



Interventions Performed to Manage Intussusception

Elahe Derakhan Nezhad (MD)¹, Ali Khakshour (MD)², Hengameh Anari Moghadam (MD)³,
Zahra Chaichy (MD)^{4*}

¹ Student Research Committee, Mashhad University of Medical Sciences, Mashhad, Iran

² Associate Professor of Pediatrics, Department of Pediatrics, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran

³ Mashhad University of Medical Sciences, Mashhad, Iran

⁴ Department of Pediatric Diseases, Mashhad University of Medical Sciences, Mashhad, Iran

ARTICLE INFO

Article type

Original Article

Article history

Received: 06 Oct 2024

Revised: 21 Oct 2024

Accepted: 11 Nov 2024

Keywords

Intussusception

General surgery

Laparotomy

Diagnostic imaging

ABSTRACT

Introduction: Intussusception is the second leading cause of acute abdominal pain in preschool children and infants, which is idiopathic in origin at this stage of life. Management options include hydrostatic reduction and surgery with subsequent procedures. Considering the urgency of intussusception, the existence of multiple interventional methods, and unequal complications of these methods, this research aimed to evaluate the characteristics of intussusception patients and therapeutic interventions performed to manage intussusception in Akbar Children's Hospital in Mashhad, Razavi Khorasan province, Iran.

Methods: This descriptive cross-sectional research was performed on all children under 18 years of age, who admitted to this hospital from 2017 to 2022 and underwent reduction or surgery with the final diagnosis of intussusception. Patient information was extracted from the hospital information system (HIS). All data were analyzed using SPSS software Version 26.

Results: Totally, 348 patients were included in this research, of whom 68.4% were male. The mean age of the patients was 32.18 ± 39.54 (SD) months; 35.1% were less than one year, 45.4% were between 1 and 5 years, and 19.5% were more than 5 years. Out of 348 patients, 318 (91.8%) cases had the first visit, 22 (6.5%) had the second visit, and eight (1.9%) had the third visit. Regarding the treatment type, 304 (87.5%) patients were cured with reduction, and 44 patients underwent surgery.

Conclusion: This study findings showed that most of the patients (87.5%) recovered with reduction, and a limited percentage of them needed surgery, indicating the effectiveness of the reduction method.

Please cite this paper as:

Derakhan Nezhad E, Khakshour A, Anari Moghadam H, Chaichy Z. Interventions Performed to Manage Intussusception. Rev Clin Med. 2024;11(3): 56-63

Introduction

Intussusception is one of the most common causes of intestinal obstruction, which is defined as the telescopic insertion of the proximal segment of the bowel into the adjacent distal segment. Intussusception could lead to obstruction, strangulation, ischemia, intestinal necrosis, and

even death if left untreated (1). The disease was first described by Barbete in 1674, but the first successful operation was performed by Hutchinson in 1873. Intussusception is classified based on its location, it may be seco-colic, colocolic, jejuno-ileal, or ileo-ileal. However, the

***Corresponding author:** Zahra Chaichy, Department of Pediatric Diseases, Mashhad University of Medical Sciences, Mashhad, Iran

Email: zarichaichy@gmail.com

Tel: 09120827242

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

most common type of intussusception in children is ileocolic. In these cases, the intussusception originates from the distal part of the ileum and progresses towards the ileocecal valve, often terminating near the hepatic flexure (2). Although the mortality rate is less than 1% in developed countries, it is very important to pay attention to this disease because of complications due to obstruction and ischemia (3). The worldwide incidence rate of intussusception is approximately 1 to 4 in 2,000 infants and children of any age. However, intussusception occurs mostly in the first 2 years of life, two-thirds of patients are male, and most of them are healthy, well-nourished toddlers with no past medical history (4, 5). Intussusception is characterized by five definable components: 1) it occurs in a progressive intestinal peristalsis, 2) the proximal intestine along with its mesentery is transferred to the receiving distal intestine, 3) partial to complete intestinal obstruction occurs, 4) mesenteric vessels are compressed between layers of intussusception, and 5) intestinal ischemia progresses and leads to gangrene and finally intestinal necrosis (6). In a few cases, a pathologic factor such as Meckel's diverticulum (41%) or intestinal polyp (19%) is identified as the causative factor. Henoch-Schonlein purpura vasculitis (5%), duplication cysts (11%), lymphoid hyperplasia (10%), and appendicitis mucocele (3%) are less common causes; however, most intussusception cases occur without any causes (7). In idiopathic cases, lymphoid hyperplasia seems to occur in the intestinal wall, which is considered as the pathologic point. Therefore, the terminal ileum with lymphoid-rich tissue is probably the initiator of the intussusception process.

Clinical symptoms of intussusception include one or more of the following cases: sudden and intermittent abdominal pain, palpable abdominal mass, nausea, bilious vomiting, discharge of mucus and blood from the rectum, and jelly stool. In children who are unable to speak, the pain manifests as inconsolable cries that last for several minutes. Moreover, 17% of intussusception patients have significant neurological symptoms such as lethargy, hypotonia, and a clear change in consciousness. Hypovolemic shock occurs in 5% of children with intussusception (8, 9). In children with advanced intussusception, significant systemic symptoms may be present, including metabolic acidosis, hypotension, peritonitis, and altered consciousness, which are late findings (10).

Therapeutic interventions in intussusception include radiologic reduction, delayed repeat enema, laparoscopy, and open surgery. The risk of intestinal ischemia and subsequent

perforation should always be considered when determining the treatment type. Both surgical and non-surgical methods are used to treat intussusception, and the choice of treatment depends on the patient's condition. If there are symptoms of perforation, unresponsiveness to reduction, and unstable hemodynamics, surgical methods are preferred (11).

In non-surgical treatment, reduction is performed after resuscitation with intravenous fluids and initiation of broad-spectrum antibiotics. Reduction through positive pressure under direct imaging guidance has become the standard of care. In early 1876, Hirschsprung used enema for reduction of intussusception. The success rate of reduction with barium enema (contrast) has been reported to be from 60 to 90% (12, 13). The barium solution is kept at a column height of 100 cm, generating a pressure of 100 to 120 mm Hg. Excessive pressure should be avoided, as it may lead to bowel perforation and severe contamination of the peritoneal cavity. Studies support monitoring the reduction for 12-24 hours in the fasting state because at this time, relapse is possible (14, 15). Recently, pneumatic reduction (using air) with occasional addition of barium under fluoroscopic observation has been chosen as a non-surgical method. Studies have shown that pneumatic reduction is safer and has higher success rates than barium enema reduction due to the reduced risk of peritonitis and perforation. It is also easier to monitor and maintain adequate pressure of 120 torr with air compared to contrast. Other studies have cautioned that the air method, despite reducing the risk of peritonitis, may be slightly more invasive than contrast (16, 17). Although the use of barium could lead to significant peritonitis along with perforation, the use of air reduction could also cause pneumoperitoneal tension. In air reduction, the probability of perforation reaches 2%, although this is very rare, but it is extremely life-threatening, and surgery is definitely indicated in these cases. Accordingly, most studies have recommended the presence of a surgical team during pneumatic reduction (18). In general, the success rate of reduction with air and contrast has been reported to be from 80 to 90% and 55 to 70%, respectively. In light of recent alarming reports, the exposure of a growing child to radiation should be minimized if possible (16, 17). For this reason, ultrasound has become an option for diagnosis and monitoring during reduction with similar successful results as fluoroscopy. Another change in the reduction technique is the use of saline solution instead of contrast. Like air reduction, the use of saline reduces the risk of peritonitis, provides a better image when using ultrasound,

and is more effective than contrast. Failure in reduction is considered a surgical emergency. However, recent evidence has shown that repeated attempts at reduction with short-term monitoring are often successful. Studies support repeated attempts at reduction and monitoring only in patients who are hemodynamically stable and do not have signs of peritonitis (18).

Recent data suggest that most intussusceptions are easily reducible, but certain factors seem to predict failure, including age less than 3 months or more than 5 years, symptoms lasting more than 48 hours, presence of a pathologic point, hematochezia, evidence of small bowel obstruction on plain radiography, and prolapse visible through the anus (19). However, air reduction could be performed for patients with symptoms for more than 48 hours and stable hemodynamics, delay in reduction leads to an increased risk of perforation. The presence of a pathologic point in imaging reduces the success rate of non-surgical methods. Therefore, even with complete reduction, due to the risk of recurrence, surgical intervention is often required to remove the identified pathologic factor (20).

Indications for surgical intervention include unsuccessful or incomplete reduction, perforation during reduction, peritonitis, or the presence of a pathologic point. For surgical intervention, pre-operative preparation is needed, including the use of broad-spectrum antibiotics, adequate fluid resuscitation, and maintaining body temperature within the normal range. Placement of a nasogastric tube is recommended to reduce gastric distension and the risk of aspiration under general anesthesia. Surgical procedures vary, but a transverse incision in the right upper quadrant remains popular. The cecum and terminal ileum are completely removed and evaluated for obstruction (21, 22).

Laparoscopy, as a less invasive surgical method, was previously used to diagnose intussusception, and the treatment was done by open surgery. Recent studies have shown that laparoscopy could be used as a safe method in the definitive treatment of intussusception. A review of 10 retrospective studies showed that among 276 intussusception patients undergoing laparoscopy, the treatment success rate was 71% with low recurrence and an overall complication rate of 2.9% (23).

Intussusception interventions in different medical centers differ in prophylactic antibiotics before radiologic reduction, radiologic reduction protocols, post-reduction care, and surgical approaches when reduction fails. Considering that Akbar Children's Hospital is a referral center

for intussusception patients in Mashhad (Razavi Khorasan, Iran), this study aimed to evaluate therapeutic interventions and their outcomes in all children hospitalized with the final diagnosis of intussusception in this hospital from 2017 to 2022.

Materials and Method

This descriptive cross-sectional study was conducted on all children under 18 years of age, who admitted to Akbar Children's Hospital (referral center for intussusception patients) from 2017 to 2022, underwent reduction with the final diagnosis of intussusception, and were discharged or died. Patient information such as age, gender, and symptoms on admission, interventions performed, medications received such as corticosteroids and antibiotics, recent history of COVID-19 (coronavirus disease 2019) symptoms, results of paraclinical tests and examinations, and their conditions at discharge were extracted from the hospital information system (HIS) and entered into a pre-prepared checklist.

In cases related to intussusception reduction, a surgeon's opinion is requested after ultrasound diagnosis. After the examination by the surgeon and in the absence of absolute contraindications such as peritonitis symptoms, reduction is performed by the radiologist. The reduction method is performed using ultrasound-guided hydrostatic saline enema. First, the enema container is filled with normal saline to the appropriate height to generate the desired pressure. Then saline is introduced into the rectum through a tube connected to a gray or blue rectal tube. The rectal tube is fixed by a skilled technician and inserted into the rectum to the extent that its side holes do not remain outside the body to prevent fluid leakage. Fluid flows into the colon and displaces the intussusception to the proximal side by creating pressure until the intussusception loop is completely removed, and the fluid enters the small intestine through the ileocecal valve. This fluid flow is a sign of successful reduction. During the introduction of the liquid, the radiologist observes the reduction or non-reduction process using ultrasound. If reduction fails, increasing the height of the liquid column or elevating the enema container will often aid in successful reduction by increasing the pressure. This process could be repeated up to three times at intervals of approximately one hour if the reduction is still not performed. In cases where there are lead points such as neoplasms, Meckel's diverticulum, polyps, etc., or more than 72 hours have passed, or there is severe inflammation, edema, and signs of reduced vascularity (such as necrosis or possible necrosis),

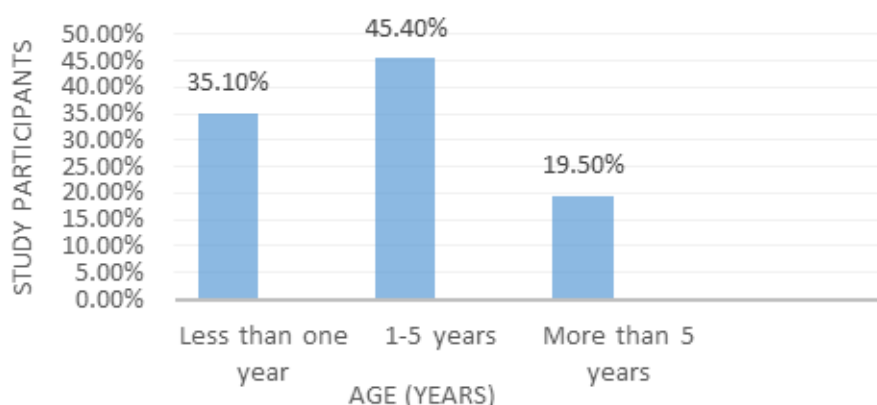


Figure 1. Distribution of intussusception patients in Akbar Hospital by age

the probability of successful reduction is reduced. A control ultrasound is performed in less than 24 hours to check the possibility of recurrence.

Statistical analysis: Data were analyzed using SPSS software Version 26. Descriptive data were presented as mean \pm standard deviation (SD), and qualitative data were reported as frequency and frequency percentage.

Results

A total of 348 patients were included in this study, of whom 68.4% (n=238) were male, and 31.6% (n=110) were female. The average age of the study participants was 32.18 ± 39.54 months, their age distribution was as follows: 35.1% were less than one year, 45.4% were between 1 and 5 years, and 19.5% were more than 5 years (Figure 1). The most common age of intussusception incidence was one year old (37.4%). Of the 348 patients, 57.4% (n=200) lived in Mashhad, and 42.6% (n=148) lived in other cities. The number of referrals in different seasons was as follows: spring 28.1%, summer 23.7%, autumn 24.1%, and winter 24.1%. The highest number of patients' referrals was in the spring season, and

the lowest number of referrals was in the summer season (Figure 2). The years 2017 (10.1%) and 2020 (13.4%) had the lowest number of referrals, while the highest number of referrals for intussusception was in 2022 (23.9%) (Figure 3). Out of 348 patients, 318 (91.8%) cases had the first visit, 22 (6.5%) had the second visit, and eight (1.9%) had the third visit.

Clinical symptoms of intussusception patients at the time of referral included abdominal pain (80.5%), restlessness (52.5%), vomiting (44.8%), fever (10.9%), bloody stool (8%), and jelly stool (7.5%). The most common symptoms were abdominal pain, restlessness, and vomiting. The average duration of hospitalization was 2.83 ± 2.24 days. Regarding the drugs received, 30.5% (n=106) received cortone, 23% (n=80) metronidazole, 20.1% (n=70) ceftazidime, 13.2% (n=46) ceftriaxone, 1.7% (n=6) ceftazolin, and 0.6% (n=2) ampicillin. Ultrasound was the most common imaging technique used to diagnose intussusception, which was performed for 100% of the patients. Control ultrasound was also performed after reduction, no recurrence was observed in 304 people, while recurrence

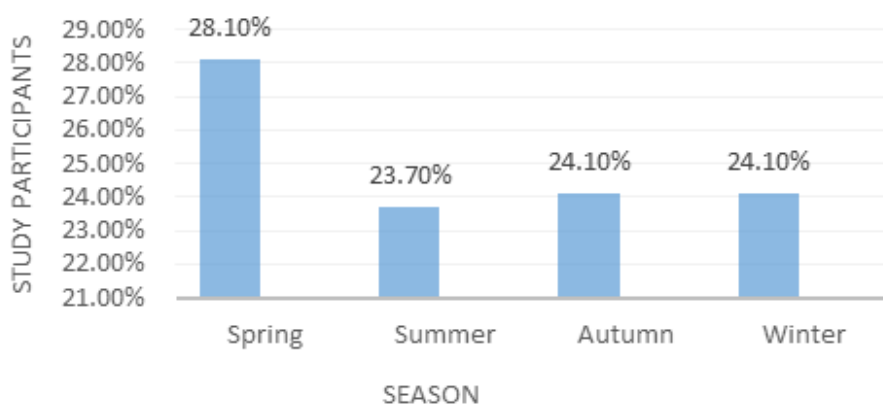


Figure 2. Distribution of intussusception patients in Akbar Hospital by season

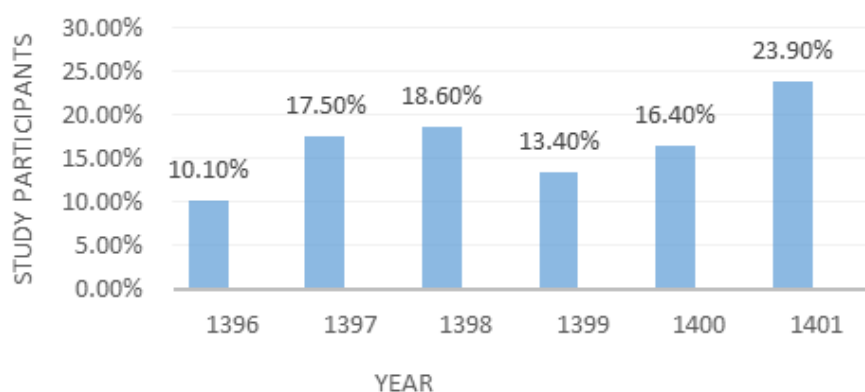


Figure 3. Distribution of intussusception patients in Akbar Hospital by year

was observed in 44 patients, who underwent surgery. Among the patients, 87.9% (n=305) had ileocolic, 6.06% (n=21) had ileal, 3.02% (n=11) had colocolic, and 3.02% (n=11) had jejunal intussusception. The type of treatment was divided into three categories: reduction and surgery with and without resection. Accordingly, 304 (87.5%) patients were cured with reduction, and only 44 patients underwent surgery, of

whom 42 (12.1%) patients underwent surgery without resection, and two (0.4%) patients underwent surgery with resection. Out of 348 people, only one in-hospital death was reported, which was equivalent to 0.4% of the population. Table 1 shows the demographic and clinical characteristics of intussusception patients included in this study.

Table 1. Demographic and clinical characteristics of intussusception patients

Characteristic	Frequency or Average	Percentage or Standard Deviation
Sex	Male	238
	Female	110
Age	32.18	39.54
Place of residence	Mashhad	200
	Other cities	148
Year	2017	35
	2018	60
	2019	64
	2020	46
	2021	57
	2022	83
Season	Spring	97
	Summer	83
	Autumn	84
	Winter	84
Number of visits	1	308
	2	22
	3	8
Drugs received	Ceftriaxone	46
	Cefazolin	6
	Metronidazole	80
	Ampicillin	2
	Ceftazidime	70
	Cortone	106
Symptoms	Fever	38
	Abdominal pain	280
	Restlessness	184
	Vomiting	156
	Bloody stool	28
	Jelly stool	26

Discussion

Intussusception is one of the most common causes of intestinal obstruction, with children younger than one year (with a peak between 5 and 9 months) accounting for 60% of cases. Therapeutic interventions in intussusception include radiologic reduction, delayed repeat enema, laparoscopy, and open surgery. The choice of treatment depends on the patient's condition. Intussusception interventions in different medical centers differ in prophylactic antibiotics before radiologic reduction, radiologic reduction protocols, post-reduction care, and surgical approaches when reduction fails. Considering that Akbar Children's Hospital is a referral center for intussusception patients in Razavi Khorasan, this study evaluated the interventions and their outcomes in all children hospitalized with the final diagnosis of intussusception in this hospital. According to the results, most of the patients were male (68.4%) and belonged to the age group of 1-5 years (45.4%), with one-year-old patients accounting for most of the cases (37.4%). The highest incidence rate of intussusception was in the spring season (28.1%), which could be due to the higher prevalence of viral diseases and lymphoid hyperplasia in the cold seasons. The years 2017 (10.1%) and 2020 (13.4%) had the lowest number of referrals, respectively, these results could be due to the new opening of the hospital and fewer patients referring to the hospital in 2017 as well as the spread of COVID-19 and fewer referrals to public hospitals in 2020. The most common clinical symptoms of intussusception patients were abdominal pain (80.5%), restlessness (52.5%), and vomiting (44.8%), these findings are consistent with similar studies results.

Zhang et al. (2024) conducted a retrospective study in China on 586 intussusception cases. In their study, 68% of the patients were male, which is consistent with the present study result. Also, 17.75% (n=104) were less than one year, 74.4% (n=436) were between 1 and 5 years, and 7.85% (n=46) were more than 5 years, these results are also similar to the present study findings, showing that most of the patients were between 1 and 5 years, and a few of them were over 5 years. In their study, the highest number of referrals was in the summer season, while the lowest number of referrals was in the winter season, which is contrary to our findings. The most common clinical symptoms of patients at the time of referral were abdominal pain (95.73%), vomiting (45.39%), and bloody stool (7.34%), which are similar to this study results. The treatment was done by two methods, reduction and surgery;

96.08% underwent reduction, and only 3.92% underwent surgery (24).

In another similar study conducted by Rajkarnikar et al. (2023) on children aged 6 months to 5 years at a tertiary level pediatric surgery hospital in Nepal from 2018 to 2020, 267 intussusception cases were identified, of whom 61.05% (n=163) were male, and 38.95% (n=104) were female. The most common symptoms at the time of referral included intermittent crying (72.9%), abdominal pain (67.41%), vomiting (63.67%), and rectal bleeding (22.47%), respectively. Among the 267 intussusception cases, 92.13% (n=246) had a successful reduction, while the rest underwent manual reduction (n=7, 33.33%) or anastomotic resection (n=14, 66.67%) after three failed reductions (22).

In another similar study conducted by Yang et al. (2023) in China on 869 intussusception cases, 68% (n=591) were male, and 32% (n=278) were female. In their study, 35.9% (n=312) were less than one year, 22.32% (n=194) were between 1 and 2 years, 18.3% (n=159) were between 2 and 3 years, and 23.48% (n=204) were more than 3 years. Seasonal distribution of patients was as follows: spring 23.4% (n=203), summer 24.9% (n=2016), autumn 26.9% (n=234), and winter 24.9% (n=216). Clinical symptoms at presentation included abdominal pain (84.7%), vomiting (63.2%), bloody stool (31.5%), and fever above 38 °C (22.9%). In their study, successful air reduction was performed for 763 (87.8%) patients, while 106 (12.19%) patients underwent surgery, of whom 84 (9.66%) patients underwent manual reduction, and nine (1.03%) patients experienced intestinal necrosis (25).

Zhang et al. (2023) also conducted a study on 624 children with intussusception, most of them were male. The incidence rate of intussusception was higher in 1-2 and 2-3 year old children, respectively. The lowest number of referrals was related to children over 4 years old. The most common symptoms at presentation were vomiting, fever, and bloody stool, respectively, while the most common symptoms in the present study were abdominal pain and restlessness, followed by vomiting and bloody and jelly stools. Most of the patients (92%) were hospitalized for less than 2 days, while the average hospitalization in the present study was 2.83 days (26).

In another study conducted by Li et al. (2023) on 402 children, the majority (n=301) of patients were male, which is similar to the present study. Unlike the present study, most of the patients belonged to the age group of 6-12 months and 1-2 years, respectively. The highest incidence rate of intussusception was in late autumn and

early winter, while the highest incidence rate in the current study was in spring. In their study, the most common clinical symptoms included abdominal pain, restlessness, abdominal mass, and vomiting, respectively. Also, 97.4% had a successful reduction, which is comparable to the present study result (87.5%) (27).

In a systematic review by Kelley-Quon et al. (2021), it was shown that receiving prophylactic antibiotics before reduction did not reduce the complications of reduction and therefore was unnecessary, while in the present study, 13.2% received ceftriaxone, 1.7% cefazolin, 23% metronidazole, 0.6% ampicillin, and 20.1% ceftazidime (21).

In a similar study conducted by San et al. (2022) on 726 children, 54.27% of the patients were male, which is lower than the present study result. Most of the patients were over 5 years old, unlike the present study where a small number of patients were over 5 years old. The majority of patients underwent reduction, and only 0.7% underwent surgery (28).

Considering the relatively high prevalence of intussusception in children, physicians should consider it in the differential diagnosis of pediatric abdominal pain. Also, reduction methods with radiology should be used in the treatment of these patients, which have an acceptable success rate. Future studies, especially clinical trials, are suggested to compare different therapeutic methods, including surgical and radiologic techniques.

Limitations of the study: The number of patients studied was limited, which reduces the generalizability of the results to the entire

population of children with intussusception. Lack of access to complete and detailed medical records of some patients, especially those visiting multiple treatment centers, limited the analyses. Long-term follow-up to assess complications or recurrence of intussusception was difficult, especially in patients who came from remote areas or did not visit the treatment center regularly. Factors such as diet, lifestyle, family status, and cultural/social differences were not investigated, these factors may affect early diagnosis and timely referral of patients to medical centers and therefore the final results.

Conclusion

Considering the high success rate of radiologic reduction, it is suggested to use this method as the first option in the treatment of intussusception patients. However, a small number of patients with advanced intussusception need surgery, which also has favorable results. Therefore, surgery is recommended as an appropriate treatment method in patients with unsuccessful or incomplete reduction, perforation during reduction, peritonitis, or a specific pathologic point.

Conflict of interest

The authors declare no competing interest.

Acknowledgments

The authors would like to thank the Research and Technology Vice-Chancellor of Mashhad University of Medical Sciences for supporting the implementation of this research.

References

- Charles T, Penninga L, Reurings JC, Berry MC. Intussusception in children: A clinical review. *Acta Chir Belg.* 2015;115(5):327-33.
- Huppertz HI, Soriano-Gabarró M, Grimprel E, Franco E, Mezner Z, Desselberger U, et al. Intussusception among young children in Europe. *Pediatr Infect Dis J.* 2006;25(1):S22-9.
- Collaborative G. Determinants of morbidity and mortality following emergency abdominal surgery in children in low-income and middle-income countries. *BMJ Glob Health.* 2016;1(4):e000091.
- Liu N, Yen C, Huang T, Cui P, Tate JE, Jiang B, et al. Incidence and epidemiology of intussusception among children under 2 years of age in Chenzhou and Kaifeng, China, 2009-2013. *Vaccine.* 2018;36(51):7862-7.
- Das MK, Arora NK, Mathai J, Sam CJ, Rajamani G, Krishnaswamy R, et al. Profile and epidemiology of intussusception in children under two years of age: A prospective surveillance. *Indian J Pediatr.* 2021;88(12):1187-94.
- Edwards EA, Pigg N, Courtier J, Zapala MA, MacKenzie JD, Phelps AS. Intussusception: Past, present, and future. *Pediatr Radiol.* 2017;47(9):1101-8.
- DiFiore JW. Intussusception. *Semin Pediatr Surg.* 1999;8(4):214-20
- Schollin Ask L, Svensson JF, Olén O, Örtqvist Å. Clinical presentation of intussusception in Swedish children under 3 years of age and the validity of diagnostic coding. *Pediatr Surg Int.* 2019;35(3):373-81.
- Cox S, Withers A, Arnold M, Chitnis M, De Vos C, Kirsten M, et al. Clinical presentation and management of childhood intussusception in South Africa. *Pediatr Surg Int.* 2021;37(10):1361-70.
- Lianos G, Xeropotamos N, Bali C, Baltogiannis G, Ignatiadou E. Adult bowel intussusception: Presentation, location, etiology, diagnosis, and treatment. *G Chir.* 2013;34(9):280-3.
- Zewde Y, Bugie T, Daniel A, Wodajo A, Meskele M. Clinical presentation and management outcome of pediatric intussusception at Wolaita Sodo University Comprehensive Specialized Hospital: A retrospective cross-sectional study. *J Int Med Res.* 2024;52(3):03000605241233525.
- Justice FA, Auld AW, Bines JE. Intussusception: Trends in clinical presentation and management. *J Gastroenterol Hepatol.* 2006;21(5):842-6.
- Hutchason A, Sura A, Vettikattu N, Goodarzi F. Clinical management and recommendations for children with more than four episodes of recurrent intussusception following successful reduction of each: An institutional

- review. *Clin Radiol*. 2020;75(11):864-7.
14. Paek SH, Kim DK, Kwak YH, Jung JY, Lee S, Park JW. Effectiveness of the implementation of pediatric intussusception clinical pathway: A pre- and postintervention trial. *Medicine*. 2021;100(48):e27971.
 15. Gluckman S, Karpelowsky J, Webster AC, McGee RG. Management for intussusception in children. *Cochrane Database Syst Rev*. 2017;6(6):CD006476.
 16. Okumus M, Emektar A. Pediatric intussusception and early discharge after pneumatic reduction. *Acta Chir Belg*. 2019;119(3):162-5.
 17. Vakaki M, Sfakiotaki R, Liasi S, Hountala A, Koutrouveli E, Vraka I, et al. Ultrasound-guided pneumatic reduction of intussusception in children: 15-year experience in a tertiary children's hospital. *Pediatr Radiol*. 2023;53(12):2436-45.
 18. Feldman O, Weiser G, Hanna M, Devir O, Balla U, Johnson DW, et al. Success rate of pneumatic reduction of intussusception with and without sedation. *Paediatr Anaesth*. 2017;27(2):190-5.
 19. Kusmayadi DD, Agnestivita LK, Indriasari V. Risk factors for failure of hydrostatic reduction in children with intussusception in Hasan Sadikin General Hospital. *Med J Malaysia*. 2022;77(Suppl 1):38-41.
 20. Younes A, Lee S, Lee JI, Seo JM, Jung SM. Factors associated with failure of pneumatic reduction in children with ileocolic intussusception. *Children*. 2021;8(2):136.
 21. Kelley-Quon LI, Arthur LG, Williams RF, Goldin AB, St Peter SD, Beres AL, et al. Management of intussusception in children: A systematic review. *J Pediatr Surg*. 2021;56(3):587-96.
 22. Rajkarnikar R, Singh S, Joshi MP, Kayastha A. Intussusception among children admitted in a department of pediatric surgery of a tertiary care centre: A descriptive cross-sectional study. *J Nepal Med Assoc*. 2023;61(258):150-3.
 23. Wei CH, Fu YW, Wang NL, Du YC, Sheu JC. Laparoscopy versus open surgery for idiopathic intussusception in children. *Surg Endosc*. 2015;29(3):668-72.
 24. Zhang L, Chen X, Huang Y, Wang G, Zhang Z, Song Z. Epidemiological characteristics, treatment, and outcomes of 586 cases of intussusception: A 4-year retrospective study in China. *Front Pediatr*. 2024;12:1379168.
 25. Yang M, Xie Y, Zhuang Y, Chen Y, Lin X, Liu Z, et al. Risk factors and predictive models for early recurrent intussusception in children: A retrospective cohort study. *Transl Pediatr*. 2023;12(10):1800-9.
 26. Zhang J, Dong Q, Su X, Long J. Factors associated with in-hospital recurrence of intestinal intussusception in children. *BMC Pediatr*. 2023;23(1):428.
 27. Li Y, Zhou Q, Liu C, Sun C, Sun H, Li X, et al. Epidemiology, clinical characteristics, and treatment of children with acute intussusception: A case series. *BMC Pediatr*. 2023;23(1):143.
 28. Sun Z, Song G, Lian D, Zhang Q, Dong L. Process management of intussusception in children: A retrospective analysis in China. *Pediatr Emerg Care*. 2022;38(7):321-5.