Ultrasound Guided Saline Enema Reduction of Intussusception: Retrospective Analysis, Single Center Experience

Tamer A Wafa, PhD, MRCS, Abdelrahman Elshafey, PhD, Sherif Abdelmaksoud, PhD, Hesham Sheir, PhD, MRCS, Mohamed El-Ghazaly, PhD
Mansoura University Children's Hospital.

ABSTRACT

Background: *Intussusception is one of most common surgical emergencies in infants and children. Non-surgical reduction in the currently the standard primary modality for treatment. Air and barium enema reduction are effective but exposure to ionizing radiation is a major drawback. There is a debate among centers so as to which type of reduction is better. Ultrasound guided reduction with saline enema offers a radiation free alternative with a reported comparable success rate. The aim of this study is to evaluate the success rate and complications of this technique.* ***Methods:*** *This is a retrospective cohort of 632 intussusception patients in Mansoura University Children's Hospital. All patients were managed by hydrostatic reduction under sonographic guidance with sedation. Patients who had sings of peritonitis, marked abdominal distension, high fever or lethargy were referred to surgical intervention and thus excluded from the study. Failure of the technique was equivalent to the need for surgery. Patients' data was collected and analyzed. Indices for success were also calculated for a standardized success rate.* ***Results:*** *The success rate was 80.7% whether after one or more trails. Perforation rate was 3.5%. recurrence rate was 4.1%. Patients who went primarily for surgery was 19.2% hence were excluded from the results. Crude reduction rate was 68%. The selective reduction rate was 80.7%. The Corrected selective reduction rate was higher (88.5%). The composite reduction rate was 79.8%.* ***Conclusion:*** *Saline enema reduction offers an effective and safe alternative to other types of reduction. The technique has the advantage of avoiding exposure to radiation. Complications are of low rate and easily manageable.*

INTRODUCTION

Intussusception is one of most common surgical emergencies in children. Non-surgical reduction is currently the standard primary modality for treatment. Hydrostatic reduction using air or fluids is employed under fluoroscopic or sonographic guidance. There is a debate among centers so as to which type of reduction is better. Although pneumatic reduction is a preferred technique in many centers, yet it carries the hazards of exposure to ionizing radiation[1]. Ultrasound guided hydrostatic reduction is reported to be safe and effective. It avoids the exposure to radiation for both the patient and the care giver. This technique was adopted by surgical department in our institution in the period between 2007 and 2014. The reported success rates using this technique are variable[2]. Moreover, the clinical decision on patients' selection for operative and non-operative reduction, and criteria for termination of hydrostatic reduction are not standardized. Consequently, there is a confounding factor questioning the accuracy of reported success rates[3]. The aim of this study is to analyze the effectiveness and complications of the technique.

PATIENTS AND METHODS

This is a retrospective cohort of 632 intussusception patients in Mansoura University Children's Hospital. The study included patients in the time period between March 2007 till December 2014. Data of patients presented to the emergency department at that time period were reviewed. Patients whom clinical presentation was favorable for non-surgical treatment were assigned for hydrostatic reduction. Patients who had signs of peritonitis, marked abdominal distension, high grade fever or lethargy were prepared for surgical intervention and thus excluded from the study. Data were evaluated for the success of reduction, number of attempts, occurrence of colonic perforation. For patients that were explored surgically after reduction attempts, the operative findings were analyzed as regards the need for resection and the cause of

failure of reduction. Recurrence was also sought for.

Technique:

After obtaining the history, and clinical examination, patients were prepared by placing an IV line, and obtaining blood samples for complete blood count and blood gases and serum potassium in cases of bad general condition. Intravenous fluids and antibiotic were started till the procedure is started, usually within 15 to 30 minutes. Informed consent was obtained from the parents in all patients. Reduction was done under sedation in the radiology department in the presence of the anasthetist. All tools and supplies for air way management and necessary drugs were prepared at hand. The ultrasound machine was Philips iU22. Diagnosis was confirmed first by the sonographer, by viewing both transverse and longitudinal views were used for confirming the invagination of one loop within the other. An 18 or 20 Fr Foley's catheter was introduced through the anus. Then, balloon was inflated with 30 mL of saline to seal the rectum and prevent leakage of the saline. Warm saline was injected slowly using a 5 cc syringe. Reduction of the intussusception was monitored though all time during injection using the linear array sonography transducer during injection of saline. It is important to keep the probe at fixed view during injection in order to evaluate movement of the head. No pressure monitoring was available at the time of the study. Multiple attempts (up to 3 times) were sometimes used in some cases. Colonic perforation was instantly detected in all cases by increased amount of free peritoneal fluid. Completeness of was confirmed by visualizing reflux of fluid through the caecum into the ileum through the ileocecal valve and disappearance of the intussusceptum. Once complete reduction was achieved, the fluid was evacuated. The abdomen was then re-examined to determine whether there was any residual lesion or recurrence of intussusception. The procedure was terminated if the intussusceptum failed to move after three attempts, 3 minutes each. After successful reduction, the patient was admitted to the ward and discharged after establishment of oral intake and normal bowel movement. Partially reduced cases of intussusceptions and those that failed to or had complications were managed surgically. Patients with successful hydrostatic reduction were routinely reevaluated by sonography the next day.

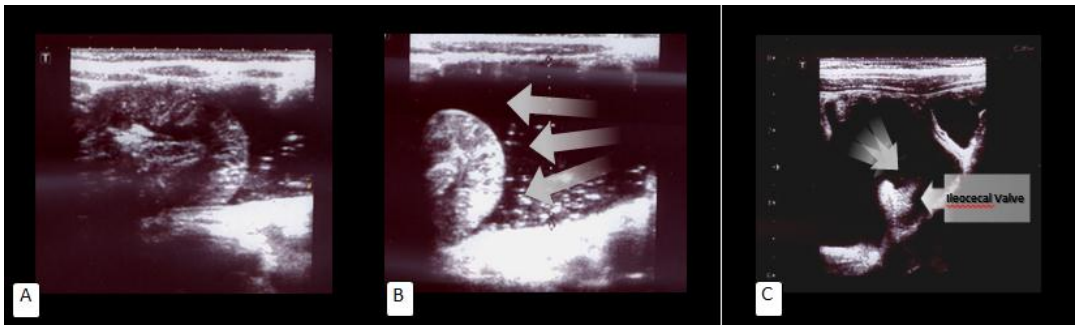

Fig. 1: A: Longitudinal section view of the reduction with saline on the right and the intussusceptum on the left B: advancement of reduction C: complete reduction and flow of fluid through the ileocecal valve.

Indices:

For measuring a validated index for outcome. The reduction success rate was calculated according the indices developed by Bekdash et al (Figure 2)[4]. For this purpose, the total group of patients with intussusception were subdivided into 3 groups:

1. Attempted non operative reduction:
   - Includes all patients treated by saline enema regardless to outcome
2. Attempted non operative reduction not requiring resection
   - Includes successful reduction via hydrostatic and surgical reduction
3. Operative reduction not requiring resection
   - Includes all successful reduction that had or didn't have non operative attempt

These subgroups form the items for calculating indices of successful non-operative reduction (Fig. 2).

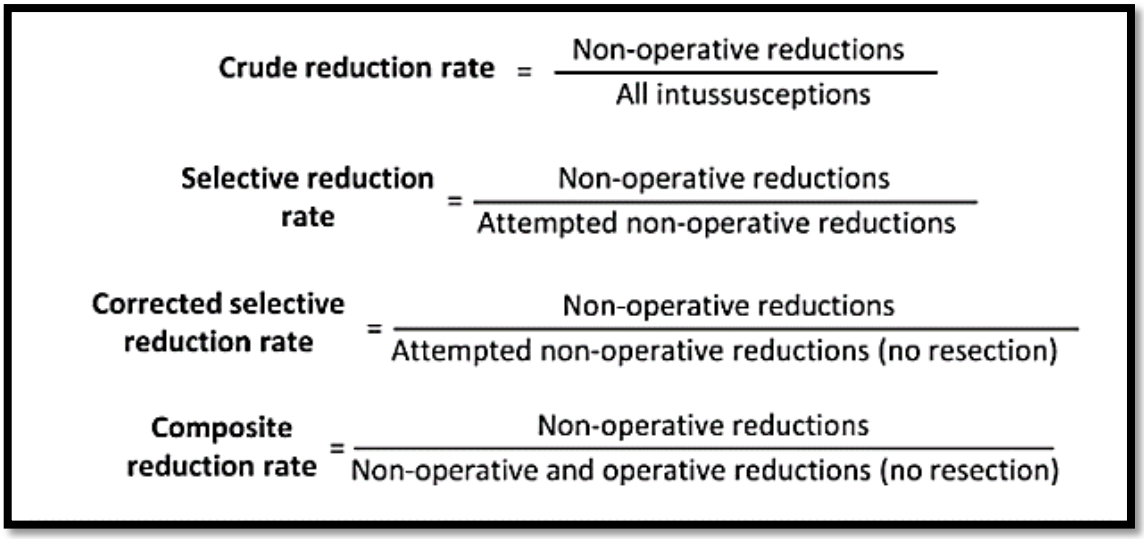

Fig. 2: Definitions of four indices of successful non-operative reduction based on the treatment modality (primary non-operative, secondary operative, primary operative) and outcome groups (resection not required, resection required) [4]

RESULTS

The records of 782 intussusception patients were evaluated. A total of 632 patients (80.8%) had the saline enema technique and were included in the study. A 150 patients went primarily for surgery hence were excluded from the study. Among the 632 patients, ages ranged from 3 months to 26 months. There were 391 (69.1%) males and 241 females (38.1%). As regards presenting symptoms, bleeding per rectum was present in 97% of patients. Abdominal colic was reported in 629 patients (99.5%), greenish vomiting in 2% and lethargy in 2 patients (0.003 %). The patients with lethargy were both dehydrated and were resuscitated well before reduction. 549 patients (86.9%) were presented in the first 24 hours of onset of symptoms. Late presentation was found in 76 patients (12%) seen in the second day after onset, while patients seen later than 2 days were 7 (1.1%) (Table 1).

Table 1: Demographic feature and presenting symptoms:

Variable		**No**	**Percentage**
Age		3-26 month	-
Gender	Male	391	(69.1%)
	Female	241	(38.1%)
Bleeding per rectum		613	97%
Abdominal Colic		629	99.5%
Greenish vomiting		12	1.9%
Lethargy		2	0.003%
Duration of symptoms	<24 hours	549	in 86.9%
	24-48 hours	76	in 12%
	>48 hours	7	in 1.1%.

Successful reduction was found in 510 patients after one or more trials (80.7 %). 82.3% of patients was reduced successfully with one attempt, 13.9% from the second and 3.7% at the third attempt. 122 (19.3 %) children showed inability to reduce the head completely, or the intussusceptum was not moving back with progressive increase in pressure. Thus, they were assigned for surgical reduction. Causes of failure are illustrated in figure 3. The most common cause was severe edema and congestion. Among the 122 patients that needed exploration, 66 did not need resection while the remaining 54 patients required resection of a pathological part of intestine. Colonic perforation happened in 22 patients (3.5 %). Perforation was detected promptly by rapid collapse of the colon and the appearance of free fluid in the abdominal cavity. Recurrence after enema reduction occurred in 26 cases (4.1%), 22 of those cases had repeated enema reduction and only two needed open surgical reduction (Table 2). Among the 150 patients who were primarily surgically treated, 63 (42%)patients had a successful simple reduction. The majority (58%) had whether an ischemic part of intestine or severe congestion making reduction impossible, thus necessitating resection.

Table 2: Hydrostatic reduction success and Failure

Variable		No	Percentage
Successful reduction		510/632	80.7%
Attempts	1st attempt	420/510	82.3%
	2nd attempt	71/510	13.9%
	3rd attempt	19/510	3.7%
Failed Reduction		122/632	19.3%
Congestion and edema		87/122	71.3%
Ileo-ileo-colic head		16/122	13.1%
Ischemic loop		18/122	14.8%
Secondary intussusception		1/122	0.8%
Perforation		22/632	3.5%
Recurrence		26/632	4.1%

Reduction Rate Indices:

The three subgroups specified to calculate the success rate index are:

1. Attempted non operative reduction:
   - Includes all patients treated by saline enema regardless to outcome= 510
2. Attempted non operative reduction not requiring resection
   - Includes successful reduction via hydrostatic and surgical reduction = successful non operative reduction + failed reduction that was surgically reduced = 510 + 66 = 576
3. Operative reduction not requiring resection
   - Includes all successful reduction that had or didn't have non operative attempt = Attempted non operative reduction operatively reduced not requiring resection + operative reduction not requiring resection = 510 + 66 + 63 = 639

Indices calculation and results are demonstrated in table 3. Crude reduction rate was 68%. The selective reduction rate was calculated to be 80.7%. the Corrected selective reduction rate was higher (88.5%). Finally, the composite reduction rate was 79.8%.

Table 3: Non operative reduction rate indices

Index	Calculation	Percentage
Crude reduction rate	510/750	68%
Selective reduction rate	510/632	80.7%
Corrected selective reduction rate	510/ (632-54)576	88.5%
Composite reduction rate	510/ (578+63) 641	79.8%

DISCUSSION

The non-surgical treatment has been established as the primary line of management of intussusception. Various techniques have been developed for hydrostatically reduce the intussusception head back through the ileo-cecal valve by increasing pressure in the colon. Although, pneumatic reduction of intussusception with fluoroscopic control is now considered the preferred technique by many centers, it carries the risk of exposure to radiation. Other pressure transmission media as saline [5], water-soluble contrast agent [6], barium[7] have been employed to comparable effect. Ultrasound is a readily available diagnostic tool that is effective for diagnosis. Ultrasound guided reduction has been employed as a radiation free alternative fluoroscopy.

The first description of using saline enema for reduction of acute intussusception was reported by Wang and Liu in 1988. The advantages of using ultrasonography are numerous. First, it is an excellent diagnostic tool as the sensitivity of the initial diagnosis is 98-100% even with junior radiologists[8]. Second, exclusion of other conditions as free peritoneal fluid, abdominal masses or associated pathology is easily established before and during the procedure. Furthermore, sonographic features can help predict the difficulty of reduction, such as presence of edema inside the intussuscepient and enlarged LN[9]. Color Doppler is used to evaluate the vascularity of involved bowel loops and offers and prognostic indicator for the possibility of enema reduction[10]. Nonetheless, it can effectively detect a lead point such as a Meckel diverticulum, duplication cyst, polyp, or lymphoma[11]. Moreover, it allows real time monitoring of the reduction progress and condition of the colon wall during reduction. Finally, ultrasound is non-invasive and radiation free, thus elimination of the radiation hazards for the patient and the medical personnel. Disadvantages of the using ultrasound is the need for a radiologist. This no not a problem in most secondary and tertiary hospitals. Cai el at reported surgeons performing the whole technique without the presence of a sonologist [5]. It has been reported using saline, tap water[12] and Hartmann's solution effectively[13].

In the current series, successful reduction was established in 80.7% of patients who were selected for no surgical reduction. Since, most of contraindication to non-surgical reduction are relative, the majority of patients showed bleeding per rectum. Being a sign of late presentation, this may explain the relatively low rate in comparison to reported success rates. The sonographic guided hydrostatic reduction is reported to have success rates ranging from 76 - 93% of cases[2,14,15,16,17,18]. There is a wide variability of reduction rate. This can be attributed to the differences in operator's experience, severity of the associated pathology, delayed presentation, and the presence of secondary causes. There is a personal judgment so as when to terminate the reduction. For example, incomplete reduction might sometimes be mistaken with edematous ileo-cecal valve or mesenteric lymph nodes[19,20].

In order to have a standardized success rate. The crude, selective, corrected selective and composite reduction rates have been calculated. Interestingly however, the composite reduction rate 79.8% was slightly lower than the selective reduction rate 80.7%. This means that the success of reduction in patients selected for non-surgical reduction is very similar to success rate in relation to the total number of patients that are retrospectively truly candidate for reduction. Composite reduction rate is supposed to be a better index of successful non-operative treatment, as the selective reduction rate is still biased by patient selection for primary operative treatment. The composite success rate eliminates this bias by calculating the proportion of intussusceptions not requiring resection that were successfully reduced non-operatively. Similarly, the selective reduction rate is better replaced by the corrected selective reduction rate that would also reduce variations caused by differences in disease spectrum (early or advanced) at presentation. [4]

The incidence of perforation during reduction has been reported to range from 0 to 5.9% [21], and there is increased risk for perforation and lower success rate (20%) if patients are less than 3 months old [22]. In our series. Perforation occurred in 3.5% of patients. This can be attributed to the unavailability of pressure monitoring and the variability in operators' experience. Some authors have reported similar observation as there were higher perforation rates related to aggressive and rapid distension of the colon with high pressures[23].

In this study, recurrence occurred in 4.1% of cases. Frequency of recurrent intussusception is extremely variable depending on the series, ranging from 2 to 20%[24]. In most series, recurrence is defined after a minimum of 12 hours following the reduction. The finding of intussusception within less than 12 hours is rather due to incomplete reduction. It is conventionally accepted that the rate of recurrent acute intussusception is lower after surgical reduction than after hydro pneumatic reduction[25]. Interestingly, one patient in this study had successful reduction of recurrent intussusception after previous surgery for primary intussusception. Recurrence up to 3 times was encountered in 2 patients that were successfully managed non surgically with saline enema.

CONCLUSION

Saline enema reduction offers an effective and safe alternative to other types of reduction. The technique has the advantage of avoiding exposure to radiation. The procedure is easy to be mastered by junior staff. Complications are of low rate and can be managed surgically with no morbidity. Ultrasound can efficiently monitor reduction and detect complications. A randomized controlled trial comparing this procedure to other popular ones is recommended. The role of intraluminal pressure monitoring is to be addressed in order to lessen complications.

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