Pneumatic versus hydrostatic reduction in the treatment of intussusception in children

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Background **The aim of this study was to compare pneumatic reduction under guidance of fluoroscopy and hydrostatic saline enema reduction under guidance of ultrasound in treatment of intussusception in pediatric patients.**

Methods **The study included 80 patients with intussusception in the time period from September 2014 to September 2015 who were divided into two groups: group A included 40 patients who underwent US guided hydrostatic reduction and group B included 40 patients who underwent fluoroscopic guided pneumatic reduction.**

Results **The success rate was significantly higher in the pneumatic group (80%) ($P=0.017$) when compared to the hydrostatic group (55%) after 1st trial. However, the outcome was equal in both groups after the 2nd trial with success rate of 82.5%. The time needed for reduction was significantly shorter in the pneumaic group ($P=0.001$). There was only one case of perforation in hydrostatic group (2.5%).**

Conclusion **Pneumatic reduction is safe, simple, fast, less messy and as effective as hydrostatic reduction.** ***Ann Pediatr Surg*** **13:199–202 © 2017 Annals of Pediatric Surgery.**

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Keywords: hydrostatic reduction, intussusception, pneumatic reduction

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Introduction

Intussusception is the most common cause of intestinal obstruction in children between 6 months and 4 years of age, with peak incidence between 3 and 9 months of age [1]. It is an emergent condition where delay in diagnosis leads to an increased risk of bowel perforation, obstruction, and necrosis [2]. The success of nonsurgical modalities of treatment, such as pneumatic and hydrostatic reduction, has greatly improved the outcome of this condition with negligible overall morbidity [3].

Numerous reduction techniques have been described in the literature with the advantages and disadvantages of each technique; therefore, choosing the best reduction method may be difficult. Commonly used techniques for nonoperative reduction of intussusception include pneumatic or hydrostatic pressure enemas under fluoroscopy or ultrasonography (US) guidance [4].

Aims

The aims of the present study were to compare pneumatic reduction under the guidance of fluoroscopy with hydrostatic saline enema reduction under the guidance of US in the treatment of intussusception in children, and to evaluate both techniques with regard to time required for reduction, maximuim pressure used, success rate of reduction, and complications during and after reduction.

Patients and methods

This was a prospective, single-blinded, randomized, closed-envelop, comparative study, conducted at the Pediatric Surgery Unit of Mansoura University Children Hospital. The study included 80 patients who were admitted to the unit from September 2014 to September 2015 and diagnosed with intussusception.

All cases were diagnosed on the basis of clinical presentation with stress on the time elapsed since intermittent colicky abdominal pain and the presence of signs suggesting late presentation, such as redcurrant jelly stool, abdominal distension, fever, and lethargy. Diagnosis of intussusception was confirmed by US, and then the decision regarding eligibility for nonsurgical reduction was made.

The protocol of this study design was approved by the ethical committee of our institution.

Inclusion criteria

(1) Hemodynamic stability.
(2) No marked abdominal distention.
(3) No clinical or radiological signs of peritonitis.
(4) Duration of symptoms less than 48 h.
(5) No clinical manifestations of small intestinal obstruction.

Informed consent was obtained from the parents of all participants who fulfilled inclusion criteria, and the following premedications were administered: a spasmolytic (buscopan), 0.3 mg/kg; steroids (dexamethasone), 0.1–0.3 mg/kg; Gram-negative antibiotics; and sedation with 1–2 mg/kg of ketamine hydrochloride. All patients underwent nonsurgical reduction of intussusception in the form of US-guided hydrostatic reduction (40 cases) or fluoroscopy-guided pneumatic reduction (40 cases).

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All patients were evaluated for the following:

(1) Primary outcomes:
  (i) Time required for reduction.
  (ii) Maximum pressure used.
  (iii) Number of attempts.
  (iv) Success of reduction.
  (v) Complications during and after reduction.
(2) Secondary outcomes:
  (vi) Effect of repeated enemas and success rates.
  (vii) Corelation between delayed presentation and outcome.

Results

The present study included 80 patients who were divided into two groups:

(1) Group A included 40 patients who underwent US-guided hydrostatic reduction.
(2) Group B included 40 patients who underwent fluoroscopy-guided pneumatic reduction.

The age of patients at the time of reduction ranged from 3.5 to 32 months, with a median age of 7 months. Regarding sex distribution, 45 (56.3%) of them were males, whereas the remaining 35 (43.8%) were females, with a male-to-female ratio of 1.3 : 1. Regarding age, sex, body weight, and time since onset of symptoms, there were no statistically significant differences between both groups. Moreover, when different clinical presentations and their distribution were compared between the two groups, none of them showed a statistically significant difference, denoting that there was no significant variation that could affect comparison in the outcome of both groups.

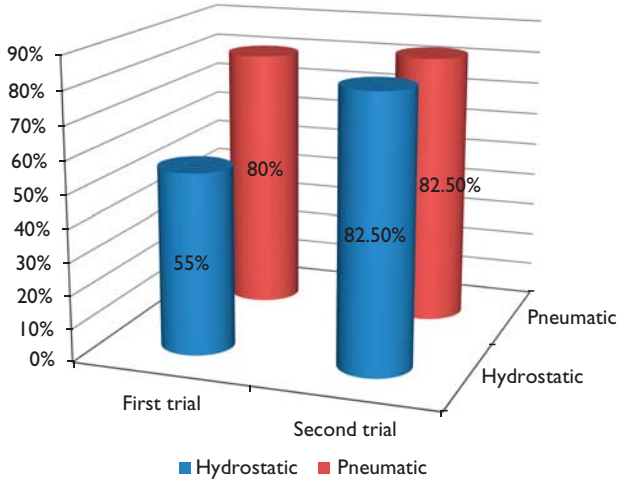
The success rate after the first trial of reduction was significantly higher in the pneumatic group (80%) when compared with the hydrostatic group (55%) ($P = 0.017$). However, after the second trial of reduction, the outcome became equal in both groups with a success rate of 82.5% (Fig. 1). The delayed repeat enema raised the overall success rate of nonsurgical reduction from 67.5 to 82.5%. A total of 26 cases underwent delayed repeat enema with a success rate of 46.2%. In the hydrostatic group, 18 cases underwent a second trial with a success rate 61% versus eight cases in the pneumatic group with a success rate of 12.5%.

The time required to complete the procedure was significantly shorter in the pneumatic group ($P = 0.001$). It ranged from 12 to 35 min in the hydrostatic group with a median time of 23.5 min, whereas in the pneumatic group it ranged from 1 to 17 min with a median time of 9 min Fig. 2).

The reduction pressure ranged from 60 to 100 mmHg in the hydrostatic group (mean: 93.5 ± 12.92) and from 40 to 100 mmHg in the pneumatic group (mean: 88.5 ± 13.12). Although the mean reduction pressure in the hydrostatic group was lower compared with the pneumatic group, this difference did not yield statistical significance ($P = 0.09$).

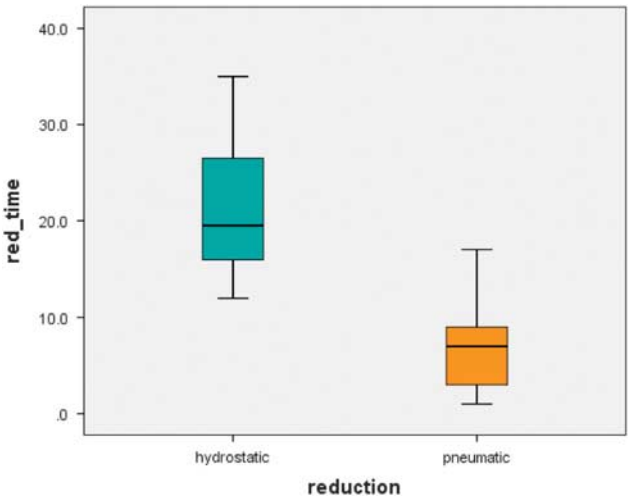
The overall incidence of perforation during reduction among all cases was 1.25%. This complication occurred in only one case in the hydrostatic group after the second trial (2.5%). On the other hand, no complications were reported in the pneumatic group. Nevertheless, this case was managed by surgical reduction of the intussusception and repair of the small perforation with an uneventful postoperative course.

Fig. 1



Success rate after nonsurgical reduction.

Fig. 2



Relationship between time required for reduction and reduction group.

Table 1 The correlation between manifestations of late presentation and outcome

	Outcome [*N* (%)]			
Late presentation	Successful ($n=66$)	Failed ($n=14$)	χ^2	*P*
Currant jelly stool	60 (75)	13 (16)	0.229	0.973
Fever	23 (28)	3 (3.7)	1.736	0.629
Lethargy	21 (26)	7 (8)	3.492	0.062
Palpable mass	18 (22)	4 (5)	4.835	0.184
Leukocytosis	29 (36)	9 (11)	4.677	0.197

Significant when $P \leq 0.05$.

The relationship between the signs of late presentation and the success rate of reduction was studied, and revealed no statistically significant correlation between any of them and success rate (Table 1). The success rate was high in cases that underwent nonsurgical reduction during the first 24 h after onset of symptoms: in 13/15 (86.7%) cases with duration of symptoms less than 12 h and in 38/41 (92.7%) cases with duration of symptoms between 12 and 24 h. The success rate declined to 58.3% (14/24 cases) in cases that presented after 24–48 h.

Discussion

High rates of success in nonoperative treatment of intussusception were reported using pneumatic and hydrostatic reductions. After a long-term experience with hydrostatic reduction and excellent early results of pneumatic reduction, this study was designed to evaluate whether the pneumatic reduction technique is of equal effectiveness as hydrostatic reduction in the management of intussusception and to assess the advantages and disadvantages of each technique.

The success rate of enema reduction varies widely, ranging from 70 to 95%, and is similar in both pneumatic and hydrostatic reduction [1,5,6]. In the present study, we found that successful reduction after the first trial was 80% in the pneumatic group versus 55% in the hydrostatic group; this can be explained by the fact that air completely surrounds the intussusceptum, exerting more constant pressure, and may result in decreased friction and, in turn, easier reduction [7]. However, we found that the success rate after the second trial was equal in both groups (82.5%) and within the reported range.

Delayed repeat trials improve the outcome of nonsurgical reduction, with success rates ranging from 57 to 72% [8,9]. In the present study, delayed repeat enema improved the success rate of reduction from 67.5% after the first trial to 82.5% after the second trial. Nevertheless, the success rate of the delayed trial was lower than that reported in other studies (46.2%). This may be attributed to the high success rate after the first trial of pneumatic reduction, and most of the cases undergoing repeat trials presented late with a long duration of presentation of more than 24 h.

Despite the equal incidence of perforation in different methods of reduction, the sequelae of perforation may vary widely according to the contrast agent used in reduction. With liquid enema, perforation results in larger colonic tears, increased peritoneal contamination, and rapid fluid shifts if hypertonic water-soluble agents are used [10]. On the other hand, the risk of tension pneumoperitoneum can be a complication of the air enema [11]. In the present study, perforation occurred in only one (1.25%) case in the hydrostatic group. We believe that the incidence of perforation can be minimized to almost 0% by careful selection of cases and continuous monitoring of pressure with manometry.

Hydrostatic reduction has the advantages of being simple, effective, economical, and associated with a very low perforation rate and no radiation hazards [12]. Yet, pneumatic reduction is easy to perform and can be carried out quickly, is less messy, is more comfortable, and results in smaller perforations and less peritoneal contamination [13]. In the present study, pneumatic reduction was found to be easier to perform as evidenced by the significant difference in the time required for reduction between both groups and the higher rate of success after the first trial in the pneumatic group. There was no significant difference in the maximum pressure required for reduction in both groups. Although some authors claimed a higher risk of perforation with the use of air in treating intussusception [14], pneumatic reduction in the present study was devoid of complications. The main disadvantage of pneumatic reduction was exposure to radiation, but we minimized the radiation period to the least by taking interrupted shots during the procedure instead of following the whole procedure under screening.

The effect of the duration of symptoms on the outcome of reduction is controversial. Some authors have claimed a significant lower success rate of reduction in patients presenting after more than 24 h [15,16], whereas others have denied the impact of delayed diagnosis on the outcome [17,18]. These conflicting results are probably because of the type of statistical analysis used, not accounting for the adjusted effect of multiple factors. In the present study, delayed diagnosis (> 24 h) was the clinical parameter most closely associated with failure. However, a high success rate can be achieved after 24–48 h (58.3%). Although rectal bleeding has been used as an exclusion criterion for pressure reduction in some centers [19], other studies including our study have not revealed a significant trend toward higher failure rates in the presence of rectal bleeding or other symptoms of delayed presentation [20].

Conclusion

Pneumatic reduction is as effective as hydrostatic reduction in treating intussusception with the advantages of being easier to perform, more rapid, less messy, and devoid of additional risks. However, exposure to radiation remains the main disadvantage of this reduction method.

Conflicts of interest

There are no conflicts of interest.

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