction, compared to only 11.1% with symptoms lasting more than 48 hours (p = 0.005). Physical examinations showed no significant differences, and all chest X-rays were normal, indicating no correlation with reduction success.

Regarding abdominal X-ray findings, an empty right iliac fossa was present in 22 (61.1%) patients with reduced intussusception and in 3 (75%) of those not reduced, with a p-value of 0.586, indicating statistical insignificance. Air fluid levels were found in 22 (61.1%) of reduced patients and only 1 (25%) of not reduced patients, yielding a p-value of 0.079, which is statistically insignificant. Distal rectal absence of gas was noted in 21 (58.3%) of reduced patients versus 1 (25%) of those not reduced (p = 0.195), also statistically insignificant. Proximal bowel wall edema was present in 22 (61.1%) of reduced patients compared to 1 (25%) of not reduced patients, with a p-value of 0.166, indicating statistical insignificance. Free gas in the peritoneal cavity was absent in both groups. Overall, these findings suggest that chest and abdominal X-ray results were non-specific in predicting the nature and recurrence of intussusception.

In terms of laboratory values, the mean hemoglobin level was 11.52 (±1.20) in reduced patients versus 12.25 (±0.50) in non-reduced patients (p = 0.24), and the mean ESR was 13.66 (±4.50) for reduced patients and 13.75 (±6.23) for those not reduced (p = 0.973), indicating no significant differences related to intussusception reduction. Additionally, ileo-colic type was present in 34 (94.4%) of reduced patients versus 4 (100%) of not reduced patients (p = 0.629), and the presence of nodes was noted in 20 (55.6%) reduced patients compared to 2 (50%) not reduced (p = 0.832). The bowel diameter was 2.5 cm or greater in 2 (50%) not reduced patients compared to 16 (44.4%) reduced patients (p = 0.106), all indicating no significant differences.

The mean length of intussusception was 4.40 cm (±0.85) in patients with successful reduction and 4.95 cm (±0.77) in those without reduction (p = 0.235), indicating no statistically significant difference. Similarly, the mean proximal bowel diameter was 2.38 cm (±0.83) for reduced patients and 1.57 cm (±0.28) for non-reduced patients (p = 0.063), while the mean node size was 2.36 cm (±2.84) for reduced patients and 3.0 cm (±4.24) for those not reduced (p = 0.68), all of which showed no significant association.

Among the patients, 41.7% with successful reduction exhibited minimal inter-loop free fluid, while none of the non-reduced patients displayed this finding (p = 0.004), which was statistically significant. Additionally, minimal inter-loop free fluid with pelvic free fluid was observed in 25% of patients with unsuccessful reduction but not in any reduced patients. The remaining patients had no significant findings. Overall, Ileo-colic intussusception was the most common type; however, the length of intussusception, proximal bowel diameter, and node size did not correlate with reduction outcomes. Notably, patients with minimal inter-loop free fluid and pelvic free fluid were significantly more likely to experience reduction failure.

The mean time since the last intussusception episode was 136.05 days (±89.29) for reduced patients and 193.75 days (±134.12) for non-reduced patients (p = 0.250), showing no statistically significant difference. There was no significant difference in reduction outcomes (p = 1.00) between patients with two or three episodes of intussusception. However, reduction attempts were significant; all patients (100%) with unsuccessful reductions failed on their first attempt, while 61.1% of reduced patients were successfully treated on the first attempt and 38.9% on the second (p = 0.000).

In managing intussusception, conservative treatment was administered to all 36 patients (100%) with successful reduction. in 4 patients (10%) hydrostatic reduction failed and all of them were taken for surgical intervention. Overall, abdominal pain (80.6%) was the most common clinical feature among patients with intussusception, with clinical symptoms such as bleeding per rectum, abdominal distention, and constipation significantly distinguishing between those with reduced versus not reduced intussusception, highlighting their potential role in clinical assessment.

**Table 1: Demographic & Clinical Factors Influencing Intussusception Reduction**

| Variable | Reduced No. of Patients (%) | Not Reduced No. of Patients (%) | p-value |
|---|---|---|---|
| **Gender** | | | |
| Male | 18 (50%) | 3 (75%) | 0.60 |
| Female | 18 (50%) | 1 (25%) | |
| **Clinical Symptoms** | | | |
| Abdominal Pain Present | 29 (80.6%) | 2 (50%) | 0.165 |
| Abdominal Pain Absent | 7 (19.4%) | 2 (50%) | |
| Abdominal Distention Present | 11 (30.56%) | 3 (75%) | 0.046 |
| Abdominal Distention Absent | 25 (69.44%) | 1 (25%) | |
| Bleeding Per Rectum Present | 8 (22.22%) | 3 (75%) | 0.011 |
| Bleeding Per Rectum Absent | 28 (77.78%) | 1 (25%) | |
| Fever Present | 16 (44.4%) | 3 (75%) | 0.246 |
| Fever Absent | 20 (55.6%) | 1 (25%) | |

**Table 2: Infection, Duration, and X-ray Findings in Relation to Intussusception Reduction**

| Variable | Reduced No. of Patients (%) | Not Reduced No. of Patients (%) | p-value |
|---|---|---|---|
| **Type of Infection** | | | |
| Gastrointestinal | 11 (30.6%) | 0 (0%) | 0.17 |
| URTI | 11 (30.6%) | 3 (75%) | |
| None | 14 (38.9%) | 1 (25%) | |
| **Duration of Symptoms** | | | |
| <24 hours | 19 (52.8%) | 0 (0%) | 0.005 |
| 24-48 hours | 13 (36.1%) | 1 (25%) | |
| >48 hours | 4 (11.1%) | 3 (75%) | |
| **Abdominal X-ray Findings** | | | |
| Empty Right Iliac Fossa Present | 22 (61.1%) | 3 (75%) | 0.586 |
| Air Fluid Levels Present | 22 (61.1%) | 1 (25%) | 0.079 |
| Free Gas in Peritoneal Cavity | 0 (0%) | 0 (0%) | --- |

**Table 3: Physical Examination & Intussusception Episodes Related to Reduction Outcome**

| Variable | Reduced No. of Patients (%) | Not Reduced No. of Patients (%) | p-value |
|---|---|---|---|
| **Physical Examination** | | | |
| Tender Abdomen | 22 (61.1%) | 3 (75%) | 0.586 |
| Soft Abdomen | 14 (38.9%) | 1 (25%) | |
| Proximal Bowel Wall Edema Present | 22 (61.1%) | 1 (25%) | 0.166 |
| **Intussusception Episodes** | | | |
| Two Reduction Attempts | 27 (75%) | 3 (75%) | 1.00 |
| First Attempt Success | 22 (61.1%) | 0 (0%) | 0.000 |
| Second Attempt Success | 14 (38.9%) | 0 (0%) | |
| Could Not Be Reduced | 0 (0%) | 4 (100%) | |

## DISCUSSION

Intussusception, continues to pose a significant challenge in pediatric gastroenterology, especially due to its recurrent nature. This condition is most commonly observed in infants and young children, Despite advancements in diagnostic and therapeutic modalities, recurrence rates for intussusception range from 8% to 20%, with variations attributed to differences in patient demographics, treatment modalities, and follow-up durations.[1-6]

Recurrent intussusception poses unique challenges, often linked to underlying anatomical abnormalities, including Meckel's diverticulum, intestinal polyps, or lymphomas.[7] Hsu et al. noted that the presence of a pathological lead point significantly increases the recurrence rate and decreases the success of non-operative reduction.[7,8] Although our study did not specifically investigate pathological lead points, existing literature underscores their importance. Future research should delve deeper into this area, potentially employing advanced imaging techniques or molecular diagnostics to identify subtle anatomical or pathological abnormalities that may predispose patients to recurrence.[8-10]

The introduction of ultrasound-guided hydrostatic reduction has significantly enhanced the non-operative management of intussusception, garnering acceptance due to high success rates reported between 75% and 95%.[12-14] The literature reveals ongoing debates about managing recurrent intussusception; some clinicians recommend surgical intervention after the first or second recurrence, while others highlight the benefits of repeated non-operative reductions for their non-invasive nature and preservation of bowel integrity.[13-20] Our study corroborates the efficacy of ultrasound-guided hydrostatic reduction, achieving a 90% success rate, closely aligning with Binu et al. (2023), who reported a 90.5% success rate, and Menke & Kahl (2015), who documented a composite reduction rate of 83.7%.[35,36] These consistent findings reinforce ultrasound-guided hydrostatic reduction as a first-line treatment, even in recurrent cases.

Regarding patient characteristics, our study found no significant impact of gender or age on the success of intussusception reduction. This aligns with the findings of Wondemagegnehu et al. (2024) and Xie et al. (2019), who also reported no significant association between gender and reduction success.[52,53] However, contrasting evidence from Krishankumar et al. (2006) and Lee et al. (2019) identified younger age as a risk factor for failed hydrostatic reduction and increased recurrence rates.[39,51] This apparent disparity suggests that the relationship between age and reduction outcomes may be more complex than previously recognized. Younger patients might present with more acute symptoms or have a higher incidence of pathological lead points complicating reduction. Additionally, immature immune systems in younger age groups may influence inflammatory responses and subsequent reduction outcomes. Further investigations, particularly those stratifying patients by narrower age ranges and including detailed clinical and pathological assessments, are warranted.

The influence of preceding infections on intussusception outcomes is another important aspect. Our study revealed that the type of preceding infection, whether gastrointestinal or respiratory, was not significantly predictive of successful intussusception reduction. This finding is consistent with Wondemagegnehu et al. and Chukwubuike et al. (2020), who also found no significant association between infection type and reduction success.[44,53] However, Lee et al. (2019) suggested that the absence of an infection history was a significant predictor of recurrence.[51] This suggests a complex interplay between infections and intussusception. It is plausible that specific infections or the immune responses they elicit could predispose the bowel to telescoping or affect reduction outcomes. Additional research is necessary to delineate these relationships, exploring the roles of specific pathogens, immune responses, and their interactions with the gastrointestinal tract.

Clinically, our study identified abdominal pain as the most common symptom in patients with successful reduction, observed in 80.6% of cases. In contrast, features like abdominal distention, rectal bleeding, and constipation were significantly associated with failed reduction, corroborating findings from Chukwubuike et al. and Xie et al.[44,52] Karadal et al. (2015) specifically highlighted rectal bleeding as a significant predictor of failed hydrostatic reduction, indicating that such symptoms may signify more severe bowel involvement, such as ischemia or necrosis.[42] Identifying these clinical features as predictors of reduction failure is vital for guiding clinical decision-making, particularly when considering alternative treatment strategies like surgical intervention.

Duration of symptoms prior to treatment emerged as a crucial factor, with shorter durations (<24 hours) linked to higher success rates. This aligns with studies by Caruso et al. (2017) and Datta et al. (2015), which indicated that prolonged symptom durations significantly increase the risk of reduction failure.[43,50] The relationship between symptom duration and reduction outcomes likely reflects the progressive nature of intussusception; as time passes, the bowel may become increasingly edematous, ischemic, or necrotic, reducing the likelihood of successful non-operative reduction. These findings underscore the importance of early intervention to improve outcomes and reduce recurrence risk.

In terms of radiological investigations, our study indicated that while 100% of enrolled patients had normal chest X-rays, abdominal X-ray findings were non-significant predictors of reduction outcomes. Conversely, ultrasound scans revealed that patients with minimal inter-loop free fluid and pelvic free fluid were more likely to experience reduction failure compared to those with only minimal inter-loop free

fluid (p=0.004). These findings align with Wondemagegnehu et al. (2024), who identified similar radiological predictors.[53] The presence of minimal inter-loop free fluid may indicate early or mild intussusception cases where the bowel remains viable and responsive to reduction attempts. Additionally, Xie et al. (2019) identified poor prognostic signs on ultrasound as risk factors for hydrostatic reduction failure.[52]

Finally, our study established that the number of reduction attempts was a significant predictor of hydrostatic reduction failure. Patients requiring multiple attempts experienced higher rates of failure, consistent with findings from Datta et al. (2015) and Demiral et al. (2022).[48,50] The need for repeated reduction attempts may reflect underlying factors such as pathological lead points, severe bowel involvement, or suboptimal reduction techniques. These insights emphasize the necessity for careful monitoring and decision-making during the reduction process. Clinicians should remain vigilant when initial reduction attempts fail, as this may indicate the need for alternative treatment strategies, including surgical intervention.

## CONCLUSION

This study confirms the high efficacy of ultrasound-guided hydrostatic reduction for intussusception in pediatric patients, achieving a success rate of 90%. Key findings indicate that patient characteristics such as age and gender, as well as preceding infections, do not significantly influence treatment outcomes. Notably, abdominal pain is a common indicator of successful reduction, while symptoms like abdominal distention, rectal bleeding, and constipation correlate with reduction failure.

The duration of symptoms plays a critical role, with shorter durations linked to higher success rates, underscoring the importance of early intervention. Fluid assessment revealed that the presence of both minimal inter-loop and pelvic free fluid increases the likelihood of failure. Additionally, fewer attempts at reduction are associated with better outcomes, suggesting that initial reduction efforts are crucial.

Overall, our findings support the use of ultrasound-guided hydrostatic reduction as an effective first-line treatment for recurrent intussusception, with only a small proportion requiring surgery. Further research is needed to optimize patient management strategies.

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