



4-14-2024

Section: General Surgery, Pediatrics & its Subspecialty.

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How to Cite This Article

Moussa, Mahmoud Abdelhady; Abdelmaksoud, Mostafa Mosbeh; and Hussien, Mohamed (2024)
"Comparative study between Ultrasound-guided hydrostatic reduction for ileo-caecal intussusception in pediatrics with versus without general anesthesia," *Al-Azhar International Medical Journal*: Vol. 5: Iss. 4, Article 1.

DOI: <https://doi.org/10.58675/2682-339X.2345>

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Comparative Study Between Ultrasound-Guided Hydrostatic Reduction For Ileo-Caecal Intussusception In Pediatrics With Versus Without General Anesthesia

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Abstract

Introduction: Between the ages of six and thirty-six months, intussusception—a term that describes the telescoping of a portion of the intestine into itself—is thought to be the most frequent cause of intestinal obstruction. It usually presents with sudden crampy abdominal pain, sometimes with grossly bloody stools and vomiting. For stable instances without any indication of bowel perforation, non-surgical reduction of the intussusception is advised. Ultrasonography is the preferred method of diagnosis in these circumstances. Hydrostatic or pneumatic enemas can be used to guide the decrease under the guidance of either ultrasonography or fluoroscopy. The advantages of the ultrasound-guided reduction include reduced radiation exposure and improved detection of problematic lead sites.

The aim of the work: To evaluate the role of anesthesia and muscle relaxation in a hydrostatic reduction for ileocecal intussusception, there is a significant difference in both success and complications.

Patients and methods: This prospective double-blinded randomized comparative study includes 150 patients as of February 2021. In February 2023, we were divided into two equal groups, and the same protocol was used for each group for the ultrasound-guided hydrostatic reduction with versus without general anesthesia (GA). A comparison was made regarding the successful, complication, and 24-hour reduction rates.

Results: Ultrasound-guided hydrostatic reduction under general anesthesia or muscle relaxation shows a higher successful reduction rate, a lower perforation rate, and a 24-hour recurrence rate than the reduction without general anesthesia or muscle relaxation.

Conclusion: Because it has better results and fewer complications than surgery, ultrasonography-guided hydrostatic reduction under GA and muscular relaxation is the best option for non-surgical reduction of intussusception.

Keywords: Ileo-caecal intussusception; ultrasound-guided; hydrostatic reduction

1. Introduction

Intussusception represents the prevailing etiology of emergent abdominal pain during the early stages of life. ¹ It was first described by Barbet in 1674.²

Intussusception refers to the invagination of a section of the gastrointestinal tract, known as the intussusceptum, into an adjoining segment called the intussuscepiens. This condition is frequently observed as a leading etiology of intestinal obstruction in the pediatric population.^{3,4}

Accepted 03 December 2023.
Available online 20 April 2024

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<https://doi.org/10.58675/2682-339X.2345>

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Intestinal ischemia and potential perforation may occur as a result of the elongation of the blood supply of the colon during intussusception. Intussusception has the potential to result in fatalities.⁵

It is the telescoping of a part of the bowel "intussusceptum" towards an adjacent segment "intussusceptiens." It is one of the most common causes of bowel obstruction in infants and children.^{5,6}

The bowel's blood supply is stretched as it intussuscepts, leading to intestinal ischemia and possible perforation. Intussusception can be lethal.⁷

Clinical signs are paroxysmal abdominal pain, crying, vomiting, dark red-currant jelly stool, and a tender, palpable sausage-like abdominal mass.⁸⁻¹¹

The clinical manifestations of this condition include paroxysmal stomach discomfort, sobbing, vomiting, the presence of dark red-currant jelly stool, and a tender, palpable abdominal mass resembling a sausage in shape. The numerical range of interest in this context is from six to nine, inclusive. Primary intussusception accounts for a significant proportion, up to 90%, of cases.^{10,11}

Acute intussusception exhibits rapid progression. The potential consequences of delayed diagnosis and treatment in children include the development of intestinal necrosis, peritonitis, and septic-toxic shock, which can pose significant risks to their well-being.^{6, 7, 12-15}

Since its sonographic characteristics were first documented in 1977, ultrasound has been widely employed by numerous researchers to accurately identify the condition, with specificity and sensitivity rates of up to 100%.¹⁶

Ultrasonography has gained recognition as a valid indication for employing tap water, saline, or Ringer's lactated fluid to decrease intussusception.^{5,17}

Research findings indicate that children who manifest symptoms lasting longer than 48 hours demonstrate a diminished hydrostatic decrease. As a result, surgical reduction has emerged as the predominant therapeutic approach for people experiencing prolonged discomfort.^{1,16,17}

The objective of this study is to assess the impact of GA and muscle relaxation on the efficacy and occurrence of problems in hydrostatic reduction for ileocecal intussusception, with the purpose of determining whether they play a significant role in these outcomes.

2. Patients and methods

The present study, a prospective double-blinded randomized comparative investigation, was carried out at the Pediatric Surgery Unit of Al-Azhar University Hospitals. The study encompassed a total of 150 children diagnosed with acute intussusception, who were divided into two distinct groups. The data collection period spanned from February 2021 to February 2023. In this study, Group A consisted of 75 patients who underwent ultrasound-guided hydrostatic reduction without the use of GA or muscle relaxants. In contrast, Group B comprised 75 patients who underwent ultrasound-guided hydrostatic reduction while under the influence of general anesthesia and muscle relaxants. Both groups were under the supervision of the identical pediatric surgery team, radiologist, and anesthesiologist.

2.1. Inclusion criteria includes: children within weaning age from 6-month to 1½-year, hemodynamically stable and the start time of intussusception's symptom of bilious vomiting within the first 24-hour.

2.2. Exclusion criteria includes: children's age less than 6-month or more than 1½-years old, timing of intussusception's symptom of bilious vomiting more than 24-hour, signs of peritonitis either clinically suspected, radiologically suspected through pneumoperitoneum on X-ray, ascites on abdominal sonogram or impaired intestinal blood flow on ultrasound-doppler, or laboratory suspected through high CRP > 100, severe anemia "Hemoglobin less than 8 gm/dl, thrombocytosis or leucocytosis more than 16000/mm³.

Additionally; associated comorbidity including T1DM, inborn error of metabolism, impaired liver function tests, associated cardiac disease either structurally "valvular or septal defect" or functionally "Pulmonary hypertension or myopathy" and associated chest infections as pneumonia, bronchitis or bronchiolitis are exclusion criteria from this study.

Both groups of patients had symptoms commonly associated with intestinal blockages, such as stomach pain, bilious vomiting, rectal bleeding, red-currant jelly feces, and the presence or absence of a palpable mass. The presence of ileo-caecal intussusception was verified with the use of abdominal sonography, which revealed the characteristic target sign, also known as the "Donut sign"

2.3. Mode of anesthesia:

General anesthesia with endotracheal intubation and ventilation is done for these procedures. Pre-oxygenation followed by rapid sequence induction with cricoid pressure. Ketamine 1-2 mg/kg is used as the induction agent, Suxamethonium 1-1.5mg/kg provides more rapid relaxation and better intubating conditions in the presence of a full stomach Rocuronium can be used in larger doses 1.2 mg /kg as part of rapid sequence induction. Maintenance is done by Sevoflurane as it provides more hemodynamic stability.

Simple analgesics (paracetamol) are given as apart of multimodal analgesia with Narcotics (e.g. morphine, meperidine (pethidine) are used judiciously as they may cause hypotension especially in the presence of hypovolaemia or sepsis. Ventilation should be controlled, with continuous monitoring of end-tidal carbon dioxide, Multichannel monitoring include bloodpressure and pulse oximetry and ECG and end tidal co2. Temperature maintained by warming the room and the irrigating solutions.

Generally it is common practice to have 5% dextrose with 0.45% saline as the maintenance solution and have a second infusion of balanced salt solution (0.9% saline or Hartmanns) to compensate for deficits and ongoing losses.

Table 1: Hourly Maintenance Fluid Requirements.

WEIGHT (KG)	HOURLY MAINTENANCE FLUID REQUIREMENTS
<10	4ml/kg
10-20	40ml+2ml/kg for every kg>10
>20	60ml+1ml/kg for every kg>20

The technique of ultrasound-guided hydrostatic reduction

The parents were provided with a detailed explanation of the process, and their informed consent was acquired. The patient received appropriate resuscitation through intravenous fluid administration, which effectively corrected the electrolyte imbalance. Subsequently, anesthesia was induced and a muscle relaxant was administered for group B. In contrast, group A underwent the procedure without the use of GA or muscle relaxant. The rectal catheter, ranging in size from 16 oF to 24 oF, was put into the rectum based on the patient's age and rectal diameter. It was secured by inflating the balloon with 30 cc of saline solution and fastening the gluteal folds with adhesive tape.

The administration of normal saline at a rate of 20-40 cc per kilogram, suspended at a height of 6 feet above the surface of the bed, facilitates the unobstructed flow of the saline solution due to the force of gravity.

The utilization of real-time abdominal ultrasound has been employed for the purpose of monitoring the flow of saline inside the intestines, the gradual expansion of the colon, and the retrograde movement of intussusception towards the ileum until it achieves full reduction.

The reduction of intussusception was proven upon meeting the following criteria: During the postevacuation ultrasound examination, several observations were made. Firstly, the intussusceptum was found to be absent.

Additionally, the reflux of fluid and air bubbles through the caecum and ascending colon into the ileum via the ileocaecal valve was visualized. Furthermore, the presence of a fluid-distended ileum and the absence of the intussusceptum were also noted.

After successful completion of the reduction process, the fluid present in the colon was removed by attaching a drainage bag to the rectal tube, allowing the fluid to passively drain. This was followed by a 24-hour hospital stay, during which the patient received intravenous fluids, broad spectrum antibiotics, and intestinal antiseptic medication. A follow-up abdominal ultrasonography is conducted 24 hours later to verify the absence of recurrence, after which the patient may commence oral intake and be discharged. To ensure non-recurrence, abdomen sonograms were conducted on the third and seventh day as a follow-up measure.

If hydrostatic reduction is unsuccessful, it is recommended to repeat the procedure twice consecutively with a time interval of 10 to 15 minutes. If these attempts also fail, surgical exploration is warranted. The surgical intervention may involve either manual reduction or a right hemicolectomy with ileo-colic anastomosis, depending on the viability of the intestine.

3. Results

A total of 150 patients divided into 2 groups; with 75 patients in each group. There was female dominance 45: 30 (60 %) in group A, and 40: 35 (~ 53.4 %) in group B. Their age was between 6-month to 1½-year based on the inclusion criteria described in methodology, with the peak age of 9 months in group A and 10 months in group B.

Table 2: Comparison of general data between the two groups of children.

CHARACTERISTICS	ALL, N (%) N = 150	GROUP A: N (%) N = 75	GROUP B: N (%) N = 75
AGE (MONTHS)	9.5 ± 1.33	9 ± 1.17	10 ± 1.49
SEX			
MALE	65 (43.4%)	30 (40%)	35 (46.6%)
FEMALE	85 (56.6%)	45 (60%)	40 (53.4%)
SYMPTOMS			
VOMITING	95 (63.3%)	46 (61.3%)	49 (65.3%)
PALPABLE MASS	134 (89.3%)	65 (86.6%)	69 (92%)
ABDOMINAL PAIN	137 (91.3%)	68 (90.6%)	33 (44%)
BLOODY STOOL	63 (42%)	30 (40%)	

Twelve out of 75 cases in group A were failed to have ultrasound-guided hydrostatic reduction with failure rate of 16 % despite of the 3 consecutive trials with 10-15 minutes apart, accordingly surgical exploration was performed with succeeded manual reduction for 11 cases and right hemicolectomy for only 1 case. While; in group B, 2 cases were failed to get ultrasound-guided hydrostatic reduction with failure rate of 2.6 %, as a result surgical exploration was done for 1 case where an intussusception mass was identified due to invaginating the intussusceptum into the intussusceptum for about 10 cm up to near the hepatic flexure with healthy bowel wall and succeeded to be manual reduced.

In group A; 3 cases developed perforation during the ultrasound-guided hydrostatic reduction (complication rate 4%) identified by sudden push of the pressure with sonographic free passage of fluid out of the bowel, the one case had minute perforation on the second trial of the hydrostatic reduction, which was primarily repaired after the surgical manual reduction of the ileo-cecal intussusception. While other case got the complication after the third trial with an identified a gangrenous bowel loop, multiple serosal tears and ischemic ileo-cecal intussusception on abdominal exploration for which right hemicolectomy and primary ileo-colic anastomosis were done. On the other hand, no complications were developed for cases in group B during the ultrasound-guided hydrostatic reduction (complication rate 0%).

Regarding the recurrence rate; 3 cases had recurrent ileo-caecal intussusception after 24-hour (recurrence rate of 4 %), which was reduced by the same technique and confirmed on the next day. While, 2 cases in group B had developed recurrence after 24-hour (recurrence rate of 2.6%) which recurred twice after 2 successful ultrasound-guided reductions on the consequent 2 days, as a result, a contrast-enhanced abdominal CT scan was performed and revealed an intra-mural cystic lesion in one case and was managed by an ileal resection with primary ileo-ileal anastomosis and the histopathological examination of the excised segment confirmed an enterogenous cyst (Ileal duplication cyst) without any identified atypia or malignant cells.

Table 3: Comparison of the outcome of the 2 groups.

CLINICAL INDEX	ALL, N (%) N = 150	GROUP A: N (%) N = 75	GROUP B: N (%) N = 75
SUCCESSFUL REDUCTION RATE	136 (90.6%)	63 (84%)	73 (97.3%)
LENGTH OF STAY (D)	1 ± 0.65	1 ± 0.8	1 ± 0.5
PERFORATION RATE	3 (4%)	3 (4%)	0 (0%)
RECURRENCE RATE WITHIN 24 H	5 (7.4)	3 (4%)	2 (2.66%)

Accordingly, the success rate for group A was 63 out of 75 cases (84 %), in contrast to the success rate for group B, which was 73 out of 75 cases (97.3%).

4. Discussion

Intussusception is a medical condition characterized by the invagination of one segment of the intestine into a distal section, resulting in acute abdominal pain and frequently leading to bowel obstruction. ^{7,9,11,18}

The prevalence of the condition is highest among individuals in the pediatric population who are younger than two years old, with a particular emphasis on children between the ages of four and ten months. The global average yearly incidence of intussusception ranges from approximately 50 to 250 cases per 100,000 individuals. Moreover, there exists a male-to-female ratio of approximately 2 to 3 cases for every 1 case, respectively. ^{9, 13, 18-21}

The disease exhibits a year-round presence, with a higher prevalence observed throughout the spring season, followed by summer and winter, and a comparatively lower incidence during the autumn. Intussusception exhibits a quick onset. Failure to immediately recognize and treat this condition may result in the development of intestinal ischemia, necrosis, perforation, peritonitis, septic shock, and potentially fatal outcomes. ^{7, 8}

The ages of the children at the time of reduction in our study ranged from 6 to 9 months. Nevertheless, Kaiser et al.²² found that the study findings indicated a broader spectrum of ages, ranging from 16 days to 12 years.

According to Mooney et al.²³, the phenomenon of intussusception is also characterized by a significant range of age variance among affected individuals. However, it is worth noting that approximately 75% of occurrences take place within the initial two years of an individual's existence, with an even higher percentage of approximately 90% occurring within the first three years of life.

Various symptoms were noted in the patients included in this study. On numerous occasions, the presence of multiple symptoms was seen. The occurrence of vomiting was seen in 63.3% of instances within the scope of our investigation.

Additional research papers have documented elevated rates of emesis. According to the data provided, the incidence rates were recorded as 80%, 86%, and 81% (Tareen et al.,²⁴; Van den Ende et al.,²⁵; and Kaiser et al.,²², respectively).

Similar to McDermott et al.²⁶, a statistically significant association between reduced results and vomiting was not observed in our study.

In the current investigation, it was observed that 89.3% of cases exhibited a palpable abdominal mass.

The prevalence seen in this study exceeds that reported by Van den Ende et al.²⁵, Kaiser et al.²², and Tareen et al.²⁴, who documented rates of 35%, 24%, and 50%, respectively.

The findings of this study indicate that the presence of a palpable mass did not exert any significant influence on the outcome of the reduction. McDermott et al.²⁶ Okuyama et al.,²⁷; and Fragoso et al.,²⁸

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The findings of this study indicate that the presence of a palpable mass did not exert any significant influence on the outcome of the reduction.²⁹

The progress of medical technology has led to enhancements in nonsurgical image-guided reduction techniques, including X-ray-monitored pneumatic (or barium) reduction and ultrasound-guided hydrostatic reduction. According to several sources, the utilization of ultrasound-guided hydrostatic reduction has been found to possess certain advantages. The

utilization of X-rays does not subject medical workers, children, and their families to exposure.^{8, 10,20,14,30,1}

The hydrostatic reduction exerts a gentle and sustained pressure, hence decreasing the likelihood of intestinal perforation.^{14,16} In the event of perforation, the introduction of saline solution into the abdominal cavity would not induce irritation, hence mitigating the likelihood of peritonitis.

This stands in contrast to the effects observed in barium reduction and tension pneumoperitoneum with pneumatic reduction.^{9,14,2}

Ultrasound can be utilized to determine the specific form of intussusception and identify the associated disease-leading point.^{10, 14, 20, 31,} and 3 reduction success rates are high.²⁰

The safety of administering general anesthesia to pediatric patients has significantly improved due to advancements in pediatric anesthesia procedures. General anesthesia is capable of relaxing the abdominal muscle tone and reducing the voluntary pressure exerted by a screaming kid, even in the absence of muscle relaxants. This effect is attributed to the inherent analgesic and muscle-relaxant properties of GA. In the event of an unsuccessful reduction or the occurrence of a problem, the patient is promptly sent to the operating room, resulting in efficient utilization of time resources. Hence, it may be argued that GA is both a safer and more efficacious approach compared to sedation.³²

The present study demonstrates that the success rate of hydrostatic reduction performed under general anesthesia or muscle relaxant (97.3%) surpasses that of hydrostatic reduction conducted without general anesthesia or muscle relaxant (84%).

5. Conclusion

The findings of this study demonstrate that ultrasound-guided hydrostatic reduction under general anesthesia or muscle relaxation yields better outcomes than reduction procedures conducted without anesthesia or muscle relaxation. It is considered a primary option for non-surgical intussusception reduction and deemed appropriate for clinical advancement.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

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