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## Comparative Study between Hydrostatic and Pneumatic Reduction For Early Intussusception In Pediatrics

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### ABSTRACT

**Background:** Intussusception is an operative emergency that occurs frequently in children, particularly infants. Intussusception can be treated non-surgically or surgically. Intussusception is increasingly being treated non-surgically.

**Aim of The Work:** To compare the safety and efficacy of hydrostatic and pneumatic reductions for early intussusception in pediatrics and to evaluate both techniques.

**Patients and Methods:** Twenty patients were involved in this prospective single-blind randomized comparative study. They have been allocated into two groups at random: Group A, which comprises 10 patients who had hydrostatic reduction; and Group B, which comprises 10 patients who had pneumatic reduction. The patients' ages at the time of reduction varied from 3 to 36 months, with an average and IQR range of 8 months (5-14). Regarding gender distribution, 11 of them were males (55%) while the remaining 9 (45%) were females with male to female ratio 1.2:1. The patient's body weight ranged from 5.5 kilograms to 13 kilograms with the mean weight of 8.57±1.94 kg.

**Results:** The rate of success was significantly higher in the pneumatic group (80%) compared to the hydrostatic group (60%) after the first trial. The rate of success was significantly higher in the hydrostatic group (50%) when compared to the pneumatic group (0%) following the second trial.

**Conclusion:** Pneumatic reduction is a simple, quick, and mess-free method. There is no need for a radiologist. Hydrostatic reduction is a safe technique. It avoids exposure of the child to a significant amount of radiation.

**Keywords:** Hydrostatic; pneumatic Reduction; early intussusception; children.

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### INTRODUCTION

The invagination of one intestinal segment inside a more distal segment is known as intussusception <sup>1, 2</sup>. It is the most prevalent reason for intestinal blockage in infants, typically happening between the ages of 4 and 10 months <sup>3</sup>.

Intussusception results when the ileum invaginates into the cecum through the ileocecal valve in most infants.

The bowel's blood supply is pulled along as it intussuscepts, leading to intestinal ischemia and potentially perforation. Intussusception can be lethal <sup>2</sup>.

Intussusception is a frequent abdominal emergency in infants and children, with a one-to-four occurrence in 2000 <sup>4</sup>. Idiopathic intussusception and pathologic lead-point intussusception are the two most common types of intussusception.

The majority of instances are idiopathic. Non-surgical and surgical techniques are currently available for intussusception therapy. If there are no

limitations, such as evidence of peritonitis, perforation, or a hemodynamically unwell patient <sup>5,6</sup>.

When nonsurgical therapy is prohibited or has failed, surgical techniques will be used. Nonsurgical decrease success rates have been reported to vary from 46% to 94% in the literature <sup>7</sup>. Under ultrasonography or fluoroscopy, a hydrostatic or pneumatic pressure enema could be used. pneumatic decrease employing air in the therapy of intussusception is a very efficient option that offers extra benefits such as reduced cost, and a lower perforation risk <sup>8</sup>. On the other hand, children with intussusception will be exposed to radiation if the pneumatic decrease approach is used under fluoroscopy. An alternate approach that avoids radiation is ultrasound-guided hydrostatic decrease using normal saline. Both of these approaches have claimed rates of success of 80–90% <sup>9</sup>.

Nevertheless, there is still debate over the best way to reduce mortality and morbidity while maximizing rates of success.

As a result, we performed a randomized controlled trial to examine the safety and efficacy of hydrostatic and pneumatic reductions with ultrasound and fluoroscopic monitoring, respectively.

The goal of this research is to compare the efficacy and safety of hydrostatic and pneumatic reductions using ultrasound and fluoroscopic monitoring, respectively, as non-operative management for early intussusception in pediatrics and to evaluate both techniques with regard to time required for reduction, maximum pressure used, number of attempts, success rate of reduction, and complications during and after reduction

### PATIENTS AND METHODS

This prospective single-blinded randomized comparative study was undertaken by the Pediatric Surgery Unit of Al-Azhar University Hospitals. Twenty patients were enrolled in the study, all of whom had been admitted to the department in the time period from November 2020 to November 2021 and diagnosed with intussusception.

The study included patients with ages eligible for study: 3 months- 3 Year of age, haemodynamically stable children with no significant abdominal distention, no clinical or radiological signs of peritonitis and symptoms less than 24 hours.

While patients with shock, which isn't easily corrected by intravenous hydration, significant abdominal distention, signs of peritonitis, symptoms lasting more than 24 hours and clinical manifestations of small intestinal obstruction were eliminated from the research.

Patients have been allocated into two groups at random:

Group A, which was comprised of 10 patients who had hydrostatic reduction under US-guided.

Group B, which was comprised of 10 patients who had pneumatic reduction under fluoroscopic guided.

#### These cases were diagnosed by:

**History taking:** (detailed history from parents): with stress on the following points: a. Age, b. Sex, c. Presenting symptom(s): (colic, bleeding/rectum, vomiting ), d. Feeding solid foods, e. History of upper respiratory tract infection, f. History of gastroenteritis, g. History of previous similar attacks.

**Clinical Examination** (and reporting the following points): body weight, temperature, lethargy or not, abdominal distention, palpable abdominal mass, red currant jelly stool, and palpable mass on PR.

**Investigations:** complete blood count, arterial blood gases, abdominal Ultrasound (L.S: pseudokidney sign & T.S: doughnut sign , pathological lead point, free fluid), cases were selected randomly for either pneumatic or hydrostatic reduction.

Informed consent: was obtained after detailed discussion with the parents.

#### Pneumatic reduction technique:

##### Equipment:

The pressure gauge was connected to a hand-held pump. The air was insufflated through the rectum using a 3-way Foley's balloon catheter. The pressure has been monitored using a sphygmomanometer connected to the Foley catheter, which was connected to the pump's inlet. The age of the patient detects the caliber of the catheter that range from 18FG to 22FG.

##### Technique:

Under fluoroscopy, the Foley's catheter has been inserted into the rectum and the balloon has been inflated using 20 to 40 cc of air, the patient's gluteal folds have been tied together.

The hand pump was used to insufflate air with intermittent fluoroscopy monitoring to a maximum pressure of 100 mmHg. For three minutes, the pressure was kept up. The insufflation was repeated after a minute. Three insufflations have been conducted in total, each lasting 3 minutes. If the intussusception had not been reduced by the conclusion of three insufflations and the patient's vital signs were stable, the operation would have been repeated following a 4-to 12-hour interval. When the intussusception had not been reduced following the second try, the pneumatic reduction had been declared a failure, and the patient had been referred to surgery <sup>10</sup>.

#### Ultrasound guided hydrostatic reduction:

##### Equipment:

a. Initial abdominal ultrasound scan was done to confirm diagnosis. b. A Foley catheter has been placed in the rectum of the child. c. A 30-ml syringe was used to inject normal saline solution through the Foley's catheter.

##### Technique:

Following lubricating the rectum with KY jelly, the child was placed in a left lateral position and a 3-way Foley's catheter was inserted.

In order to inflate the catheter's balloon, 30 mL of water has been injected. To achieve a tight anal seal, the patient has been positioned in a supine position and his thighs have been manually squeezed together.

A fluid line has been used to link one litre of normal saline (pre-warmed to normal body temperature) to the catheter, which has been suspended 100 cm above the bed level. Under the influence of gravity, normal saline was permitted to flow freely into the rectum. Real-time ultrasound has been used to monitor the colon's gradual distension and the intussusception's retrograde movement toward the caecum.

A total of three tries at hydrostatic reduction have been performed, with every episode lasting three minutes, the abdomen was reexamined and the ultrasound is repeated to ensured success. If the reduction fails, we can repeat the operation after a 4-to 12-hour interval <sup>11</sup>.

#### Statistical analysis:

The statistical package for the social sciences, version 23.0, was employed to analyze the data

collected (SPSS Inc., Chicago, Illinois, USA). When the distribution of the quantitative data was parametric (normal), the mean±SD, and ranges were reported. However, non-normally distributed variables (non-parametric data) were represented as median with an inter-quartile range (IQR). Numbers

and percentages were also employed to represent qualitative variables. The Kolmogorov-Smirnov and Shapiro-Wilk tests were employed to determine data normality. P-values of less than 0.05 were deemed significant.

**RESULTS**

In comparing both groups, the median age was equal (8 months) and, in terms of other population data, no statistically significant differences existed between the two groups.

Demographic data	Group A (Hydrostatic) (n=10)	Group B (Pneumatic) (n=10)	Total	Test value	p value
Age (months)	3-36	8(5-12)	3-36	0.983	0.442
Range					
Median (IQR)					
Gender	6 (60%)	4 (40%)	11 (55%)	FE	0.661
Male		5 (50%)	5 (45%)		
Female					
Body weight (kg)	5.5-12	6-13	5.5-13	0.399	0.695
Range	8.32±2.07	8.67±1.85	8.57±1.94		
Mean±SD					

**Table 1:** Comparison of groups based on demographic data.

Different presentations and their distribution between both groups are enlisted in table (2). Notably, none of those variables showed statistical significant difference when both groups were compared.

	Group A (Hydrostatic) (n=10)	Group B (Pneumatic) (n=10)	p-value
Colic	10 (100%)	10 (100%)	1.000
Vomiting	9 (90%)	8 (80%)	0.542
Fever	2 (20%)	4 (40%)	0.342
Lethargy	3 (30%)	4 (40%)	0.648
Mild distention	1 (10%)	3 (30%)	0.648
Palpable mass	2 (20%)	4 (40%)	0.342
Red currant jelly stool	9 (90%)	9 (90%)	1.000
Leukocytosis	4 (40%)	6 (60%)	0.383

**Table 2:** Different presentations of study groups.

When contrasted to the hydrostatic group (60%), the pneumatic group had a higher rate of success (80%), but the difference was insignificant (p-value 0.05 NS).

Success rate after 2nd trial: was higher in the hydrostatic group (50%) when compared to the pneumatic group (0%)

The result was equal in both groups, with success rate of 80%

Incidence of perforation in hydrostatic group was zero percent after 2nd trial, and it was zero percent in pneumatic group in table (3).

	Group A (Hydrostatic) (n=10)	Group B (Pneumatic) (n=10)	Test value	p-value
Perforation	0 (0%)	0 (0%)	0.000	1.000

**Table 3:** Perforation rate in both groups.

Regarding the time of the procedure, it was significantly shorter in the pneumatic groups (table 4). It ranged from 10 to 30 minutes in the hydrostatic group with a median time of 21 (13-28) minutes whereas in pneumatic group, it ranged from 2 to 20 minutes with the median time 10 (4-17) minutes.

Reduction time “min”	Group A (Hydrostatic) (n=10)	Group B (Pneumatic) (n=10)	Test value	p-value
Range	10-30	2-20	8.682	<0.001**
Median (IQR)	21 (13-28)	10 (4-17)		

**Table 4:** Reduction time of both groups.

Second trial enema reduction:

There were 6 cases who underwent second trial enema reduction with success rate of 33.3%

There were 4 cases in hydrostatic group underwent 2nd trial with success rate 50%. In pneumatic group only 2 cases required 2nd trial with success rate zero percent.

Outcome	Successful 2 <sup>nd</sup> trial		Total		X <sup>2</sup>	p-value
	No.	%	No.	%		
Hydrostatic group	2	50.0%	4	40.0%	2.333	0.127
Pneumatic group	0	0.0%	2	20.0%	0.000	1.000
Total	2	33.3%	6	30.0%		

**Table 5:** Correlation between second trial in both groups and outcome.

## DISCUSSION

Non-surgical and surgical management of intussusception are two options for treatment. Hydrostatic and pneumatic reductions are two non-surgical options for intussusception therapy<sup>12</sup>. A high rate of success in non-surgical treatment of intussusception was reported<sup>13</sup>.

In our study, the children's ages at the time of reduction varied from 3 to 36 months, with an average and IQR range of 8 months (5-14). The same age range was reported in multiple studies<sup>12,13,14</sup>. However, Kaiser et al.<sup>15</sup> reported wider age range from 16 days to 12 years. Mooney et al.<sup>16</sup> similarly referred to the wide variation of age among cases of intussusception. but, 75% of instances happen during the first two years of life, and 90% happen during the first three years of life.

Different presentations were observed in the patients included in this study. Frequently, more than one symptom was noted.

Vomiting was found in 85% of cases of our study. Other studies reported similar high incidences of vomiting. The incidence was 80%<sup>19</sup>, 86%, 81% according to Tareen et al.,<sup>19</sup> Van den Ende et al.<sup>20</sup>, and Kaiser et al.,<sup>15</sup> respectively. Similar to McDermott et al.,<sup>17</sup> we discovered no statistically significant correlation between the outcomes of reduction and vomiting.

In the present study, palpable abdominal mass was found in 30% of cases. This is comparable to the results of Van den Ende et al.,<sup>20</sup> and Kaiser et al.,<sup>15</sup> who found an occurrence of 35% and 24% respectively, but lower than the incidence of 50% reported by Tareen et al.<sup>19</sup>. In the present study, the presence of palpable mass did not significantly affect the outcome of reduction. McDermott et al.<sup>17</sup>, Okuyama et al.,<sup>22</sup>, and Fragoso et al.<sup>18</sup> referred to the same observation. However, other studies have reported that palpable abdominal mass significantly affect poor outcome<sup>21</sup>.

In the present study, we found that successful reduction after 1s trial was 80% in pneumatic group while 60% in hydrostatic group. Zulfiqar MA et al.,<sup>10</sup> reported that the rate of success of pneumatic reduction is greater than the success rate of hydrostatic reduction and his explanation was that as air surrounds the intussusceptum more fully, it exerts more continuous pressure, which may lead to less friction and, as a consequence, easier reduction. In

the available literature, the rate of success of enema reduction differs greatly.

The published rate of success of non-operative reduction of intussusception in some studies ranges from 70% to 95% and is similar in both pneumatic and hydrostatic reduction<sup>13,14,23</sup>.

Shiels et al.,<sup>24</sup> and Lui et al.,<sup>25</sup> who performed pneumatic reduction reported success rates of 87% (65\75) and 84% (152\181) respectively. At the same time, Wood et al.,<sup>26</sup> González-Spínola et al.,<sup>27</sup>, and Nayak & Jagdish,<sup>28</sup> with hydrostatic reduction reported success rates of 85% (63\75), 81.9% (159\194), and 81% (83\102) respectively; which are very close to the previous results of pneumatic reduction.

In 147 patients, prospective research compared air reduction, barium reduction with fluoroscopy, and saline reduction with ultrasonography guidance for intussusception diagnosis and therapy. In 45 out of 50 children, air reduction was successful (90%).

Barium enema was successful in 35 of 50 children (70%), while the US was successful in 32 of 47 children (67%)<sup>29</sup>.

These previous results of a higher rate of success of pneumatic reduction are similar to our observation of a significantly higher rate of success of pneumatic reduction after the 1st trial.

Of the 20 cases of our study, 6 cases underwent 2nd trial for failed initial attempt. 2/6 cases had showed successful reduction at success rate of 33.3%. The success rate for delayed repeat trials ranges from 57 to 72%<sup>31,32</sup>. Our research exhibited a lower success rate of delayed repeat enema. This can be explained as most cases requiring a delayed repeat enema present late with symptoms lasting longer than 12 hours.

In the present study, there were 4 cases in hydrostatic group underwent second trial with success rate 50%. In pneumatic group only 2 cases required second trial with success rate 0 %. Successful second trial of pneumatic reduction is 59%, 50%, 43%<sup>32,33,34</sup> respectively. At least 30 mins following the first partial resolution, a successful second trial of ultrasound guided saline enema reduction is 15%<sup>35</sup>.

Hospital admission is a routine policy after successful enema reduction in our department. A 24-hour in-hospital observation is required for possible early recurrence or post-reduction complication. Contrastingly, Jinzhe et al.<sup>36</sup> stated outpatient

management of 87% of cases after successful reduction but without clear demonstration of the safety of this practice due to lack of follow up. A retrospective study was conducted on 568 intussusception patients, of whom 329 had been admitted following reduction and 239 had been treated as outpatients with early release from the emergency department. In all groups, total recurrence rates and the requirement for surgical intervention were similar, with no increased morbidity or death recorded<sup>30</sup>.

### CONCLUSION

Pneumatic reduction is a simple, quick, and mess-free method. There is no need for radiologist but there is risk of exposure to radiation. US-guided saline enema for intussusception reduction is a safe treatment. It protects the child from being exposed to a significant level of radiation. A clear echogram can be obtained using transverse and longitudinal scans.. During reduction, ileo-ileo-colic intussusception can be detected. The method of sonography has another benefit in that it is capable of identifying pathological lead point during reduction, such as Meckel diverticulum. Perforation can be recognized promptly. However, this technique requires longer time than pneumatic reduction. It needs an expert radiologist. There is more potential peritoneal contamination if perforation occurs.

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