

Risk factors for conversion to open approach during laparoscopic reduction of intussusception in children who failed fluoroscopy-guided pneumatic enema reduction: experience from a single-center experience in 94 consecutive patients- an original article.

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Abstract

Objective

To summarize our experience in laparoscopic treatment of intussusception in children who failed fluoroscopy-guided pneumatic enema reduction, and to identify the independent risk factors that may relate to conversion to open approach.

Methods

A retrospective analysis of patients with intussusception who failed pneumatic enema reduction was performed from August 2014 to March 2021. Patients who completed laparoscopic intussusception reduction were compared with those who converted to open approach regarding demographic (age, gender), history (previous abdominal surgery history, number (No.) of intussusception before), clinical manifestations (preoperative pneumatic enema attempts, abdominal pain, irritable crying, emesis, bloody stool, abdominal mass, fever, diarrhea, duration of symptoms, body mass index, American Society of Anesthesiologists fitness grade), work-up (Leukocyte counts), and intra-operative findings (anatomic type of intussusception, number (No.) of intussusceptions, length of intussusception, outcome (operative time, complications, postoperative hospital stay). Statistic analyze was performed using univariate and Logistic regression analysis.

Results

Univariate analysis showed that small bowel intussusception was associated with conversion to laparotomy ($p < 0.05$). Logistic regression analysis indicated that bloody stool (odds ratio (OR)26.071; 95% confidence interval (CI)2.341,290.33; $p < 0.01$) and small bowel intussusception (odds ratio (OR)39.194; 95% confidence interval (CI)3.562,431.281; $p < 0.01$) may be independent risk factors related to the conversion from laparoscopic intussusception to open procedure ($p < 0.01$).

Conclusion

Bloody stool and small bowel intussusception may be the independent risk factors associated with the conversion to laparotomy in laparoscopic treatment for intussusception in children who failed fluoroscopy-guided pneumatic enema reduction.

Introduction

In the past few years, laparoscopy have found a place in the surgical therapy for intussusception in pediatric population offering notable results. However, conversion to open surgery remains required every now and then. The risk factors for the need of conversion in pediatric intussusception have not been well elucidated. Our study aims to define the factors that may relate to conversion to open procedure in laparoscopic intussusception reduction in pediatric population after failed fluoroscopy-guided pneumatic enema reduction.

Methods

We retrospectively reviewed the electronic medical records of all patients underwent laparoscopic procedures with the diagnose of intussusception (International Classification of Diseases-10 code k56.100) between August 2014 and October 2020. The study was approved by the committee of ethics in our hospital. Patients younger than 18 yrs. with intussusception irreducible by air enema and then underwent laparoscopic reduction during the study period were enrolled. Patients who received open reduction initially and those who lost follow-up were excluded.

All patients were confirmed by ultrasound. Fluoroscopy-guided pneumatic enema was initiated immediately after diagnosis, providing that the patient was well fluid resuscitated and there were no signs of peritonitis or shock. A surgeon was kept on stand-by in case bowel perforation occurs. Air pressure was kept at 80-120mmHg. Maximum of three pneumatic enemas were attempted with three minutes each. The time intervals ranged from minutes to hours. Delayed pneumatic enema was utilized if the patient was stable with the intussusception been partially reduced on previous attempt and there is no evidence of peritonitis. Operation was taken if nonsurgical reduction failed or there is clinical suspicion of bowel necrosis or pathological lead point. For hemodynamically stable patients, laparoscopic procedure was attempted initially. A conventional 3-port technique was employed-Hasson port was inserted through umbilical approach (3 mm, 30-degree camera), the other two working port (5-mm) was placed in the left flank, one above and one below the level of the umbilicus or both below it. After identifying the level of intussusception, reduction was performed by a combination of taxis and traction using atraumatic graspers. with two 5 mm atraumatic bowel graspers. (Video 1). Appendectomy was performed if there is inflammation or ischemia of appendix. Conversion was defined as extending incision to assist reduction or perform bowel resection and anastomosis.

A retrospective analysis of 22 variables in these patients was carried out, including demographics, clinical history, laboratory studies, imaging examinations, intervention type, intraoperative findings and outcome data. The patients were divided into two groups based on operative intervention type: laparoscopic (LAP) and conversion.

Statistical analysis was carried out using the SPSS (IBM, version 25.0, Chicago, USA). A Shapiro-Wilk test was used to check the normal distribution of continuous quantitative parameters. Continuous quantitative data are expressed as the mean and standard deviation ($M \pm SD$), and were compared using the two-side Student's t-test for normally distributed variables. Continuous data non-normally distributed were described as median with an interquartile range and were compared using the Wilcoxon–Mann–Whitney test. Comparisons between groups for categorical variables were performed using the Chi-square test or Fisher's exact test. To identify variables that were independent predictors of conversion, a logistic regression analysis was constructed, employing those variables with a significant level of $p < 0.2$. A p value < 0.05 indicates statistical significance.

Results

Patient characteristics

A total of ninety-four patients (65 males, 29 females) with a median age of 12 months (range 8.58 months–36.25 months) underwent operative reduction for intussusception during the study period. Their presenting symptoms and signs as described by their parents ranged from emesis and abdominal mass to bloody stool (Table 1). Bloody stool was the predominant symptom and occurred in 71 patients (76%), followed by emesis presented in 67 patients (71%) and abdominal mass was observed in 54 patients (57%). There were no significant differences in the conversion rate regarding in age, gender, previous abdominal surgery history, No. of intussusception before, preoperative pneumatic enema attempts, abdominal pain, irritable crying, emesis, bloody stool, abdominal mass, fever, diarrhea, duration of symptoms, body mass index (BMI), American Society of Anesthesiologists fitness grade (ASA), leukocyte counts (Table 1).

The reasons and rate of conversion to open surgery

In total, conversion was required in 45 (48%) of the 94 patients. 11 patients received conversion as complete reduction cannot be achieved laparoscopically due to a 'tight' intussusception. 14 cases subject to limited working space with poor visualization due to marked bowel dilation. 17 patients were converted to open procedure to facilitate intestinal resection and anastomosis. Three patients required conversion due to the lack of tactile cues to exclude a pathological lead point.

Risk factors associated with conversion to open surgery

Small bowel intussusception accounted for 6% (3/49) in LAP group and 36% (16/45) in conversion group respectively ($p = 0.003$). Bloody stool was found in 70% (34/48) of patients in LAP group compared with 86% (37/43) in conversion group ($p = 0.08$). Although bloody stool was demonstrated to be irrelevant to conversion ($p = 0.08$) by using Pearson's chi square test, it still has important clinical significance as a sign of intestinal ischemic even necrosis, which may require bowel resection. Thereafter, logistic regression analysis demonstrated that bloody stool (OR 26.071; 95% CI 2.341,290.33; $p = 0.008$) and small bowel intussusception (OR 39.194; 95% CI 3.562,431.281; $p = 0.003$) were risk factors for conversion to open procedure (Table 3).

Comparison of the operative data and postoperative outcomes in patients of the two groups

Table 2 summarized the comparisons of the operative findings and postoperative outcomes between the two groups. There were no significant differences between the two groups when comparing No. and

length of intussusceptions. Patients who required conversion experienced longer operative time (a median of 138mins vs 58mins for patients in the LAP group, $p = 0.0$). Postoperative hospital stay was significantly longer in the conversion group (a median of 7d vs 5d for the LAP group, $p = 0.0$). There were no significant differences between the two groups with regards to complication.

Overall, pathological lead points were identified in 20 patients of the conversion group: Meckel diverticula in 10 cases, polyps in 5 cases, duplication in 4 cases and lymphoma in one case, while no pathological lead point was found in LAP group ($p = 0.000$).

Ileocolic intussusception formed the vast majority anatomic type of intussusception in both groups, 86% and 58%, respectively ($p = 0.774$). Followed by small bowel intussusception, which consisted 6% of the LAP group and 36% of the conversion group respectively ($p = 0.003$).

Discussion

Intussusception is the invagination of one part of the intestine (intussusceptum) into adjacent distal segment (intussusciens)[1-3]. It is one of the most common causes of acute bowel obstruction in infants and toddlers[2]. For those hemodynamically stable patients with no signs of perforation or peritonitis, non-surgical reduction was attempted initially. Most patients could be successfully managed by non-surgical reduction, while a few patients who failed in radiological reduction still require operative reduction[4, 5]. Given the shorter length of hospital stay and equivalent complication rates compared with open surgery, laparoscopic reduction is demonstrated to be a safe and feasible approach and has been recommended as the prime option[6-11]. Every now and then, conversion was required in a laparoscopic approach. However, the risk factors associated with conversion to open procedure in pediatric intussusception have not yet been fully illuminated.

M. van der Laan argued that a high conversion rate up to 78% makes patients not benefit from a laparoscopic approach[12]. Our conversion rate from laparoscopic to open procedure of 48% disproves it. Likewise, Kia et al report only a 12.5% conversion rate[13]. The wide range of conversion rates reported in the literature may be partially ascribed to the different definition of conversion in the respective publication. Actually, the standard definition of conversion from laparoscopic procedure to open procedure is lacking[14].

We demonstrated that bloody stool and small bowel intestine intussusception were risk factors for conversion in a laparoscopic management. In our study, bloody stool was defined as red currant jelly stool or occult blood in stool. Bloody stool was a sign of intestinal ischemia, and its relationship with the requirement of bowel resection and conversion is apparent. Patients with small bowel intussusception have a higher likelihood of conversion is probably on the grounds that these patients have a higher prevalence of pathological lead point[2].

Nevertheless, our results should be explicated with wariness as there are several limitations of our study. One limitation relates to its retrospective design with lacking a standard protocol for data collection,

which may impact data quality. Accordingly, we only involved the patients from the latest six years, as the patients' information are most complete and reliable. Fortunately, there is no patient loss to follow-up. Furthermore, retrospective studies are often limited by selection bias, whereby the patients' intervention option may be affected by their baseline characteristics and the operators. With regards to our study, there was no significant difference in baseline characteristics between the two groups. However, as an emergent surgery, operative reduction for intussusception was performed by the surgeon on duty, which makes the surgeon is not the same for all the procedures. Inevitably, the results might be influenced by the surgeons' judgements and capabilities, which may result in selection bias. Taken together, further investigation should take these factors into account.

Conclusion

During laparoscopic treatment for intussusception in children who failed fluoroscopy-guided pneumatic enema reduction, conversion is likely be required in patients with bloody stool and small bowel intussusception. Although conversion does not increase complications in comparison with completely laparoscopic approach, efforts to reduce longer operative time and duration of postoperative hospital stay associated with conversion to open approach are desirable to improve the laparoscopy outcomes.

Declarations

Ethics approval and consent to participate:

The study was approved by ethics committee of shanghai children's hospital. We have gotten informed consents from the legal guardians whose data is used in the study.

Guidelines:

all methods were carried out in accordance with guidelines and regulations of pediatric intussusception.

Consent for publication:

Not applicable.

Availability of data and materials:

The datasets analyzed during the current study are not publicly available due to the license for the current study, but are available from the corresponding author on reasonable request.

Competing interests:

Ying-Hua Liu, Jun Sun, Zhi-Bao Lv, Wei-Jue Xu, Jiang-Bin Liu, Qing-Feng Sheng have no conflicts of interest or financial ties to disclose.

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None

Authors' contributions:

J. Sun: Conceptualization, Methodology, Writing- Reviewing and Editing. Y. H. Liu: Data curation, Writing- Original draft preparation, Software. W. J. Xu: Visualization, Investigation. Z. B. Lv: Supervision. J. B. Liu: Software. Q. F. Sheng: Validation

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Tables

Table 1

Clinical and operative data compared between LAP and conversion group

	LAP [N=49]	Conversion [N=45]	Statistic	p value
Age (months)	16(9.8, 36)	10.7(8.3, 44)	Z=-0.958	0.338
Gender (male/female)	36/13	29/16	$\chi^2=0.896$	0.344
Clinical manifestations				
Abdominal pain	20	16	$\chi^2=0.275$	0.600
Irritable crying	27	19	$\chi^2=1.557$	0.212
Emesis	37	30	$\chi^2=0.896$	0.344
Bloody stool	34/48	37/43	$\chi^2=3.061$	0.080
Abdominal mass	32	22	$\chi^2=2.586$	0.108
Fever	10	14	$\chi^2=1.413$	0.235
Diarrhea	0	1		0.479
Leukocyte counts				0.139
decreased	6	8	Z=-1.48	
normal	18	21		
elevated	25	16		
BMI (kg/m ²)	16.7(15.3, 18.5)	17.3(15.1, 19.5)	Z=-0.715	0.474
Duration of symptoms (hours)	16(10, 30)	21.5(11.3, 48)	Z=-1.557	0.120
Previous abdominal surgery	2	0		0.496
No. of intussusception before				0.749
First episode	38	37		
Second episode	4	4		
More than 2 episodes	7	4		
preoperative air enema attempts			$\chi^2=8.505$	0.037
none	4	6		
once	8	18		
twice	30	17		
more than two times	7	4		
ASA score				0.830

I	10	39	$c^2=0.046$
II	10	35	

Table 2

A comparison of operative findings and postoperative outcomes between the two groups

	LAP (N=49)	Conversion (N=45)	Statistic	p value
No. of intussusceptions				0.496
1	47	45		
More than 2	2	0		
Length of intussusception bowel (cm)	8(6, 12.5)	10(5, 18.8)	Z=-1.048	0.295
Anatomic type of intussusception				0.001
Ileocolic	42	26		
Ileo-ileo-colic	1	1		
colocolic	1	0		
cecocolic	2	2		
Ileoileal	3	16		
Pathological lead point	0	20		0.000
Meckel diverticula		10		
polyps		5		
duplication		4		
lymphoma		1		
Operative time (minutes)	58(35, 80)	138(112.3, 171)	Z=-7.267	0.000
Complications	1	3		0.346
Portsite hernia	0	1		
Recurrence	1	0		
Fever	0	1		
Anastomotic leakage	0	1		
Postoperative hospital stays (days)	5(4, 6)	7(6, 8)	Z=-5.001	0.000

Table 3

Logistic regression of possible risk factors for the need of conversion.

variation	OR	95%CI	<i>p</i> value
Bloody stool	26.071	2.341-290.33	0.008
Small bowel intussusception	39.194	3.562-431.281	0.003
preoperative air enema attempts			0.277
Pathological lead point			1.000