Original article

Ultrasound-Guided Pneumatic Reduction Of Intussusception In Children

Sanjay Kumar Sah[1], Dipak Kumar Yadav[1], Saurav Poudel[1], Bivusha Parajuli[1], Ramanandan Prasad Chaudhary[2]

Abstract

Introduction:Intussusception, occurring most commonly in 6-month to 3-year-olds, involves bowel invagination with symptoms like abdominal pain, red currant jelly stool, and a palpable mass. The preferred treatment is non-operative, especially in stable cases without contraindications. Non-operative methods include ultrasound-guided hydrostatic and pneumatic reduction, as well as fluoroscopic-guided hydrostatic reduction with barium and pneumatic reduction with air enema.

Methods: The prospective study took place at a specialized pediatric hospital over 36 months period. All children experiencing intussusception underwent abdominal sonographic assessment for diagnosis. Subsequently, an attempt was made to perform ultrasound-guided pneumatic reduction of the intussusception. Exclusions comprised hemodynamically unstable children, those displaying signs of peritonitis or bowel perforation, and those with sonographically identified pathological lead points.

Results: A total of 98 children were treated with ultrasound-guided pneumatic reduction for intussusception.The average age of the patient was 11.38±9.24 months. Ileocolic intussusception was the most common finding in 98.9%. Around 80% of the patients was presented with complaints of severe abdominal pain. In 43.8% of the patients, the duration of symptoms was less than 24 hours. The mean length of intussusception was 3.64 cm. A total of 94 (96%) children had successful reduction of intussusceptions with recurrence found in only two of cases.

Conclusion: Pneumatic reduction of intussusception is a highly effective procedure. It is associated with reduced morbidity and mortality and reduced risk of exploratory laparotomy. The main predictor for the outcome was the duration of symptoms before presentation to the institute, thus early use of pneumatic reduction is advisable.

Keywords: Child; Enema; Intussusception; Ultrasound

Author affiliations:

[1] Department of Pediatric Surgery, Nobel Medical College Teaching Hospital, Biratnagar, Nepal.

[2] Department of Pediatric Surgery, Ishan Children and Women's Hospital Pvt Ltd, Kathmandu, Nepal.

Correspondence:

Dr. Sanjay Kumar Sah,
Department of Pediatric Surgery, Nobel Medical College Teaching Hospital, Biratnagar, Nepal.

Email: dr.sks213@gmail.com

Disclosures:

Ethical Clearance: Taken

Conflict of interest: None

Financial aid: None

How to cite this article:

Sah SK, Yadav DK, Poudel S, Parajuli B, Chaudhary RP. Ultrasound-guided pneumatic reduction of Intussusception in children. J Soc Surg Nep. 2023;26(2):74-78.

DOI:

https://doi.org/10.3126/jssn.v26i2.63628

Introduction

Intussusception is defined as the invagination of one segment of the bowel into an immediately adjacent segment. The intussusceptum is the proximal segment that invaginates into the distal segment known as the intussuscipiens.[1,2] Intussusception is considered to be one of the most common causes of intestinal obstructions in a young child and is regarded as an emergency with considerable morbidity and mortality, if not treated on time.[3–5] It is most commonly seen in the ages of 6 months to 3 years, with a male predominance of around 1.5:1 to 3:1.[6,7] The classical triad of intussusception has been described as abdominal pain, red currant jelly stool, and a palpable abdominal mass, however, this triad is only present in 25-50% of cases.[8,9] A clinical case definition proposed by Bines et al can identify intussusception with a sensitivity of 97%.[10] Ultrasonography is the most reliable method for the diagnosis of intussusception at the current time.[9,11]

The treatment modalities for intussusception include both operative and non-operative procedures. Non-operative procedures have preferential status in the current treatment of intussusception in children.[8,12] Non-operative procedures are indicated in states of hemodynamic stability and without contraindications such as perforation or peritonitis.[13] Operative procedures are indicated when there is a failure of non-operative measures or there is a contraindication to non-operative methods.[14] The non-operative methods include ultrasound-guided hydrostatic reduction, ultrasound-guided pneumatic reduction, fluoroscopic-guided hydrostatic reduction with barium, and fluoroscopic-guided pneumatic reduction as air-enema.[5,8,9]

Pneumatic reduction of intussusception has been regarded as superior to barium and hydrostatic reduction. It is a cheaper, easier, and quicker procedure to perform with higher success rates, and reduces the chance of radiation associated with barium procedures.[5,8,9,12] The effective and well-timed reduction of intussusception prevents the occurrence of infarction and necrosis of the bowel, perforation, peritonitis, shock, and even death.[1,2,9]

The study aims to evaluate the effectiveness of ultrasound-guided pneumatic reduction in treating pediatric intussusception at our institute and identify and evaluate other factors that affect the efficacy of the procedure and the recurrence of the condition.

Methodology

This is a prospective descriptive cross-sectional study conducted in the Department of pediatric surgery at Ishan Children & Women's Hospital, Kathmandu, Nepal. All the patients who went for pneumatic reduction from November 2019 to November 2022 were included in the study.

Inclusion criteria: All pediatric patients with a clinical diagnosis of intussusception which was confirmed by ultrasonography.

Exclusion criteria: The patients with red currant stool, fever, features of obstruction and peritonitis, and hemodynamic instability were excluded.

Failure of pneumatic reduction was defined as unsuccessful reduction even after three attempts of pneumatic reduction at a pressure range of 80-120 mm of Hg for 3 to 5 minutes.

Informed consent was taken from the parents, and ethical clearance was taken from the Hospital Ethical Committee. The procedure involved using a catheter and sphygmomanometer to reduce intussusception in children. The catheter was locally assembled and appropriately sized (18 – 26 Fr) as shown in **Figure 1**. Before the procedure, the patients were resuscitated with fluids and given antibiotics. Necessary blood tests were done, and the patients were booked for emergency laparotomy if the procedure failed. Under intravenous anesthesia in the operating room, the patient was positioned in a supine or left lateral position, and the two-way Foley's catheter lubricated with lignocaine jelly was introduced per-rectum, with the balloon inflated with 30 to 50 ml of normal saline and gluteal fold held together to prevent leakage of air as shown in **Figure 2**. Air was gradually introduced into the rectum using the inflation bulb, while the pressure was maintained between 80-120 mmHg for 3-5 minutes.

The success of the procedure was determined using an ultrasound scan after procedure with no evidence of telescoping of bowel into bowel. Three attempts were allowed at the interval of 5 minutes. Patients who failed the procedure underwent emergency laparotomy, while successful cases were monitored in the ward before being discharged. Patients who experienced a recurrence after successful reduction were allowed a maximum of three repeat procedures.

Figure 1. Assembled equipments

Figure 2. Position of the patient

The variables that were analyzed to predict outcome are: age, gender, type of intussusceptions, presenting complaint, duration of symptoms before presentation, length of intussusception, and duration of pneumatic reduction.The data was calculated using SPSS 26th edition.

Results

Over three years, 98 children were treated with ultrasound-guided pneumatic reduction for intussusception and included in this study.

Table 1. Patient demographic (N = 98)

Demographic		
Age at presentation	<6 months	29 (29.59%)
	6 to 12 months	41 (41.84%)
	12 to 24 months	18 (18.37%)
	24 to 36 months	7 (7.14%)
	>36 months	3 (3.06%)
Gender	Male	56 (57.14%)
	Female	42 (42.86%)

Male: Female Ratio was 1.33:1. The Average age of the patient was 11.38 ± 9.24 months.

The mean length of intussusception was 3.64±0.72 cm.There were four cases of failed pneumatic reduction. Among those cases, 3 were of ileocolic type while 1 case was of ileoileal type of intussusception. The common factor among the cases of failed pneumatic reduction was presentation after more than 72 hours of the onset of symptoms to our institute, and rectal bleeding/red currant stool. Exploratory laparotomy with manual reduction was done for all these failed cases.Lead points were observed in two cases undergoing exploratory laparotomy. The surgical reduction cases were discharged on the 5th postoperative day. The cases of pneumatic reduction were discharged on 2nd post-procedure day.

Table 2. Type of Intussusception (N=98)

Type	n (%)
Ileocolic	97 (98.98%)
Ileoileal	1 (1.02%)
Total	98 (100%)

Table 3. Presenting complaints

Symptoms	n (%)
Abdominal pain	79(80.6%)
Red currant stool	38(38.7%)
Vomiting	62(63.2%)
Abdominal distention	69(70.4%)

Table 4. Duration of symptoms before presentation

Duration before symptoms	n (%)
<24 hours	43 (43.88%)
24 to 48 hours	27 (27.55%)
49 to 72 hours	16 (16.33%)
> 72 hours	10 (13.24%)

Recurrence of intussusception occurred in two cases. The first case had a recurrence the following day, while the second patient experienced recurrence after six months of the initial pneumatic reduction.For both cases, the pneumatic reduction of intussusception was repeated and the symptoms were alleviated. The intussusception in both cases was of ileocolic type. There was no incidence of perforation during the procedure.

Discussion

Air enema reduction or pneumatic reduction of intussusception has gained widespread popularity, particularly among the pediatric population.[5,6,15] Ultrasound-guided pneumatic reduction of intussusception has shown better outcome compared to other methods of reduction of intussusception.[8,9,15] A study by Khorana et al showed that pneumatic reduction is around 1.48 times more effective than hydrostatic reduction, but both can be used according to the availability of resources at the institute and the experience of the doctor performing the reduction.[14] Similar results were also reported by Beres and Baird.[16] The risk of perforation was found similar between pneumatic or hydrostatic reduction. The risk of peritoneal contamination and complication was found to be greater in hydrostatic reduction compared to pneumatic reduction, along with an increased risk of radiation present in the reduction procedure using flouroscopy.[2,6,16]

The success rate of pneumatic intussusception has been described variably according to different studies, ranging

as low as 60% from the African region to as high as 97% in studies from China, Japan, and North America.[9,17–20] In our study, we achieved a success rate of 95.91% with an ultrasound-guided pneumatic reduction of intussusception, which is comparable to the success rate achieved by Wang et al and Todani et al.[17,18] A similar study from Nepal by Adhikari also achieved a 92% success rate which is similar to our study.[2]

According to Kumar et al, age less than three months or more than two years is associated with an increased likelihood of pathological lead points and failure of pneumatic reduction.[7] Our study did not demonstrate age to influence the outcome of pneumatic reduction, similar to studies by Mensah et al, Tang et al, and Dung et al.[5,9,21]

A significant predictor of outcome has been the duration of symptoms of obstruction. We observed that the longer the duration of symptoms before reduction, the more the chance of failure was seen. We observed four cases among 98 total cases with duration of symptoms of more than 72 hours, which observed failure of pneumatic reduction and thus had to undergo exploratory laparotomy. Duration being the predictor of outcome has been reported by various other authors as well including Tang et al, Stein et al, and Katz et al.[20–22]

Another significant predictor of reduction failure observed in our study was rectal bleeding or the occurrence of red currant stool. Rectal bleeding occurred in only 38 (38.7%) cases of 98 total cases; however rectal bleeding and duration of symptoms for more than 72 hours were seen in all four cases of reduction failure. Hematochezia is most likely due to mucosal ulceration associated with bowel wall ischemia.[21] A study by Reijnen et al found that patients with symptom duration of more than 48 hours and rectal bleeding were associated with a 92% risk of failure of pneumatic reduction.[23] A similar finding was seen by Tang et al which is similar to the observation of our study.[21]

The mean length of intussusception was 3.64 ± 0.72 cm. The study by Adhikari had the mean length of intussusception at 3cm while Binkovitz et al recorded a mean length of intussusception of 4cm.[2,24] The length of intussusception was not related to a failed reduction in our study which is per the study by Binkovitz et al.[24]

The sex ratio in intussusception is considered to be male-dominated ranging from 1.5:1 to 3:1.[5–7] In our study, we found the M:F ratio to be 1.33:1, similar to the study by Kumar et al, Hazra et al, and Dung et al.[7,9,25] In our study, we observed that sex was not associated with an increased risk of failure of reduction of intussusception by pneumatic methods, which is similar to the finding observed in the study by Tang et al.[21]

As discussed in the literature, the main complication of pneumatic reduction is bowel perforation, and the perforation rate is taken as a marker of the safety and performance of the procedure.[21,26,27.]Various studies have given perforation rates ranging from 0.5-1%.[21,26,27] Our study did not experience any perforation during the pneumatic reduction of intussusception. In case of perforation, rapid hemodynamic and respiratory deterioration can occur, even leading to death.[27] Immediate measures to decompress the high abdominal pressure should be kept ready to deal with such complications and constant vigilance should be kept by the surgeon or the radiologist performing the procedure. Another disadvantage of air enema is the difficulty in the identification of lead points, which are better identified by hydrostatic methods.[5,21,28] In our study, the patients with failed reduction were taken directly for exploratory laparotomy, where 2(2.04%) cases were found to have lead points. Another disadvantage of pneumatic reduction is pseudo-reduction wherein gas enters the small bowel without the intussusception being reduced.[4,20] In our study, we did not observe any pseudo-reduction.

There are some limitations in our study. The study is done at a single institute with a small sample size. Fecal matter in the colon obstructs the air-entry while inappropriate taping of the buttocks allows air to leak out. These affect the efficacy of the procedure.

Conclusion

Pneumatic reduction of intussusception is a cheap, safe, easily assembled, and highly effective procedure. It is associated with reduced morbidity and mortality and reduced risk of exploratory laparotomy. The main predictor for the outcome was the duration of symptoms before presentation to the institute, thus early use of pneumatic reduction is advisable. Red currant stool or rectal bleeding should also be considered as a bad predictor. Ultrasound-guided pneumatic reduction is thus, a safe and recommended procedure for the treatment of intussusception in the pediatric population.

References

1. Marsicovetere P, Ivatury SJ, White B, Holubar SD. Intestinal Intussusception: Etiology, Diagnosis, and Treatment. Clin Colon Rectal Surg. 2017;30(1):30-39.
2. Adhikari SB. Early experience with ultrasound guided pneumatic reduction of intussusception using locally assembled equipment in Nepal. J Soc Surg Nep. 2019;22(2):27-31.
3. Plut D, Phillips GS, Johnston PR, Lee EY. Practical Imaging Strategies for Intussusception in Children. Am J Roentgenol. 2020;215(6):1449-63.
4. Meyer JS, Dangman BC, Buonomo C, Berlin JA. Air and liquid contrast agents in the management of intussusception: a controlled, randomized trial. Radiology. 1993;188(2):507-511.

5. Mensah YB, Glover-Addy H, Etwire V, Twum MB, Asiamah S, Appeadu-Mensah W, et al. Pneumatic reduction of intussusception in children at Korle Bu Teaching Hospital: an initial experience. Afr J Paediatr Surg. 2011;8(2):176-81.
6. Bowker B, Rascati S. Intussusception. J Am Acad Physician Assist. 2018;31(1):48-49.
7. Kumar KMK, Kumar TS, Pavan BM, Ashok C, Kottur S. Study of factors influencing pneumatic reduction of intussusception in children in Tumkur, South India. Int J Sci Study. 2014;2(3):30-32.
8. Özcan R, Hüseynov M, Emre Ş, Tutuncu C, Vehid HE, Dervisoglu S, et al. A review of intussusception cases involving failed pneumatic reduction and re-intussusception. Ulus Travma Acil Cerrahi Derg. 2016;22(3):259-64.
9. Dung ED, Shitta AH, Alayande BT, Patrick TM, Kagoro B, Odunze N, et al. Pneumatic reduction of intussusception in children: experience and analysis of outcome at juth, jos, a tertiary health centre in north central nigeria. J West Afr Coll Surg. 2018;8(4):45-66.
10. Bines JE, Ivanoff B, Justice F, Mulholland K. Clinical Case Definition for the Diagnosis of Acute Intussusception. J Pediatr Gastroenterol Nutr. 2004;39(5):511-518.
11. Hasan O Bin, Farres SN, Ibrahim M. Ultrasound guided pneumatic reduction of intussusception in children–A case series. Int J Recent Sci Res. 2015;6:4204-07.
12. Joda AE, Salih WM, Shakarly NH. Ultrasound Guided Pneumatic Reduction of Intussusception: A Clinical Experience from Baghdad. Am J Pediatr. 2017;3(6):76-82.
13. Ito Y, Kusakawa I, Murata Y, Ukiyama E, Kawase H, Kamagata S, et al. Japanese guidelines for the management of intussusception in children, 2011. Pediatr Int. 2012;54(6):948-958.
14. Khorana J, Patumanond J, Ukarapol N, Laohapensang M, Visrutaratna P, Singhavejsakul J. Clinical prediction rules for failed nonoperative reduction of intussusception. Ther Clin Risk Manag. 2016;12:1411-16.
15. Singh A, Tanger R, Mathur V, Gupta A. Pneumatic reduction of intussusception in children. Saudi Surg J. 2017;5(1):21-5.
16. Beres AL, Baird R. An institutional analysis and systematic review with meta-analysis of pneumatic versus hydrostatic reduction for pediatric intussusception. Surgery. 2013;154(2):328-34.
17. Wang G, Liu XG, Zitsman JL. Nonfluoroscopic reduction of intussusception by air enema. World J Surg. 1995;19(3):435-8.
18. Todani T, Sato Y, Watanabe Y, Toki A, Uemura S, Urushihara N. Air Reduction for Intussusception in Infancy and Childhood: Ultrasonographic Diagnosis and Management Without X-Ray Exposure. Eur J Pediatr Surg. 1990;45(04):222-6.
19. Shiels WE, Maves CK, Hedlund GL, Kirks DR. Air enema for diagnosis and reduction of intussusception: clinical experience and pressure correlates. Radiology. 1991;181(1):169-72.
20. Stein M, Alton DJ, Daneman A. Pneumatic reduction of intussusception: 5-year experience. Radiology. 1992;183(3):681-4.
21. Tang P, Law E, Chu W. Pneumatic Reduction of Paediatric Intussusception: Clinical Experience and Factors Affecting Outcome. Hong Kong J Radiol. 2016:200-07.
22. Katz M, Phelan E, Carlin JB, Beasley SW. Gas enema for the reduction of intussusception: relationship between clinical signs and symptoms and outcome. AJR Am J Roentgenol. 1993;160(2):363-6.
23. Reijnen JA, Festen C, van Roosmalen RP. Intussusception: factors related to treatment. Arch Dis Child. 1990;65(8):871-3
24. Binkovitz LA, Kolbe AB, Orth RC, Mahood NF, Thapa P, Hull NC, et al. Pediatric ileocolic intussusception: new observations and unexpected implications. Pediatr Radiol. 2019;49(1):76-81.
25. Hazra NK, Karki OB, Verma M, Rijal D, De A, Nath B. Intussusception in children: A short-term analysis in a tertiary care hospital. Am J Public Health Res. 2015;3(4):53-6.
26. Ko HS, Schenk JP, Tröger J, Rohrschneider WK. Current radiological management of intussusception in children. Eur Radiol. 2007;17(9):2411-21.
27. Guo JZ, Ma XY, Zhou QH. Results of air pressure enema reduction of intussusception: 6,396 cases in 13 years. J Pediatr Surg. 1986;21(12):1201-03.
28. Miller SF, Landes AB, Dautenhahn LW, Pereira JK, Connolly BL, Babyn PS, et al. Intussusception: ability of fluoroscopic images obtained during air enemas to depict lead points and other abnormalities. Radiology. 1995;197(2):493-6.