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ORIGINAL ARTICLE

Clinical Characteristics of Intussusception with Surgical Reduction: a Single-Center Experience with 568 Cases

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Abstract

Background Intussusception is among the most common acute abdominal emergencies in infancy, but only some cases need surgical reduction. This study assessed the clinical characteristics of patients undergoing surgical reduction of intussusception.

Methods This retrospective study reviewed 568 pediatric patients who failed air-enema reduction and underwent surgical reduction for intussusception in our department between 2008 and 2017.

Results The series comprised 376 boys and 192 girls (2.0:1, male:female ratio) and most of the intussusceptions were primary, which is typical before the age of 1 year. The success rate of air-enema reduction in our hospital was 94.2%. Patients over 3 years old had the highest rate of surgical reduction (ca. 11.8%). The probabilities of primary and secondary intussusception were equal above 2 years old. Intussusception caused by intestinal malignant lymphoma was diagnosed above 2 years of age with atypical symptoms. Gender was irrelevant regarding the presence of bloody stools ($P = 0.594$), but the younger patients and children with complex/compound intussusception had a higher proportion of bloody stools ($n = 148$, 40.0%, $P = 0.000$) and intestinal necrosis ($n = 44$, 42.3%, $P = 0.024$). The occurrence time of bloody stools (OTBS) in complex/compound intussusception was shorter than for other types.

Conclusions This retrospective study analyzed the clinical features of patients undergoing surgical reduction for intussusception and summarized the characteristics and management of complex/compound intussusception.

Keywords Intussusception · Surgical reduction · Bloody stools · Complex/compound

Introduction

Intussusception is among the most common acute abdominal emergencies in infants. It primarily affects children in the first 2 years of life, with the highest incidence in those aged 4–10 months.[1–3] Typical clinical manifestations include new intermittent crying, vomiting, a palpable abdominal mass, and bloody stools.[1,4] Bloody stools, which are often described as looking like red currant jelly,[1,5,6] strongly suggest intussusception.[1]

Intussusception is defined as the invagination of one segment of the intestine into a distal intestine segment.[1,4,7] Delayed diagnosis and therapy can lead to bowel necrosis or even death. Most cases (ca. 90%) are primary intussusception (PI) in which there is no obvious cause other than lymphoid hyperplasia of the terminal ileum. The remaining cases are secondary intussusception (SI) in which the invagination is secondary to an identifiable cause (i.e., a pathological lead point (PLP)), mainly including Meckel's diverticulum (MD), intestinal duplication cyst (DC), intestinal polyps (IP), and intestinal malignant lymphoma (ML).[8–10]

Currently, the standard treatment for intussusception is non-surgical reduction by air or hydrostatic.[11–13] Surgical reduction is primarily applicable for those cases in which non-surgical reduction fails or for those who present with bowel necrosis or peritonitis.[1,14,15]

Many studies have systematically reviewed the presentation and management of intussusception, especially the diagnosis and non-surgical reduction of PI, but few have retrospectively analyzed the clinical characteristics of patients undergoing surgical reduction for intussusception.[3,7,16,17] Therefore, we reviewed 568 patients with intussusception

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who failed air-enema reduction and underwent surgical reduction during the last decade, assessed the clinical characteristics of the patients undergoing surgical reduction, and summarized some of the features and the management of complex/compound intussusception.

Materials and Methods

Patients

Between January 2008 and December 2017, 9739 pediatric patients with intestinal intussusception underwent non-surgical reduction in our hospital. In our practice, most pediatric patients suspected of having an intussusception will be evaluated and reduced with an air-enema reduction in the outpatient department. Over the past 10 years, most of the air-enema reductions were successful and only 651 pediatric patients were hospitalized in our department. Of these, 69 cases had a successful repeat enema as an inpatient and 14 cases with bowel necrosis or peritonitis went directly to surgery without air-enema reduction. Ultimately, this study enrolled 568 patients with a diagnosis of intestinal intussusception who failed air-enema reduction and underwent laparotomy. All patients were initially diagnosed by ultrasonography.[9,18,19]

Methods and Definitions

The medical records of the patients were retrospectively reviewed. Demographic and clinical features were recorded, including the findings at surgery. The intraoperative types of intussusception included ileocolic defined as telescoping of the distal ileum into the adjacent colon, ileocecal defined as telescoping of the distal ileum into the adjacent cecum, complex/compound defined as more than one intussusceptum prolapsed into the same intussuscipiens and its typical representative is ileoileocolic intussusception, and small intestinal defined as telescoping of proximal small intestine into adjacent distal small intestine. Whether there was intestinal necrosis was also noted. We quantitatively analyzed the sign hematochezia using the occurrence time of bloody stools (OTBS), which was defined as the time interval from the first sign of intussusception to the presence of bloody stools.

Statistical Analyses

The population was described using categorical and discrete variables. The Student's t test was used to compare discrete variables. The chi-square test or Fisher's exact test was used to compare categorical variables as appropriate. Finally, the patients with bloody stools in PI were subdivided into four groups based on the intraoperative types of intussusception to compare the average OTBS of each group by analysis of variance (ANOVA) and pairwise comparisons. A P value of less than 0.05 was considered significant. All analyses were performed with SPSS 18.0.

Results

Demographic and Clinical Features of the Intussusception Patients

During the 10-year period, 9739 cases of intussusception underwent air-enema reduction in our department. Only 568 cases (518 PI; 50 SI) were hospitalized after failed reduction in the outpatient department and ultimately underwent surgical reduction. Table 1 summarizes the numbers of visits, operations, PI and SI, and sex ratio of visits (2.0:1 male:female; range 1.5–3.2) and operations (2.0:1 male:female; range 1.2–3.5). Two groups of visits and operations were identified with no significant differences in the sex ratio ($P = 0.707$). Over time, the number of outpatient tended to increase, while the numbers of operations and PI requiring surgical reduction decreased significantly, while SI increased. The average success of air-enema reduction in our hospital was 94.2%. A statistical difference was found that the success rate of air-enema reduction has increased significantly with time ($P = 0.000$).

Table 2 gives the numbers of PI and SI cases and types of PLPs in all age groups. Most intussusception patients who underwent air-enema (ca. 92.8%) or surgical (ca. 90.7%) reduction were in their first year of life, regardless of PI or SI. Patients older than 3 years of age had the highest rate of surgical reduction (ca. 11.8%) of all age groups. Meanwhile, two groups of visits and operations were identified with no significant differences, except for the higher proportion of patients older than 36 months ($P = 0.002$) in the operations group. The probabilities of PI and SI were equal above 2 years of age. Of the 568 patients, 50 were ultimately found to have PLPs. Most of the cases ($n = 29$, 58.0%) were diagnosed intraoperatively in children 1–12 months old. The main types of PLP were MD ($n = 28$, 56.0%) and DC ($n = 14$, 28.0%), while ML ($n = 4$, 8.0%) and IP ($n = 4$, 8.0%) were less frequent. Unlike the other types, ML occurred only above 2 years of age in our series.

Table 3 lists the common symptoms and types of intussusception confirmed intraoperatively. The typical symptoms and signs included intermittent crying ($n = 432$, 76.1%), vomiting ($n = 511$, 90.0%), a palpable abdominal mass ($n = 382$, 67.3%), and bloody stools ($n = 386$, 68.0%). The main types

Table 1 The number of patients and success rate of air-enema reduction by year

Year	Visits (male:female)	Operations (male:female)	[a]*P* value	PI (%)	SI (%)	Success rate
2008	863 (517:346)	82 (48:34)	*.790*	74 (90.2)	8 (9.8)	90.5%
2009	900 (612:288)	81 (59:22)	*.328*	73 (90.1)	8 (9.9)	91.0%
2010	783 (549:234)	72 (53:19)	*.496*	69 (95.8)	3 (4.2)	90.8%
2011	786 (598:188)	63 (49:14)	*.742*	61 (96.8)	2 (3.2)	92.0%
2012	1050 (714:336)	63 (41:22)	*.608*	60 (95.2)	3 (4.8)	94.0%
2013	1086 (698:388)	63 (34:29)	*.079*	57 (90.5)	6 (9.5)	94.2%
2014	1089 (752:337)	49 (31:18)	*.370*	42 (85.7)	7 (14.3)	95.5%
2015	974 (618:356)	38 (26:12)	*.516*	35 (92.1)	3 (7.9)	96.1%
2016	1052 (673:379)	20 (11:9)	*.399*	18 (90.0)	2 (10.0)	98.1%
2017	1156 (786:370)	37 (24:13)	*.678*	29 (78.4)	8 (21.6)	96.8%
Total	9739 (6517:3222)	568 (376:192)	*.707*	518 (91.2)	50 (8.8)	94.2% *(P = .000*)*

[a] *P* value for chi-square test or Fisher's exact test and *P* value of sex ratio of visit group vs. operation group

P stands for *P* value of the differences of success rate of air-enema reduction among groups

*Significant

PI, primary intussusception; *SI*, secondary intussusception

of intussusception were ileocolic ($n = 241$, 42.4%), ileocecal ($n = 89$, 15.7%), complex/compound ($n = 177$, 31.2%), and small intestinal ($n = 61$, 10.7%). The most common symptom for PI was vomiting ($n = 475$, 91.7%) and intermittent crying for SI ($n = 40$, 80.0%). Perhaps most interestingly, all cases of ML presented without vomiting or bloody stools. The most common type of intussusception was ileocolic ($n = 226$, 43.6%) for PI and small intestinal ($n = 22$, 44.0%) for SI.

Average Age, Sex Ratio, and Types of Intussusception for PI with or without Bloody Stools and Intestinal Necrosis

As the clinical manifestation, age distribution, and types of SI depend to a certain extent on the types of PLPs. In order to remove the interference factors caused by PLPs effectively and improve the accuracy of data, only PI cases were analyzed

Table 2 Distribution of PI and types of PLPs by age

Characteristics	< 12 months	12–24 months	24–36 months	> 36 months	Total
Visits, no. (%)	9035 (92.8)	389 (4.0)	146 (1.5)	169 (1.7)	9739
Operations, no. (%)	515 (90.7)	21 (3.7)	12 (2.1)	20 (3.5)	568
Surgical rate	5.7%	5.4%	8.2%	11.8%	5.8%
[a]*P* value	*.062*	*.725*	*.247*	*.002**	
PI (%)	486 (94.4)	16 (76.2)	6 (50.0)	10 (50.0)	518 (91.2)
SI (%)	29 (5.6)	5 (23.8)	6 (50.0)	10 (50.0)	50 (8.8)
MD	16	3	5	4	28 (56.0)
DC	10	2	0	2	14 (28.0)
ML	0	0	1	3	4 (8.0)
IP	3	0	0	1	4 (8.0)

[a] *P* value for chi-square test or Fisher's exact test

*Significant

PI, primary intussusception; *SI*, secondary intussusception; *MD*, Meckel's diverticulum; *DC*, intestinal duplication cyst; *ML*, intestinal malignant lymphoma; *IP*, intestinal polyps

Table 3 The common symptoms and types of intussusception with surgical reduction

Characteristics	PI	SI	MD	DC	ML	IP	Total
Symptoms							
Intermittent crying (%)	392 (75.7)	40 (80.0)	23 (82.1)	10 (71.4)	4 (100.0)	3 (75.0)	432 (76.1)
Vomiting (%)	475 (91.7)	36 (72.0)	23 (82.1)	10 (71.4)	0	3 (75.0)	511 (90.0)
Abdominal mass (%)	354 (68.3)	28 (56.0)	19 (67.9)	4 (28.6)	3 (75.0)	2 (50.0)	382 (67.3)
Bloody stools (%)	370 (71.4)	16 (32.0)	12 (42.9)	3 (21.4)	0	1 (25.0)	386 (68.0)
Types							
Ileocolic (%)	226 (43.6)	15 (30.0)	8 (28.6)	4 (28.6)	2 (50.0)	1 (25.0)	241 (42.4)
Ileocecal (%)	82 (15.8)	7 (14.0)	2 (7.1)	4 (28.6)	1 (25.0)	0	89 (15.7)
Complex/compound (%)	171 (33.0)	6 (12.0)	5 (17.9)	1 (7.1)	0	0	177 (31.2)
Small intestinal (%)	39 (7.5)	22 (44.0)	13 (46.4)	5 (35.7)	1 (25.0)	3 (75.0)	61 (10.7)
Total	518	50	28	14	4	4	568

PI, primary intussusception; *SI*, secondary intussusception; *MD*, Meckel's diverticulum; *DC*, intestinal duplication cyst; *ML*, intestinal malignant lymphoma; *IP*, intestinal polyps

and discussed in the following sections. Table 4 shows the average age, sex ratio, and types of intussusception for PI with bloody stools and intestinal necrosis. In total, 370 patients had bloody stools (246 boys, 124 girls; male-to-female ratio 2.0:1). No bloody stools were noted in 148 cases (102 boys, 46 girls; male-to-female ratio 2.2:1). Gender did not differ significantly in cases of PI with bloody stools ($P = 0.594$).

Intestinal necrosis occurred in 104 patients (60 boys, 44 girls; male-to-female ratio 1.4:1) while there was no intestinal necrosis in 414 cases (288 boys, 126 girls; male-to-female ratio 2.3:1). Gender significantly ($P = 0.021$) influenced intestinal necrosis in PI cases. The group with bloody stools was younger ($P = 0.000$) than those with no bloody stools, as in the intestinal necrosis group ($P = 0.015$).

Based on the surgical findings, the 518 PI cases were subdivided into four types. Before performing comparisons about the types for PI with or without bloody stools and intestinal necrosis, the average age and sex ratio of types in each group with or without bloody stools and intestinal necrosis have been compared first, all of them showed no statistical differences ($P > 0.05$). The group with bloody stools had lower percentages of ileocolic ($n = 145$, 39.2%, $P = 0.001$) and small intestinal ($n = 22$, 5.9%, $P = 0.031$), and a higher percentage of complex/compound ($n = 148$, 40.0%, $P = 0.000$) types than the group with no bloody stools. The percentage of ileocecal type ($n = 55$, 14.9%) did not differ significantly ($P = 0.341$) between the two groups. There were no significant differences in the groups with and without intestinal necrosis,

Table 4 Clinical features of patients with bloody stools and intestinal necrosis for primary intussusception

Characteristics	BS ($n = 370$)	NBS ($n = 148$)	P_1 value	IN ($n = 104$)	NIN ($n = 414$)	P_2 value
Age (months)[1]	7.0 (2–36)	13.4 (2–48)	[a].000*	6.5 (4–36)	8.9 (2–48)	[a].015*
Sex						
Male	246	102	[b].594	60	288	[b].021*
Female	124	46		44	126	
Type						
Ileocolic (%)	145 (39.2)	81 (54.7)	[b].001*	39 (37.5)	187 (45.2)	[b].159
Ileocecal (%)	55 (14.9)	27 (18.2)	[b].341	11 (10.6)	71 (17.1)	[b].101
Complex/compound (%)	148 (40.0)	23 (15.5)	[b].000*	44 (42.3)	127 (30.7)	[b].024*
Small intestinal (%)	22 (5.9)	17 (11.5)	[b].031*	10 (9.6)	29 (7.0)	[b].367

P_1 stands for P value between BS and NBS, P_2 stands for P value between IN and NIN

[1] Values are the median (range)

[a] P value for Student t test

[b] P value for chi-square test or Fisher's exact test

*Significant

BS, bloody stools group; *NBS*, non-bloody stools group; *IN*, intestinal necrosis group; *NIN*, non-intestinal necrosis group

except for a higher proportion of complex/compound ($n = 44$, 42.3%, $P = 0.024$) in the intestinal necrosis group.

Clinical Relevance of OTBS and Types of PI with Surgical Reduction

Four groups (370 patients) with PI and bloody stools were distinguished based on the anatomical location of the intussusception at surgery. The OTBS, measured in hours, was scored "0" if bloody stools were the initial symptom, or as the time interval from other first symptoms or signs to the presence of hematochezia. Table 5 compares the average OTBS for each type by ANOVA. There were statistical differences among the types ($P = 0.000$); the time gap for complex/compound [10.1 (range 0–48) hours] was shorter than for the ileocolic [17.7 (range 0–64) hours; $P = 0.000$] and ileocecal [15.9 (range 0–63) hours; $P = 0.048$] types.

Discussion

Clinical Characteristics of Intussusception Patients with Surgical Reduction

Intussusception is a common cause of acute abdominal pain that involves the invagination of one segment of the intestine into a distal segment, often leading to bowel obstruction. Most cases can be treated by non-surgical reduction with air or hydrostatic, even those caused by PLPs; only a few cases need surgical reduction. The vast majority of intussusception cases are primary; the remaining secondary cases are caused by PLPs and are relatively difficult to diagnose preoperatively. With the recent improvements in perinatology, the survival of premature infants, especially infants with very low birth weight, has gradually increased; furthermore, the changes in fertility policy and extension of the hospital's service region have contributed to the increase in outpatient cases seen in our department. Remarkably, the operation volume, especially the number for PI, has decreased significantly with time. This also indicates that the success rate of air-enema reduction has increased significantly with time in our series. These results may be explained by an increased understanding of the clinical characteristics of intussusception, greater vigilance by pediatric surgeons, the application of diagnostic air-enema reduction for patients with typical intussusception symptoms who are negative on ultrasonography, and the use of a delayed repeat enema. In addition, the accumulation of doctor's experience, the promotion, and popularization of intussusception knowledge in public, and even the convenience of traffic will enable children of intussusception to receive regular treatment in time and improve the success rate of air-enema reduction. Although the sex ratios fluctuated, the number of males was always greater and the total male-to-female ratio with successful air-enema reduction or surgical reduction for intussusception during the 10 years was consistent with reported values.[17,18,20–22] In other words, the success rate of air-enema reduction is not influenced by sex.

Although the overwhelming majority of cases of intussusception occurred in children in the first 12 months of life, which is consistent with the widely accepted view that intussusception primarily affects young children with a peak in age between 4 and 10 months,[1,8,14] patients older than 3 years have a higher likelihood of requiring operative reduction. The increasing proportion of SI in children older than 2 years old with surgical reduction may explain the result. The proportion of operations for SI was significantly increased in

Table 5 Comparison of OTBS in four types of primary intussusception with surgical reduction

Types	OTBS (h)[1]	[a]P	P_1	P_2	P_3	P_4	P_5	P_6
Ileocolic ($n = 145$)	17.7 (0–64)	.000*	.873	.000*	.753	.048*	.975	.564
Ileocecal ($n = 55$)	15.9 (0–63)							
Complex/compound ($n = 148$)	10.1 (0–48)							
Small intestinal ($n = 22$)	14.3(0–52)							

[1] Values are the median (range)

[a] P stands for P value of ileocolic group vs. ileocecal group vs. complex/compound group vs. small intestinal group

P_1 stands for P value of ileocolic group vs. ileocecal group

P_2 stands for P value of ileocolic group vs. complex/compound group

P_3 stands for P value of ileocolic group vs. small intestinal group

P_4 stands for P value of ileocecal group vs. complex/compound group

P_5 stands for P value of ileocecal group vs. small intestinal group

P_6 stands for P value of complex/compound group vs. small intestinal group

*Significant

OTBS, occurrence time of bloody stools

children more than 2 years old and equaled the proportion with PI in our series. Therefore, in a pediatric patient over 2 years of age, with typical clinical symptoms, a diagnosis of intussusception by ultrasonography, failed non-surgical reduction, and the probability of the intussusception being primary or caused by PLPs is the same. Therefore, inexperienced doctors should be more careful to avoid missing PLPs intraoperatively and perform a further examination to exclude a PLP in patients with successful non-surgical reduction. Of note, the success rate of air-enema reduction remained at nearly 90% in our series, even in patients over 3 years of age with the highest rate of surgical reduction. In other words, non-surgical reduction is still the preferred method for treating intussusception patients in different age groups, and its high success rate will significantly improve the patient outcome by avoiding unnecessary surgical reduction. Regarding the types of PLPs, MD was the most common type in all age groups. Of note, in our series, ML occurred only in children older than 2 years of age. This might be the result of the small number of ML cases, its atypical clinical symptoms (more on this below), lack of the measures of early diagnosis, and the failure of clinicians to consider this disease. As intestinal malignant lymphoma has atypical symptoms, a higher degree of malignancy is easily misdiagnosed or not diagnosed and has lower rates of radical surgery and survival; future research should examine how to improve the rate of early diagnosis of ML in SI.

Typical clinical manifestations include onset of intermittent crying, vomiting, a palpable abdominal mass, and bloody stools. In our study, only a few cases with surgical reduction for intussusception had all of those symptoms and not one symptom occurred in every case. Based on symptoms alone, it seems impossible to distinguish between PI and SI, particularly PLPs caused by ML that presented only with intermittent crying or a palpable abdominal mass in our series (Table 3). As the low incidence of ML cases in SI and its atypical clinical symptoms, it can be easily misdiagnosed or missed, especially in the patients undergoing successful non-surgical reduction without undergoing a laparotomy or further examination. Future research should examine how to improve the preoperative diagnostic accuracy of SI in patients with non-surgical reduction. The proportions of the various types in our series differed markedly from the traditional literature, in which the most common pediatric intussusception was ileocolic, accounting for 80–95%.[1,23,24] In our series, no more than half of the patients with surgical reduction had the ileocolic type, and the most common type of intussusception was ileocolic ($n = 226$, 43.6%) for PI and small intestinal ($n = 22$, 44.0%) for SI. The differences in the success rates of non-surgical reduction for different types of intussusception may have contributed to this result. We speculate that the huge increase in the proportion of complex/compound cases was the principal reason for the low proportion of ileocolic cases. In other words, the success rate of non-surgical reduction of complex/compound intussusception may be the lowest among the different types of PI, which caused more pediatric patients with complex/compound intussusception to fail air-enema reduction and to undergo surgical reduction during the last decade.

Age, Sex Ratio, and Types of PI with or without Bloody Stools and Intestinal Necrosis

This section discusses only primary intussusception with bloody stools and intestinal necrosis requiring surgical reduction. Younger patients frequently have bloody stools or intestinal necrosis at the time of admission, possibly because of the peak incidence of intussusception in this age group, lack of an infant's ability to express him/herself, and neglect of suspicious symptoms such as intermittent crying or vomiting by parents.

Gender did not influence bloody stools in PI cases, while the male-to-female ratio in the intestinal necrosis group was 1.4:1, which was significantly lower than in the non-intestinal necrosis group (2.3:1; Table 4). Worldwide, the male-to-female ratio of intussusception is close to 2:1, which suggests that gender is not relevant to the presence of bloody stools, although there were more males than females in the bloody stools group. It is not clear whether females who failed non-surgical reduction for intussusception are more likely to have intestinal necrosis than males. The conclusion that females have a higher intestinal necrosis rate should be drawn cautiously primarily because no similar results were found according to the related literature we had referred. In our series, the group with intestinal necrosis was younger ($P = 0.015$) than those without intestinal necrosis. The conclusion that younger patients frequently have intestinal necrosis, which has been mentioned in other references[14], was also referred to in our study. So the mean age at the time of diagnosis in intussusception between males and females in intestinal necrosis group was recalculated and compared by Student's t test. We eventually found the mean age of females [7.3 (range 2–48) months] was younger than males [9.3 (range 2–48) months] in the group, which showed statistical difference ($P = 0.014$). There is a reason to believe the younger age of female may contribute to the result that female seemingly has a higher intestinal necrosis rate in our study. This cannot be assessed without removing factors such as morbidity age and duration of illness in randomized controlled trials.

In our study, 86.5% of the surgery cases of complex/compound PI had bloody stools and 25.7% of them ultimately developed intestinal necrosis verified by surgery and biopsy. A significantly higher proportion of the patients with complex/compound intussusception may have bloody stools and intestinal necrosis compared with the other types. As reported elsewhere, the stool may become mucoid and blood tinged as the ischemic mucosa sloughs in the later course of

intussusception, and the presence of bloody stools, as a late sign, is usually considered to be a risk factor associated with intestinal necrosis.[1,14,25] Unlike other types, complex/compound intussusception is defined as more than one intussusceptum prolapsed into the same intussuscipiens, which may result in greater intestinal mucosal ischemia. The tight invagination of complex/compound intussusception probably leads to the low success rate of non-surgical reduction, bloody stools, and the ultimate development of intestinal necrosis.

The Clinical Significance of OTBS in PI with Surgical Reduction

To investigate the symptom of bloody stools, a quantitative index is needed for analysis. Commonly used indices are the duration of the symptom, volume of bleeding, and time of bleeding.[14, 26–28] These indices are widely applied in the medical assessment and clinical decision but, inevitably, have shortcomings. The duration of bloody stools depends mostly on prompt diagnosis and treatment. It is simply the time from the beginning of symptoms until hospitalization and is often considered a risk factor for intestinal necrosis.[14] The bleeding volume and bleeding times suffer from recall bias on the part of patients' parents or guardians, and the former cannot be calculated accurately using a generally recognized method. As a non-durable and unusual symptom, bloody stools should be described by "occurrence" rather than "duration." A new evaluation index, the occurrence time of bloody stools (OTBS), was put forward to assess the clinical relevance to the types of PI and is defined as the time from the beginning of the first sign of intussusception to when bloody stools were detected. In our study, the time gap was shorter for complex/compound intussusception than for ileocolic or ileocecal intussusception but did not differ for small intestinal intussusception. No doubt, the more serious the intestinal mucosal ischemia is, the earlier bloody stools occur. The tight invagination of complex/compound intussusception mentioned above may explain the differences in OTBS among types. Unlike the radius of ileocolic and ileocecal intussusceptions, the same radii, approximately, of the intussusceptum and intussuscipiens may explain the lack of a statistical difference between the OTBS of small intestinal and complex/compound intussusception.

Conclusion

In conclusion, although recent results have not fundamentally changed the management of patients with intussusception, some meaningful results are reported in this study. This study retrospectively analyzes the clinical features of intussusception patients received surgical reduction during the last decade, including the shift in surgical volume, sex ratio, and success rate of non-surgical reduction. Comparing the numbers of visits, operations, surgical rates, PI, and types of PLPs in each age group, we found that the overwhelming majority of cases occurred in children within 12 months of age, while patients older than 3 years had a higher likelihood of requiring operative reduction. For children more than 2 years old, the proportions undergoing surgery for PI and SI were equal. With its high success rate, non-surgical reduction remains the preferred method for treating intussusception in different age groups, as the patients have better outcomes by avoiding surgical reduction. We retrospectively analyzed the demographic and clinical features of PLPs at different ages, common symptoms, and various types in PI and SI. The importance of an early diagnosis for ML in SI is noted for inexperienced doctors. Of the patients undergoing surgical reduction for intussusception, younger patients or children with complex/compound intussusception may have a higher proportion of bloody stools and intestinal necrosis and a shorter OTBS. Patients with these findings and an unsuccessful non-surgical reduction are more likely to have the complex/compound type, suggesting that such patients should be taken directly to the operating room for reduction given the low success rate of non-surgical reduction and high possibility of intestinal necrosis rather than attempt to perform a repeated enema after unsuccessful primary enema. Finally, given the possibility of complex/compound intussusception, inexperienced doctors should look for it carefully during surgery to avoid incomplete reduction, even when other types have already been found.

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