DOI: 10.4274/jbuch.galenos.2026.62582
J Dr Behcet Uz Child Hosp 2026;16(2):140-147

Original Article

Ultrasound-guided Hydrostatic Reduction in Pediatric Intussusception: Factors Associated with Treatment Success

Pediyatrik İnvajinasyonda Ultrasonografi Eşliğinde Hidrostatik Redüksiyon: Tedavi Başarısı ile İlişkili Faktörler

Yusuf Kenan Çetinoğlu[1], Dilek Süral[2], Oğuzhan Çelik[2], Ayşe Demet Payza[3], Mehmet Coşkun[1]

[1]University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital, Department of Radiology, İzmir, Türkiye
[2]İzmir Katip Çelebi University, Atatürk Training and Research Hospital, Department of Radiology, İzmir, Türkiye
[3]University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital, Department of Pediatric Surgery, İzmir, Türkiye

ABSTRACT

Objective: This study aimed to assess demographic and sonographic factors associated with successful ultrasound-guided hydrostatic reduction in pediatric patients with intussusception.

Method: This retrospective, single-center study included children with ultrasonographically confirmed intussusception who underwent ultrasound-guided hydrostatic reduction. Demographic characteristics, intussusception location, intussuscepted segment length, mesenteric lymphadenopathy, free intraperitoneal fluid, and increased mesenteric echogenicity were evaluated. The optimal cut-off value for intussuscepted segment length was determined using receiver operating characteristic (ROC) curve analysis.

Results: A total of 132 patients were included; 79 were male (59.8%), and the median age was 2 years. Hydrostatic reduction was successful in 109 (82.6%) patients. No procedure-related perforation or major complication occurred. Surgical treatment was required in 23 patients (17.4%); manual reduction was achieved in 18, whereas 5 patients with bowel ischemia underwent segmental resection and primary anastomosis. The mean intussuscepted segment length was shorter in the successful reduction group than in the failed reduction group (48.4±17.9 mm vs. 68.8±23.4 mm; p<0.001). ROC curve analysis identified 70 mm as the optimal cut-off for predicting failed reduction, with an area under the curve of 0.762. Free intraperitoneal fluid and increased mesenteric echogenicity were associated with failed reduction (p=0.002 and p=0.037, respectively). Age, sex, intussusception location, and lymphadenopathy were not significantly associated with hydrostatic reduction success.

Conclusion: Ultrasound-guided hydrostatic reduction is safe and effective for pediatric intussusception. Longer intussuscepted segment length, free intraperitoneal fluid, and increased mesenteric echogenicity may help predict failed reduction and the need for surgery.

Keywords: Hydrostatic reduction, ileocolic, intussusception, pediatric intestinal obstruction, ultrasonography

ÖZ

Amaç: Bu çalışmada, pediyatrik invajinasyon hastalarında ultrasonografi eşliğinde hidrostatik redüksiyon başarısı ile ilişkili demografik ve sonografik faktörlerin değerlendirilmesi amaçlandı.

Yöntem: Bu retrospektif, tek merkezli çalışmada ultrasonografi ile invajinasyon tanısı doğrulanan ve ultrasonografi eşliğinde hidrostatik redüksiyon uygulanan çocuk hastalar değerlendirildi. Demografik özellikler, invajinasyon lokalizasyonu, invajine segment uzunluğu, mezenterik lenfadenopati, peritoneal serbest sıvı ve mezenterik ekojenite artışı incelendi. Bu değişkenler ile hidrostatik redüksiyon başarısı arasındaki ilişkiler istatistiksel olarak analiz edildi. İnvajine segment uzunluğu için optimal eşik değer, alıcı işletim karakteristiği (ROC) eğrisi analizi ile belirlendi.

Bulgular: Çalışmaya toplam 132 hasta dahil edildi. Hastaların 79'u erkekti (%59,8) ve medyan yaş 2 yıldı. Hidrostatik redüksiyon 109 hastada başarılı oldu (%82,6). İşleme bağlı perforasyon veya majör komplikasyon

Received: 02.06.2026
Accepted: 22.06.2026
Publication Date: 21.08.2026

Corresponding Author
Yusuf Kenan Çetinoğlu,
University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital, Department of Radiology, İzmir, Türkiye
E-mail: kenancetinoglu@hotmail.com
ORCID: 0000-0002-7878-6117

Cite as: Çetinoğlu YK, Süral D, Çelik O, Payza AD, Coşkun M. Ultrasound-guided hydrostatic reduction in pediatric intussusception: factors associated with treatment success. J J Dr Behcet Uz Child Hosp. 2026;16(2):140-147

izlenmedi. Cerrahi tedavi 23 hastada gerekli oldu (%17,4); 18 hastada manuel redüksiyon sağlanırken, iskemi saptanan 5 hastaya segmental rezeksiyon ve primer anastomoz uygulandı. Ortalama invajine segment uzunluğu, hidrostatik redüksiyonun başarılı olduğu grupta başarısız olduğu gruba göre daha düşüktü (48,4±17,9 mm'ye karşı 68,8±23,4 mm; p<0,001). ROC eğrisi analizi, başarısız redüksiyonu öngörmede optimal eşik değerin 70 mm olduğunu gösterdi (eğri altında kalan alan: 0,762). Peritoneal serbest sıvı ve mezenterik ekojenite artışı, başarısız hidrostatik redüksiyon ile ilişkiliydi (sırasıyla p=0,002 ve p=0,037). Yaş, cinsiyet, invajinasyon lokalizasyonu veya lenfadenopati ile redüksiyon başarısı arasında anlamlı ilişki saptanmadı.

Sonuç: Ultrasonografi eşliğinde hidrostatik redüksiyon, pediyatrik invajinasyonda güvenli ve etkili bir tedavi yöntemidir. Artmış invajine segment uzunluğu, peritoneal serbest sıvı ve mezenterik ekojenite artışı, başarısız redüksiyonu ve buna bağlı cerrahi tedavi gereksinimini öngörmede yardımcı olabilir.

Anahtar kelimeler: Hidrostatik redüksiyon, ileokolik, invajinasyon, pediyatrik intestinal obstrüksiyon, ultrasonografi

INTRODUCTION

Intussusception is the leading cause of bowel obstruction during infancy and early childhood. Approximately 80% of intussusception cases occur in patients younger than 2 years[1,2]. Intussusception most commonly involves the ileocolic region. Clinical presentation is usually characterized by non-specific symptoms such as vomiting, diarrhea, and fever[2]. Given the young age of affected patients, clinical diagnosis may be challenging; therefore, radiological evaluation is frequently required. Diagnosis is usually established by ultrasound (US)[3]. Early diagnosis and treatment are important because delays may lead to intestinal ischemia, necrosis, or perforation[4].

Treatment options for intussusception include pneumatic reduction, hydrostatic reduction, and surgery[2,5]. Pneumatic reduction is performed under fluoroscopic guidance, whereas hydrostatic reduction is performed under US guidance. Since pneumatic and hydrostatic reduction techniques are associated with lower morbidity and mortality rates compared to surgery, they are preferred as first-line treatment options. US-guided hydrostatic reduction has been reported to have a higher success rate than pneumatic reduction[6]. In addition, because US-guided hydrostatic reduction does not involve ionizing radiation and is easy and inexpensive to perform, it is considered a first-line treatment method[7]. The reported success rates of hydrostatic reduction range from 82% to 92.9%[8-10]. Surgery is indicated in cases of failed reduction, shock, peritonitis, or intestinal perforation[2].

Clinical factors such as age, time from symptom onset to treatment, presence of rectal bleeding, and vomiting may affect the success of hydrostatic reduction[11,12]. In addition, radiological findings such as intussuscepted segment length, presence of enlarged intra-abdominal lymph nodes, air-fluid levels, and a pathological lead point have also been shown to be associated with procedural success of hydrostatic reduction[13-15].

This study aimed to assess the associations of demographic and sonographic factors with hydrostatic reduction success in pediatric intussusception. Identifying these factors may reduce the need for surgical treatment and the related morbidity and mortality.

MATERIALS and METHODS

Patient Selection

Approval for this retrospective study was obtained from the local ethics committee of University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital with decision no: 2026/05-08, dated: 12.03.2026. The study population included children who were diagnosed with intussusception by US and underwent US-guided hydrostatic reduction at a single tertiary pediatric center between September 2020 and February 2026. In our center, all patients with suspected intussusception were routinely evaluated by US, and US-guided hydrostatic reduction was attempted in all patients when the diagnosis of intussusception was confirmed. No patient was referred directly to surgery without a prior attempted hydrostatic reduction during the study period. Patients with spontaneously reduced intussusception (n=4) and patients who underwent surgery after failed hydrostatic reduction but had no intraoperative evidence of intussusception (n=1) were excluded.

Radiological Evaluation

Diagnosis of intussusception was established using US by a single radiologist. A high-frequency linear probe (Toshiba, Aplio 500) was used for diagnosis and treatment. Cases of intussusception were categorized as ileocolic, ileoileal, or colocolic according to the involved bowel segment. In all US examinations, the length of the intussuscepted segment was measured along the long axis and recorded. The presence of lymphadenopathy, free intraperitoneal fluid, and increased mesenteric echogenicity was also noted. Increased mesenteric echogenicity was defined as subjectively increased echogenicity of the mesenteric fat adjacent to the

intussuscepted segment compared with the surrounding mesenteric fat. Mesenteric lymph nodes with a short-axis diameter of 6 mm or greater were considered lymphadenopathy.

Considering transient intussusception as a possibility, patients with an intussuscepted segment length of <20 mm on US were managed conservatively. These patients were observed for 1-6 hours and re-evaluated by US. If the finding persisted, an evacuation enema was performed. These patients then underwent repeat US examinations performed by the same radiologist. Patients in whom reduction was not achieved based on follow-up US images and those with an intussuscepted segment length of ≥20 mm underwent hydrostatic reduction.

Hydrostatic Reduction Procedure

After insertion of a 16-18 Fr catheter in the rectum, the balloon of the catheter was inflated to maintain catheter stability. Saline solution was administered through the catheter by gently compressing the suspended saline bag. During administration of saline solution, colonic distension was monitored simultaneously with US. Colonic expansion was allowed up to a maximum diameter of 40 mm. If the luminal diameter exceeded 40 mm, administration of saline solution was stopped because of the risk of perforation.

Hydrostatic reduction was considered successful when saline solution passage proximal to the intussuscepted segment was observed, at which point the procedure was terminated. If passage of saline solution proximal to the intussuscepted segment was not observed, reduction was attempted with the patient first in the right and then in the left lateral decubitus position. If proximal passage of saline solution still could not be achieved, hydrostatic reduction was considered unsuccessful, and the patient was referred for surgery. The reduction procedure lasted approximately 10 minutes.

All patients who underwent reduction procedures were hospitalized for at least 24 hours and underwent at least one follow-up US examination. Recurrent intussusception was detected in two patients during the 24 hour observation period. Both patients were successfully treated with repeat US-guided hydrostatic reduction. No pathological lead point was suspected on US in either patient.

Surgical Reduction

During intraoperative evaluation, bowel viability was assessed in terms of color, peristalsis, and mesenteric circulation. The bowel and mesentery were explored for a possible pathological lead point, such as an associated mass or space-occupying lesion. Enlarged lymph nodes were resected for sampling.

The primary surgical approach was laparotomy and manual reduction. During this procedure, the intussuscepted segment was gently and carefully reduced from distal to proximal using the milking technique. Manual reduction was adopted as the standard approach because it allows preservation of intestinal continuity. The affected bowel segment was resected, and primary anastomosis was performed when manual reduction failed or when irreversible ischemia, necrosis, or perforation was present. Patients were hospitalized for at least 48 hours postoperatively and underwent US 24-48 hours after surgery to evaluate for complications.

Statistical Analysis

A two-tailed p-value below 0.05 was accepted as indicating statistical significance. Data analyses were conducted with Statistical Package for the Social Sciences (SPSS) software, version 20.0 (IBM Corp., NY, USA).

The association between hydrostatic reduction success and age was evaluated using the Mann-Whitney U test, whereas the association with sex was assessed using the chi-square test. The association between intussusception location and hydrostatic reduction success was analyzed using the likelihood-ratio chi-square test. Preprocedural intussuscepted segment length was compared between the successful and failed reduction groups using the independent-samples t-test. Receiver operating characteristic (ROC) curve analysis was performed to determine the intussuscepted segment length cut-off with the best discriminatory ability for predicting failed reduction. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the area under the ROC curve (AUC) were calculated for the identified cut-off. The associations between hydrostatic reduction success and lymphadenopathy, free intraperitoneal fluid, and increased mesenteric echogenicity were evaluated separately using Fisher's exact test.

RESULTS

The study included 132 patients, of whom 79 were male (59.8%) and 53 were female (40.2%). The median age was 2 years [interquartile range (IQR), 1-4 years; minimum age, 3 months; maximum age, 12 years]. Intussusception was ileocolic in 117 patients (88.6%), colocolic in 8 patients (6.1%), and ileoileal in 7 patients (5.3%). Intussusception was successfully reduced by hydrostatic reduction in 109

(82.6%) patients. Recurrent intussusception was observed on follow-up US in two patients during the 24-hour observation period after initially successful hydrostatic reduction. Both patients were successfully treated with repeat US-guided hydrostatic reduction. No pathological lead point was suspected or identified in these patients.

Reduction was achieved surgically in 23 (17.4%) patients. Among these 23 patients, successful manual reduction was achieved in 18 patients. Small bowel resection and anastomosis were performed in 5 patients (3.8%) because of irreversible bowel ischemia. A pathological lead point was identified in 8 patients (6.1%): Meckel diverticulum in 3 patients, acute appendicitis in 2 patients, hemangioma in the adjacent mesentery in 1 patient, adenomyoma in 1 patient, and adhesion in 1 patient. Lymph node resection was performed in 9 patients, and all resected lymph nodes were reported as lymphoid hyperplasia. All patients who underwent surgical treatment were discharged without complications. The demographic findings are summarized in Table 1.

In all patients, the mean intussuscepted segment length was 52.0±20.4 mm. Lymphadenopathy was observed in 87 (65.9%), free intraperitoneal fluid in 32 (24.2%), and increased mesenteric echogenicity in 5 (3.8%) patients. The median short-axis diameter of the lymph nodes was 8 mm (IQR, 6-9 mm).

No significant association was found between reduction success and age or sex (p=0.118 and p=0.721, respectively). The reduction success rates were 84.6% for ileocolic, 75.0% for colocolic, and 57.1% for ileoileal intussusceptions. Intussusception location was not significantly associated with reduction success (p=0.213).

The mean intussuscepted segment length was 48.4±17.9 mm in patients who underwent successful reductions and 68.8±23.4 mm in patients with failed reduction. Intussuscepted segment length was significantly associated with hydrostatic reduction success (p<0.001) (Figure 1). ROC curve analysis identified 70 mm as the optimal cut-off for predicting failed reduction. At this cut-off, sensitivity was 60.9%, specificity was 85.3%, PPV was 46.7%, NPV was 91.2%, and the AUC was 0.762.

Lymphadenopathy was observed in 65.1% of patients who underwent successful reduction and in 69.6% of patients in whom reduction attempts failed. The association between lymphadenopathy and successful hydrostatic reduction was not significant (p=0.81). Free intraperitoneal fluid was more frequent in the failed reduction group than in the successful reduction group (52.2% vs. 18.3%) and was significantly associated with failed hydrostatic reduction (p=0.002). Increased mesenteric echogenicity was also more common in the failed reduction group (13.0% vs. 1.8%) and was significantly associated with failed hydrostatic reduction

Table 1. Demographic, sonographic, and treatment-related findings

Parameters	
Male/female, n	79/53
Median age (yrs)	2 years (IQR, 1-4 years)
Intussusception location, n (%)	
Ileocolic	117 (88.6)
Colocolic	8 (6.1)
Ileoileal	7 (5.3)
Hydrostatic reduction	
Success rates, n (%)	109 (82.6)
Surgical treatment, n (%)	
Manual reduction	18 (13.6)
Resection	5 (3.8)
Pathological lead point	8 (6.1)
Ultrasonographic findings	
Intussuscepted segment length, mean (±SD)	52 (±20.4) mm
Lymphadenopathy, n (%)	87 (65.9)
Free intraperitoneal fluid, n (%)	32 (24.2)
Increased mesenteric echogenicity, n (%)	5 (3.8)

IQR: Interquartile range, SD: Standard deviation

(p=0.037) (Figure 2). The comparative statistical results are summarized in Table 2.

DISCUSSION

In this study, we evaluated demographic and sonographic factors associated with hydrostatic reduction success in pediatric intussusception. The hydrostatic reduction success rate was 82.6%, and no complications occurred during the procedure. The likelihood of successful hydrostatic reduction decreased as intussuscepted segment length increased. The optimal cut-off value for the length of the intussuscepted segment in terms of differentiating successful and failed reduction attempts was calculated as 70 mm. In addition, free intraperitoneal fluid and increased mesenteric echogenicity were significantly associated with failed reduction.

Hydrostatic reduction is a first-line treatment option for pediatric intussusception. In the meta-analysis by Kim et al.[9], the pooled reduction success rate was 82%. In the large series of 543 patients reported by Ntoulia et al.[10], the reduction success rate was 86.7%, and 72 patients required surgery. Among the surgically treated patients,

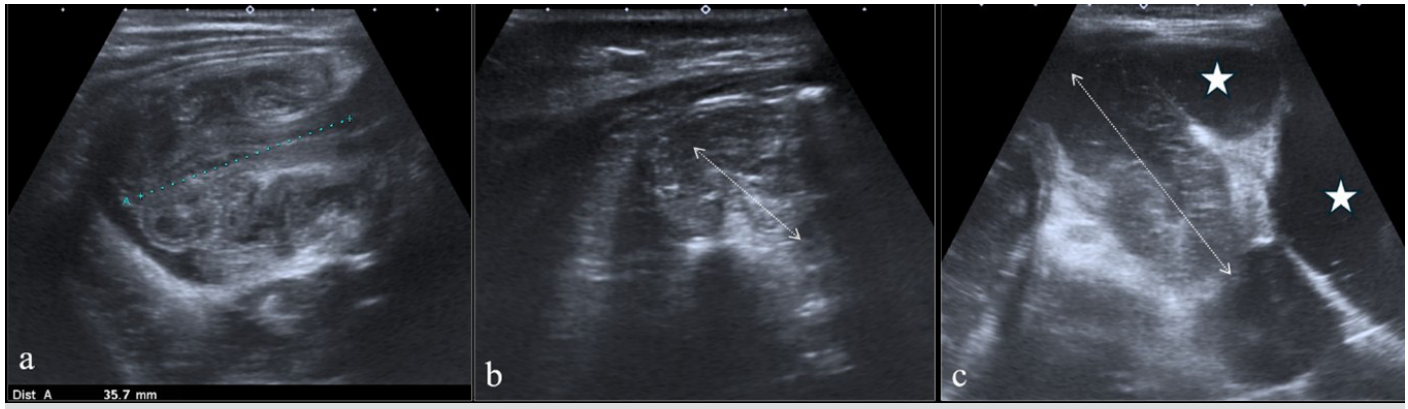

Figure 1. Representative examples of intussusception. a) Ileocolic intussusception measuring 36 mm in length in a 6-month-old female patient. Hydrostatic reduction was successful in this patient. b) A 30-mm intussusception of the ileocecal valve into the cecum in a 2-year-old male patient (dashed arrow). Hydrostatic reduction was successful in this patient. c) Long-segment ileocolic intussusception measuring 75 mm in a 1-year-old male patient (dashed arrow). Diffuse wall thickening of the intussuscepted segment and distension of the proximal small bowel loops are present (stars). Hydrostatic reduction failed, and the patient underwent manual reduction at surgery

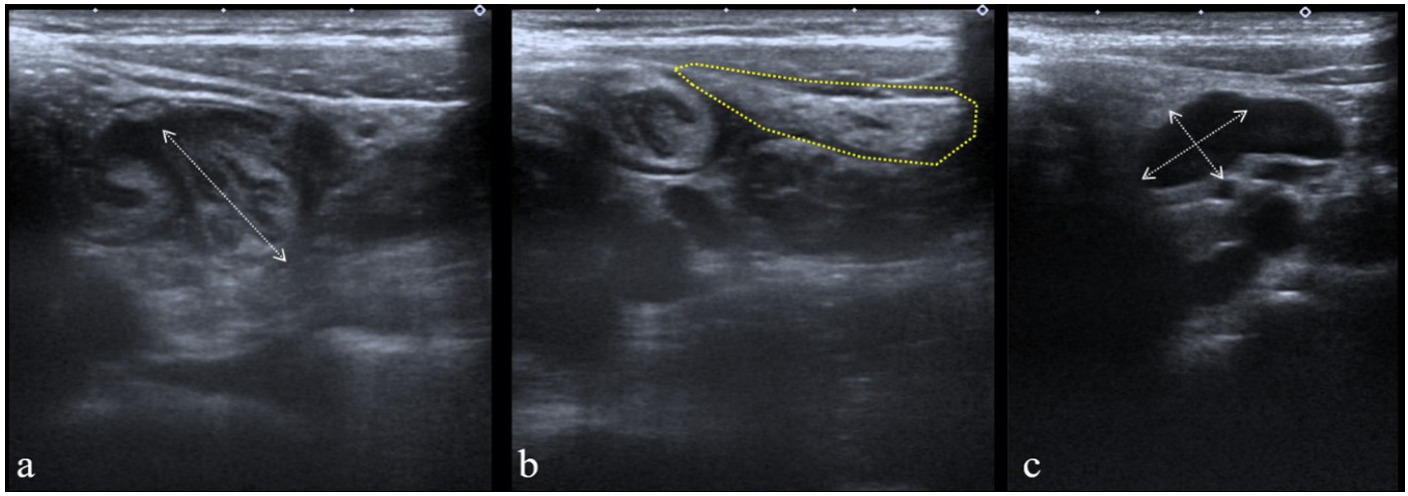

Figure 2. Ultrasonographic findings of a 7-month-old female patient. a) Ileocolic intussusception measuring 35 mm in length (white dashed arrow) and b) increased inflammatory echogenicity in the adjacent mesentery (yellow shaded area). c) Adjacent mesenteric lymph nodes are seen near the intussuscepted segment. The larger lymph node measures 8×13 mm in size (white dashed arrows). Hydrostatic reduction was successful in this patient

Table 2. Comparative statistical results			
Demographic and sonographic findings	**Hydrostatic reduction**		**p-value**
	Successful	**Failed**	
Median age	2 years	3.25 years	0.118
Sex (male/female)	66/43	13/10	0.721
Intussuscepted segment length, mean (± standard deviation)	48.4 (±17.9) mm	68.8 (±23.4) mm	<0.001
Lymphadenopathy, %	65.1	69.6	0.81
Free intraperitoneal fluid, %	18.3	52.2	0.002
Increased mesenteric echogenicity, %	1.8	13	0.037

spontaneous or manual reduction was achieved in 68%, whereas small bowel resection and ileocecal resection were performed in 19.4% and 12.5%, respectively. A pathological lead point was identified in 25% of patients requiring surgery, including lymphoid hyperplasia (9.7%), Meckel diverticulum (4.2%), Burkitt lymphoma (4.2%), enteric duplication cyst (2.8%), juvenile polyp (2.8%), and adenoviral appendicitis (1.4%)[10]. In the series by Yang et al.[16], which included 3086 pediatric patients treated using two different protocols, surgical treatment was required in 19.9% of patients, and bowel resection was performed in 2.6% of all patients. In the meta-analysis by Sadigh et al.[5], the perforation rate during hydrostatic reduction was 0.43%. In our study, 17.4% of patients required surgery after failed hydrostatic reduction. Manual reduction was achieved surgically in 13.6% of patients, whereas small bowel resection was performed in 3.8% because of irreversible bowel ischemia. A pathological lead point was identified in 6.1% of patients, with Meckel diverticulum being the most common finding (2.3%). No perforation occurred during hydrostatic reduction in any patient.

Pediatric intussusception reduction success may be affected by demographic and clinical factors. In the study by Zhuang et al.[11], clinical, laboratory, and imaging parameters were evaluated together, and a nomogram was developed to estimate the need for surgery. Symptom duration, bloody stool, white blood cell count, creatine kinase isoenzyme (CK-MB), intussuscepted segment length, and mental status were identified as independent risk factors[11]. In the series of 290 patients reported by Alsinan et al.[12], female sex, age younger than 1 year, and symptom duration longer than 48 hours were associated with failed reduction. That study included patients aged between 1 and 36 months. Similarly, Elrouby et al.[17] reported that younger age, low body mass index, longer symptom duration, bloody stool, a palpable abdominal mass, left-sided intussusception, and increased air-fluid levels on radiography were associated with failed reduction. However, that study included only patients aged between 6 months and 3 years[17]. In the review by Hwang et al.[18], left-sided colocolic intussusceptions were suggested to have a lower likelihood of successful reduction. In our study, neither age nor sex was significantly associated with hydrostatic reduction success. The success rates were 84.6% for ileocolic, 75.0% for colocolic, and 57.1% for ileoileal intussusceptions. Although the success rate appeared higher for ileocolic intussusceptions, intussusception location was not significantly associated with reduction success. The differences between our findings and those reported in previous studies may partly reflect the relatively small number of patients, particularly in the failed reduction group.

Several sonographic findings have been reported to be associated with hydrostatic reduction success in pediatric patients. In the study by Gondek et al.[13], which included only patients with ileocolic intussusception, free intraperitoneal fluid and absence of Doppler vascularity in the intussuscepted segment were associated with failed reduction. Ayana et al.[14] reported that intussusceptions shorter than 35 mm were more likely to be successfully reduced. In the series by Wondemagegnehu et al.[15], which included 174 children, free intraperitoneal fluid was observed in 21.8% of patients and enlarged lymph nodes in 54.6%. The mean intussuscepted segment length was 52 mm. In that study, free intraperitoneal fluid and the presence of a pathological lead point or associated mass were significantly associated with reduced treatment success[15]. In our study, the likelihood of successful hydrostatic reduction decreased significantly as intussuscepted segment length increased. A cut-off of 70 mm showed 60.9% sensitivity and 85.3% specificity for predicting failed reduction. Free intraperitoneal fluid and increased mesenteric echogenicity were also significantly associated with failed reduction.

Study Limitations

This study has several limitations. First, because of its retrospective and single-center design, the possibility of selection bias cannot be completely excluded. Second, the relatively small number of patients in the failed

hydrostatic reduction group may have reduced statistical power, particularly in subgroup analyses. Therefore, the findings should be confirmed in larger patient cohorts. Third, because sonographic evaluations were performed by a single radiologist, interobserver variability analysis could not be performed, which may have made the results operator-dependent. Finally, because the interval between symptom onset and treatment was inconsistently documented in the medical records, symptom duration could not be analyzed in a standardized manner. This represents an important limitation because symptom duration may affect reduction success, bowel ischemia, the need for bowel resection, and the decision to proceed with surgery. In addition, free intraperitoneal fluid was evaluated only as a binary variable according to its presence or absence; its amount and distribution were not analyzed.

CONCLUSION

In conclusion, hydrostatic reduction of pediatric intussusception can be performed safely and successfully under US guidance. The likelihood of successful reduction decreases as intussuscepted segment length increases. Pre-reduction US assessment of intussuscepted segment length, free intraperitoneal fluid, and increased mesenteric echogenicity may be useful for predicting failed reduction and identifying patients who may require surgery.

Ethics

Ethics Committee Approval: Approval for this retrospective study was obtained from the local ethics committee of University of Health Sciences Türkiye, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital with decision no: 2026/05-08, dated: 12.03.2026.

Informed Consent: This is a retrospective study.

Declaration of AI Use: The authors used generative AI tools to improve language clarity and organization during manuscript preparation. All content was subsequently reviewed and edited by the authors, who take full responsibility for the final manuscript.

Footnotes

Author Contributions

Surgical and Medical Practices: Y.K.Ç., A.D.P., M.C., Concept: M.C., Design: Y.K.Ç., A.D.P., M.C., Data Collection or Processing: D.S., O.Ç., A.D.P., Analysis or Interpretation: Y.K.Ç., D.S., O.Ç., M.C., Literature Search: Y.K.Ç., D.S., O.Ç., Writing: Y.K.Ç., M.C.

Conflict of Interest: The authors declare no conflicts of interest.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Lioubashevsky N, Hiller N, Rozovsky K, Segev L, Simanovsky N. Ileocolic versus small-bowel intussusception in children: can US enable reliable differentiation? Radiology. 2013;269(1):266-71. doi: 10.1148/radiol.13122639.
2. Bradshaw CJ, Johnson P. Intussusception. Surgery (Oxford). 2022;40(5):311-5. doi: 10.1016/j.mpsur.2022.03.001.
3. Alsabri M, Rath S, Elkarargy MA, Aboali AA, Abouelmagd K, Ramadan AAA, et al. Accuracy of ultrasound for intussusception in pediatric emergency presentations: a systematic review and diagnostic meta-analysis. Int J Emerg Med. 2026;19(1):41. doi: 10.1186/s12245-026-01134-z.
4. Xu XX, Cai YJ, Liu J, Zhuang Y, Ma Q. Predicting bowel necrosis in pediatric acute intussusception using roundness and other related factors. BMC Pediatr. 2025;25(1):843. doi: 10.1186/s12887-025-06172-9.
5. Sadigh G, Zou KH, Razavi SA, Khan R, Applegate KE. Meta-analysis of air versus liquid enema for intussusception reduction in children. AJR Am J Roentgenol. 2015;205(5):W542-9. doi: 10.2214/AJR.14.14060.
6. Liu L, Zhang L, Fang Y, Yang Y, You W, Bai J, et al. Air enema reduction versus hydrostatic enema reduction for intussusceptions in children: a systematic review and meta-analysis. PLoS One. 2024;19(3):e0297985. doi: 10.1371/journal.pone.0297985.
7. Plut D, Phillips GS, Johnston PR, Lee EY. Practical imaging strategies for intussusception in children. AJR Am J Roentgenol. 2020;215(6):1449-63. doi: 10.2214/AJR.19.22445.
8. Yadav AK, Yadav N, Dev B, Dahal S, Yadav RP, Taparia S, et al. Ultrasound-guided hydrostatic reduction of acute intussusception in children at a tertiary care center: an observational study. JNMA J Nepal Med Assoc. 2025;63(282):73-7. doi: 10.31729/jnma.8878.
9. Kim PH, Hwang J, Yoon HM, Lee JY, Jung AY, Lee JS, et al. Predictors of failed enema reduction in children with intussusception: a systematic review and meta-analysis. Eur Radiol. 2021;31(11):8081-97. doi: 10.1007/s00330-021-07935-5.
10. Ntoulia A, Tharakan SJ, Reid JR, Mahboubi S. Failed intussusception reduction in children: correlation between radiologic, surgical, and pathologic findings. AJR Am J Roentgenol. 2016;207(2):424-33. doi: 10.2214/AJR.15.15659.
11. Zhuang Y, Wang X, Fan X, Li F, He G, Luo M, et al. Developing a nomogram for predicting surgical intervention in pediatric intussusception after hydrostatic reduction. Front Pediatr. 2023;11:1092548. doi: 10.3389/fped.2023.1092548.
12. Alsinan T, Altokhais T, Alshayeb F, Hajja A, Al Boukai M, Alsalameh S, et al. Risk factors for failure of enema reduction of intussusception in children. Sci Rep. 2024;14(1):20786. doi: 10.1038/s41598-024-71289-3.
13. Gondek AS, Riaza L, Cuadras D, Castellarnau XT, Krauel L. Ileocolic intussusception: predicting the probability of success of ultrasound guided saline enema from clinical and sonographic data. J Pediatr Surg. 2018;53(4):599-604. doi: 10.1016/j.jpedsurg.2017.10.050.

14. Ayana CT, Feleke T, Bazezew A, Mehari Z, Yaynishet YA, Getinet T, et al. Treatment outcome of ultrasound-guided hydrostatic reduction of intussusception and its associated factors among pediatric patients in a resource-limited setting. Pediatr Radiol. 2025;55(9):1829-37. doi: 10.1007/s00247-025-06305-3.
15. Wondemagegnehu BD, Kerego EN, Mammo TN, Robele AT, Gebru FT, Aklilu WK. Predictors of failure in ultrasound-guided hydrostatic reduction of intussusception in children: retrospective analysis in a specialized center in Ethiopia. Pediatric Health Med Ther. 2024;15:87-94. doi: 10.2147/PHMT.S451832.
16. Yang J, Wang G, Gao J, Zhong X, Gao K, Liu Q, et al. Liberal surgical laparoscopy reduction for acute intussusception: experience from a tertiary pediatric institute. Sci Rep. 2024;14(1):457. doi: 10.1038/s41598-023-50493-7.
17. Elrouby A, Waheeb S, Ettaby A, Elabany A. Clinical and radiological predictors of the outcome of hydrostatic reduction of primary intussusception in childhood. Alexandria Journal of Pediatrics. 2019;32(3):101-6. Available from: https://journals.lww.com/ajpp/fulltext/2019/32030/clinical_and_radiological_predictors_of_the.1.aspx
18. Hwang J, Yoon HM, Kim PH, Jung AY, Lee JS, Cho YA. Current diagnosis and image-guided reduction for intussusception in children. Clin Exp Pediatr. 2023;66(1):12-21. doi: 10.3345/cep.2021.01816.