Variables determining the success of ultrasound-guided hydrostatic reduction of intussusception in infants: a tertiary center experience

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Background **Intussusception represents one of the most common urgent surgical admissions during early infancy and childhood period. It's a form of intestinal obstruction which is manifested by colicky abdominal pain, red current jelly stool and abdominal mass. Abdominal Ultrasound is the method of choice for diagnosis. Treatment of intussusception ranged from simple non operative reduction either by pneumatic or hydrostatic enema to surgical exploration. There multiple variables that may affect the result of of non operative management.**

Aim **We tried to study them to know whom patient would pass without surgery.**

Patients and methods **Two hundred patients diagnosed with intussusceptions included in this study. All of them received ultra sound guided hydrostatic reduction using warm saline. The maximum number of attempts of reduction was three times. We used intrvenous sedation in irritable infants.**

Results **2 hundred cases with intussusception were treated in this study. One hundred forty were reduced (group A) and 60 cases (group B) required surgical exploration. The mean body weight in group A was 7.3 Kg while in group B 9.3Kg. seventy five cases from both groups were operated.**

Conclusion **Several factors affect the result of hydrostatic reduction as total leukocytic count, CRP and duration of symptoms. In addition the size of the mass and the presence or absence of free peritoneal fluid affects the non operative management. *Ann Pediatr Surg* 13:136–139**

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Introduction

Intussusception is considered as one of the most common causes for intestinal obstruction in early infancy and childhood and one of the causes for pediatric surgery emergency [1].

The most common age of presentation is between 6 months and 2 years, and the most prevalent pathological type is iliocolic intussusceptions [2].

The causes for intussusception are idiopathic, which alone represents about 90% and may be due to lymphoid hyperplasia at the terminal ileum. The remaining 10% are ileoileal types, which may be transient and asymptomatic, reducing spontaneously or associated with the presence of a pathological lead point, and are therefore surgically treated [3].

The traditional management of stable intussusception patients starts with a trial of reduction enema, either pneumatic or hydrostatic, guided by radiological imaging techniques. When failure or complications occur with these techniques, surgical management is the next option [4].

There is still controversy regarding the success rates of hydrostatic enema reduction. We aim to determine factors associated with high success rates of ultrasound-guided hydrostatic reduction of intussusception in infants.

Patients and methods

During the period between March 2012 and June 2016, 250 infants presented with a classic clinical picture of intussusception, which included history of gastroenteritis days before the condition, abdominal distention, and passage of red currant jelly stools. On examination, abdominal mass was palpated in most cases. Fifty cases were excluded as they had clear peritonitis, perforation, or were hemodynamicaly unstable. All cases underwent routine ultrasound, as it is the best diagnostic tool. The characteristic appearance of the mass either in the cross-section or the longitudinal section proved the diagnosis. In addition, comments on the size of the mass, edema in the intestine, thickening of the wall, and presence of free peritoneal fluid were registered All cases underwent routine complete blood count, C-reactive protein (CRP) assay, arterial blood gases, serum electrolytes, and plain erect film. The parents were informed about the management strategy, and ethics committee approval was obtained. A nasogastric tube was inserted to decrease distention and prevent aspiration. Venous access was achieved, and intravenous fluid replacement was maintained. Hydrostatic ultrasound-guided reduction was then performed when the infant was in the left lateral position. Ultrasound was performed using warm normal saline 0.9% through a Foley's catheter that was passed into the rectum. Irritable infants received slow intravenous diazepam 0.05 mg/kg. The procedure was completed

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Table 1 Demographic data

	Group A ($N=140$)	Group B ($N=60$)	SD	P value
Age (mean) (months)	7.3	9.38	4.19	0.003*
Sex				
Males	74	31	–	–
Females	66	29		
Body weight (mean) (kg)	6.3	7.9	3.23	0.457

*Significant.

Table 2 Evaluation of patients in both groups

	Group A ($N=140$)	Group B ($N=60$)	SD	P value
Duration of symptoms (mean) (days)	2.1	2.68	1.124	0.001*
Size of mass (mean) (cm^3)	33.9	55.64	24.09	0.002*
Free peritoneal fluid (%)				
Present	22.1	68.3		0.0001*
Absent	77.9	31.7		
Bowel edema (%)				
Absent	80.7	56.7		0.039*
present	19.3	43.3		
Total leukocytic count (mean) ($\times 10^3$)	9.23	11.09	4.9	0.004*
C-reactive protein (mean) (mg/dl)	42.18	76.77	47.022	0.001*

*Significant.

by ultrasound monitoring, which showed reduction of the mass and free passage of the saline through the intestinal loops. Cases with successful reduction were followed-up by ultrasound every 4 h for the next 12 h. If the intussusception was reduced, oral intake was initiated, and the infant was discharged after 24 h. To study different variables that affect the outcome of the management of intussusception, we classified patients into two groups – A and B. Group A included cases with successful hydrostatic ultrasound-guided reduction, whereas group B included those with failure of hydrostatic reduction. The data obtained were statically analyzed using SPSS, version 22. Informed parents' consent was obtained as rules of ethics of scientific committee.

Results

Our study included all cases that presented with classical intussusception. The total number of cases during the study period from March 2012 to June 2016 was 250. Fifty cases were excluded because they were unstable or had peritonitis. One hundred and forty (70%) cases had successful attempts of reduction (group A), whereas 60 (30%) cases had failed attempts of reduction and surgical intervention was planned (group B). The mean age of group A was 7.3 months, whereas in group B the mean age was 9.38 months (Table 1). The mean duration of symptoms in group A was 2.1 days, whereas in group B it was 2.6 days. The average total leukocyte count in group A was 9.25×10^3, whereas in group B it was 11.56×10^3, which was significant. The mean CRP value in group A was 42.18 mg/dl, whereas in group B it was 76.77 mg/dl. Ultrasound showed free fluid in 31 cases in group A, whereas free fluid was present in 41 cases in group B. Bowel edema was present in 27 cases in group A, whereas it was present in 26 cases in group B. The mean size of the mass in group A was 33.9 cm^3, whereas in group B it was 55.6 cm^3 Table 2. With regard to the number of attempts of reduction for all infants, we found that 110 cases showed reduction after the first attempt, 20 cases after the second attempt, and 10 cases after the third attempt. Fifteen cases in group A had recurrence after successful hydrostatic reduction Table 3. The most common findings during exploration were small bowel intussusceptions and simple reduction (52%), ischemic gut with resection (34.6%), and finally the presence of specific pathology (Meckel's diverticulum, lipoma, or duplication cyst) and resection (13.6%) Table 4.

Table 3 Results of the attempts of ultrasound-guided hydrostatic reduction in both groups

	$n=200$ [n (%)]
First attempt	110 (55)
Second attempt	20 (10)
Third attempt	10 (5)
Failed after third trial	60 (30)
Recurrent after reduction	15 (10.71) (of total reduced cases)

Table 4 Operative findings

	Group A	Group B	%
Simple reduction	9	30	52
Resection due to an ischemic gut	4	22	34.6
Specific pathology	2	8	13.4
Total	75		100

Discussion

The management of pediatric intussusception has greatly changed from surgical exploration once diagnosed to routine trial of reduction of intussusception, either hydrostatic or pneumatic, with minimal morbidity [5].

However, the success rates of enema reduction either pneumatic or hydrostatic ranged from 42 to 95% [6].

Operative management is currently reserved for patients who are unstable with the evidence of peritonitis or perforation, for patients in developing regions of the world without access to radiological reduction experience and equipment, or for patients in whom enema reduction is unsuccessful [7].

In our center, the first choice in stable babies suffering from intussusception is hydrostatic reduction using warm saline guided by ultrasound.

No randomized trial has thus far shown the superiority of either pneumatic or hydrostatic reduction with respect to complications, length of hospital stay, and success rates. In addition, retrospective reviews have had conflicting conclusions with regard to optimal approach, although certain risks and benefits are associated with each technique [8].

However, we agree with Cullmann *et al.* [10] that pneumatic reduction or reduction with contrast enema

under fluoroscopy has major disadvantages, as this led to exposure of infants to at least 11.4 cGycm^2. Another disadvantage of these techniques is that the child must be separated from parents during fluoroscopy, and this represents a source of stress to both infant and parents [9,10].

Identifying factors associated with increasing success rates of hydrostatic reduction of infantile intussusceptions was the primary aim of the present study. This was very important to decrease delay in surgical decision, improve outcomes, and save costs.

The duration of symptoms in this study was slightly longer in the failed group when compared with successful group.

Tareen *et al.* [11] has reported that the longer duration of symptoms of intussusception is a predictive factor of surgical intervention without any delay or trial of reduction.

On the other hand, McDermott *et al.* [12] has found no relationship between the duration of symptoms and the success rate of reduction.

We found that size of intussusception mass measured by ultrasound during initial assessment of infants had an impact to predict failure rate of reduction later on. It was found that the larger the mass, the lesser the liability for hydrostatic reduction.

One particular study documented a significant influence of site of intussusception mass on the rate of success of reduction. It showed a higher success rate for masses located proximal to the splenic flexure than those located distally [13].

However, we thought that this study included cases with iliocolic intussusception only and did not include cases with more proximal intussusception. We had cases with ilioileal and ilioiliocolic intussusception that were located more proximal and were not reduced with hydrostatic reduction.

With regard to the presence of free fluid in the peritoneal cavity or thickening or edema of the bowel wall, we found that these findings on ultrasound were associated with high failure rate.

Although in the same context some studies showed the same results with potential increase in surgical intervention rates, the need for additional attempts of reduction were still present [13–15].

However, Gartner *et al.* [16] showed that the presence of free fluid had no impact on the rate of success of reduction of intussusceptions.

According to laboratory data such as total leukocytic count and CRP levels, there was a significant relationship between higher values of these variables and high failure rates of reduction of intussusception, and according to our knowledge no studies thus far have documented their role as predictors of success of reduction.

The maximum number of reduction attempts was three before surgical exploration was decided in the present study. However, we noticed that the success rate decreased with increased number of trials.

A few other studies have shown that the rate of surgical intervention has reduced in infants undergoing a second trial of reduction. They explained that by the occurrence of partial reduction, which decreased bowel wall thickening and edema, hence facilitated the reduction of intussusceptions [17].

Flaum *et al.* [9] showed that the success rate of hydrostatic reduction decreased with increased number of attempts, and the success rate was about 16% after the fourth trial.

Most of the cases with failed hydrostatic reduction in the present study were due to small bowel intussusception (52%), followed by ischemia of a part of the bowel and subsequent resection (34.6%), and finally the presence of a leading point (Mikele's diverticulum, lipoma, or duplication cyst) (13.4%).

Kaiser *et al.* [18] in his series showed that the presence of a pathological leading point represented 14% of all cases requiring surgery due to failure of reduction.

In the present study, the role of sedation did not affect the success or failure of reduction, and this may be attributed to the gradual and gentle maneuver of hydrostatic reduction if compared with pneumatic reduction.

In addition, Flaum *et al.* [9] found no relationship between sedated and non-sedated infants when hydrostatic reduction was performed.

Conclusion

We found that several variables could affect the results of ultrasound hydrostatic reduction of intussusception and increase the susceptibility of surgical management.

Conflicts of interest

There are no conflicts of interest.

References

1 Vazequez JL, Ortiz M, Doniz MC, Montero M, Delcampo VM. External manual reduction of pediatric ileocolic intussusception with US assistance: a new standardized, effective and safe maneuver. *Pediatr Radiol* 2012; **42**:1197–1204.
2 Applegate KE. Intussusception in children: evidence – based diagnosis and treatment. *Pediatr Radiol* 2009; **39**:140–143.
3 Digant SM, Rucha S, Ske D. ultrasound guided reduction of an ileocolic intussusception by a hydrostatic method by using normal saline enema in pediatric patients: a study of 30 cases. *J Clin Diagn Res* 2012; **6**: 1722–1725.
4 Saxena AK, Hollwarth ME. Facts influencing management and comparison of outcomes in pediatric intussusceptions. *Acta Pediatr* 2007; **96**:1199–1202.
5 Beres AL, Barid R. An institutional analysis and systemic review with meta-analysis of pneumatic versus hydrostatic reduction for pediatric intussusceptions. *Surgery* 2013; **154**:328–334.
6 Daneman A, Navarro O. Intussusception. Part 2: an update on the evolution of management. *Pediatr Radiol* 2004; **34**:97–108.
7 Pepper VK, Stanfill AB, Pearl RH. Diagnosis and management of pediatric appendicitis, intussusception and Meckel's diverticulum. *Surg Clin North Am* 2012; **92**:505–526.

8 Janke AC, Klaassen Mielke R, Zilbauer M, Heininger U, Trampisch H, Wirth S. Intussusception incidence and treatment insights from nationwide German surveillance. *J Pediatr Gastroenterol Nutr* 2011; **52**:446–451.
9 Flaum V, Schneider A, Ferreira CG, Philippe P, Sancho CS, Lacreuse I, *et al*. Twenty years experience for reduction of ileocolic intussusception by saline enema under sonography control. *J Pediatr Surg* 2016; **51**:179–182.
10 Cullmann JI, Heverhagen JT, Puig S. Radiation dose in pneumatic reduction of ileocolic intussusception, results from a single institution study. *Pediatr Radiol* 2015; **45**:675–677.
11 Tareen F, Ryan S, Avanzini S, Pena V, Laughlin D, Puri P. Does the length of the history influence the outcome of pneumatic reduction of intussusception in children? *Pediatr Surg Int* 2011; **27**:587–589.
12 McDermott VG, Taylor T, Machenzie S, Hendry G. Pneumatic reduction of intussusception: clinical experience and factors affecting outcome. *Clin Radiol* 2009; **64**:655–663.
13 Cutis JL, Gutierrez IM, Kirk SR, Gollin G. Failure of enema reduction for ileocolic intussusception at a referring hospital does not preclude repeat attempts at a children's hospital. *J Pediatr Surg* 2010; **45**:1178–1181.
14 Pazo A, Hill J, Losek JD. Delayed repeat enema in the management of intussusception. *Pediatr Emerg Care* 2010; **26**:640–645.
15 Fallon SC, Loopez ME, Zhang W, Brandt ML, Wesson DE, Lee TC, *et al*. Risk factors for surgery in pediatric intussusception in the era of pneumatic reduction. *J Pediat Surg* 2013; **48**:1032–1036.
16 Gartner RD, Levin TL, Borenstein SH, Han BK, Blumfield E, Murphy R, *et al*. Interloop fluid in intussusception: what is its significance? *Pediatr Radiol* 2011; **41**:925–927.
17 Fike FB, Mortellaro VE, Holcomb GW, Peter SD. Predictors of failed enema reduction in childhood intussusceptions. *J Pediatr Surg* 2012; **47**:925–927.
18 Kaiser AD, Applegate KE, Ladd AP. Current success in the treatment of intussusceptions in children. *J Surg* 2007; **142**:470–477.