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Original Article

The effects of hydrostatic reduction and operative manual reduction on the success of intussusception reduction

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Abstract

Aim: Intussusception is the most common cause of bowel obstruction in children aged 3 months to 6 years. Ultrasonically guided Hydrostatic reduction (UGHR) and operative manual reduction (OMR) are among the treatment methods. The aim of this study is to compare the effects of UGHR and OMR techniques on successful reduction in children with intussusception.

Material and Methods: This study was performed retrospectively between January 2015 and May 2018. The data of intussusception child patients were reviewed. A total of 63 patients' records were reached. A total of 31 UGHR procedures and 32 OMR procedures were recorded. Demographic data, recurrence, reduction success of UGHR and OMR patients were calculated and evaluated statistically.

Results: No significant difference was found in terms of demographic information. There was no recurrence in both groups. While rate of successful reduction of patient with UGHR is 77.4%, OMR's success is 87.5%. There was no statistically significant difference in terms of reduction success. It was determined that what was important in the reduction success was the first application time.

Conclusions: When we evaluated our results, we found that the factor affecting the reduction success in a patient with intussusception was not the method of reduction. We found that the most important factor affecting reduction success was the time between onset of symptoms and initiation of reduction. If this is less than 24 hours, we have found that the reduction success is very good.

Keywords: Intussusception; Reduction; Childhood.

INTRODUCTION

Intussusception is a clinical condition in which the proximal part of the intestine passes through the distal part of the intestinal canal, such as a telescope, and causes intestinal obstruction (1). It is the most common cause of bowel obstruction in children aged 3 months to 6 years (1). If not treated, it is a fatal disease (2). The incidence in childhood is 1 to 4 in 2000 (2). It is divided into idiopathic and secondary (3). There is a lead point which causes the secondary intussusception (3). Treatment is operative and non-operative (3). The current treatment approach is usually non-operative if there is no contraindication (4). Non-operative treatment methods include ultrasound or fluoroscopy guided pneumatic or hydrostatic reduction (4).

Ultrasonically guided hydrostatic reduction (UGHR) is a reduction procedure performed under ultrasound guidance with the aid of a controlled serum saline through the anus when the parent is at the side of the child (3). The UGHR procedure is performed by a pediatric surgeon, a radiologist.

Operative manual reduction (OMR) is a technique performed by a pediatric surgeon to detect and manual reduction of invaginated intestinal segments during laparotomy under general anesthesia, in the operating room (5).

The aim of this study is to compare the effects of UGHR and OMR techniques on successful reduction in children with intussusception.

MATERIAL and METHODS

Study protocol

The study began after the ethics committee's decision was approved by the ethics committee of scientific research and publications of Inonu University. This study was performed retrospectively. From January 2015 to May

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2018, records of all pediatric patients who were diagnosed as intussusception under the age of 17 were examined at the department of pediatric surgery at Inonu University Medical Faculty. Before starting to work, inclusion and exclusion criteria were established. Inclusion criteria; intussusception to be diagnosed, to be between 0-17 years of age, manual reduction or hydrostatic reduction with ultrasonic guidance, to be able to access recorded information, to be able to learn the time between first symptom-reduction start time. The exclusion criterion was accepted for the absence of any of these conditions. In addition, the patient was not included in the study if there was free air on the abdominal plain graph, presence of pathological lead-point, and peritonitis findings on physical examination findings. These patients were also anastomosed with laparotomy. A total of 63 patients' records were reached. In these records, information such as demographic information, reduction technique, intraoperative findings, plain abdominal radiographs, laboratory findings, success status of the technique applied, clinical findings, duration of hospital stay, and the duration of the procedure were obtained. All patients with Intussusception were contacted and asked how long ago complaints had begun before the reduction started. This time for each patient was recorded for statistical analysis in hours. A total of 31 UGHR procedures and 32 OMR procedures were recorded in the patients' records.

Intussusception was diagnosed by laboratory findings, clinical findings, plain abdominal radiographs, and ultrasonographic findings (Figure 1-2) of each patient who developed intussusception.

After diagnosis, necessary preparations were made. If perforation was found clinically and radiologically, the patient underwent laparotomy. Then the UGHR method was chosen as the first option. If this technique is technically impossible (if the radiologist is not available for operation at that time, if the ultrasound are not suitable for operation at that time, if there are technical problems) then the OMR procedure was performed in the operating room.

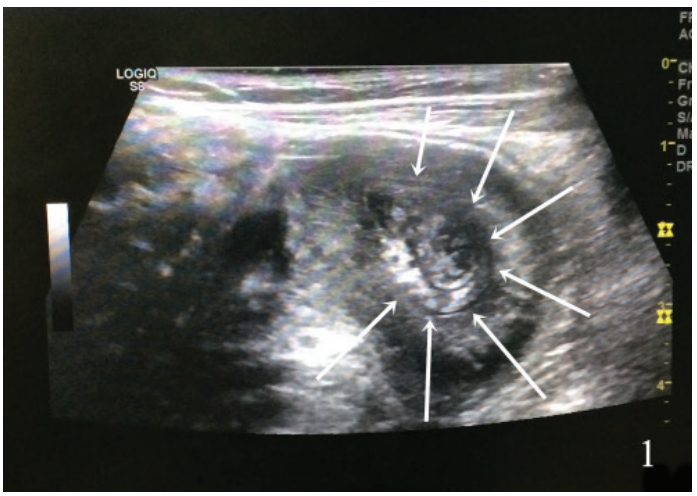

Figure 1. A 7-year-old male patient presented with intussusception in the USG showing a segment of the intestine (arrows)

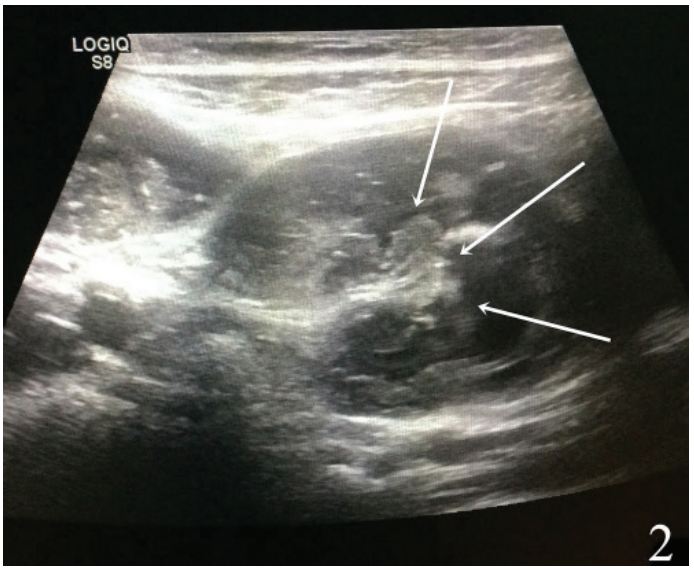

Figure 2. During the reduction of the same patient, the image of the segment of the intestine with the reduction (arrows)

Ultrasonic guidance hydrostatic reduction (UGHR).
The patient was taken to the ultrasound room prepared for this procedure. The procedure was performed by radiologist, anesthetist and pediatric surgeon. Sedation medication was given to the patient by anesthetist (Ketamine hydrochloride 1 mg / kg IV (intravenous) (Ketalar 50 mg / ml 10 ml flk Pfizer, Ortakoy, Istanbul, Turkey). The anus of the patient was placed on a 22 fr Foley catheter (Latex Foley catheter, Nantong Angel Medical Instruments Co., Ltd. Nantong China). Foley's balloon was inflated with 20-40cc Serum saline. Then, serum saline (Neoflex 500ml Turktippsan Saglik, Akyurt, Ankara, Turkey) with free fall from 120cm height was sent from foley. 50 ml of radiopaque fluid (iohexol 100 ml flacon (300 mg / ml) Omnipaque Kocsel Ilac San., Istanbul, Turkey) were mixed in 500 ml serum saline. Ultrasound was performed using a 5-10 MHz transducer. Ultrasound guidance was used to reduce intussusception in intestinal segments by sending serum saline through the anus. During the procedure a light massage of the abdomen was performed. If Reduction failed 3 times, UGHR was stopped and the patient was operated on. If the reduction was successful, abdominal plain radiograph showed that the radiopaque serum saline had passed to the small intestine (Figure 3).

Operative manual reduction (OMG).
The patient underwent OMR procedure if the reduction by UGHR failed or if technically UGHR was not achieved. Under general anesthesia, the right midline transverse incision opened the abdomen in the operating room. The intussusceptional bowel segment (IBS) was found and taken out. Intra-abdominal perforation was controlled. The IBS was held in the palm of the hand gently, not too tightly. The intussusception bowel segment was squeezed slowly and constantly from the distal end. Retrograde was pushed out. So the reduction was done. (Figure 4). Serosa defects were repaired after reduction was completed. Reduction was considered unsuccessful if there was perforation. In this case, IBS was repaired with resection-anastomosis.

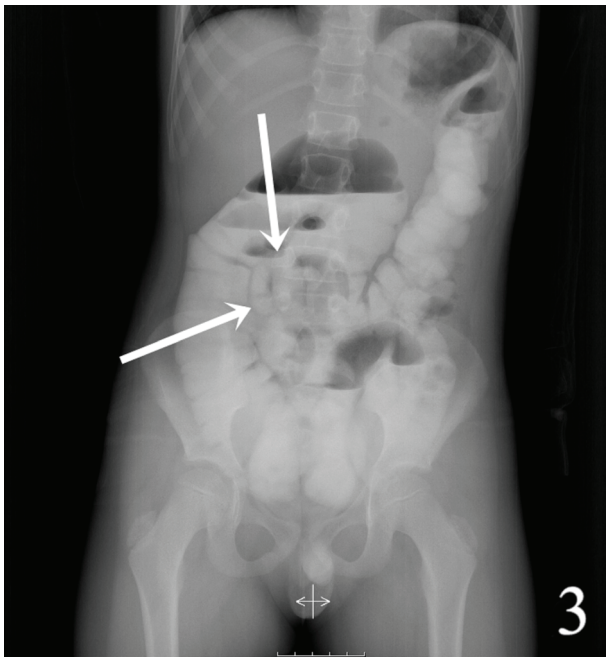

Figure 3. A 7-year-old male patient with intussusception passes the radio-opaque serum saline to the small intestine (arrows) after USG guidance reduction

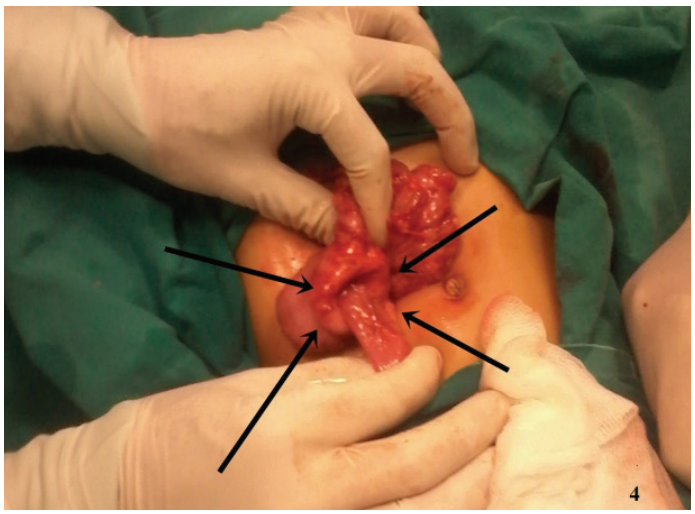

Figure 4. A 2-year-old male patient presented with intussusception of the ileum segment during manual reduction (arrows)

Criteria of reduction success.
The UGHR was deemed successful if reduction was seen with ultrasound and/or after the procedure plain abdominal radiography showed that the radiopaque serum saline passed into the small intestines.

If no reduction was seen with ultrasound, if the radio-opaque serum saline had not passed through the small intestine or perforation was detected, the procedure was considered unsuccessful.

If perforation was detected in the OMR, the procedure was considered unsuccessful.

Statistical analysis
Normal distribution of quantitative data was assessed by Shapiro-Wilk test. Since the data were not normally distributed, quantitative data were summarized by median, minimum and maximum values. Mann Whitney U test was used for comparisons. Qualitative data were expressed as count (percent) and comparisons were made by Continuity corrected chi-square test or Fisher's exact test. Determination of the best cut-off value for success due to the time to first application (hours) after the symptoms have started was performed by ROC analysis. In all analysis level of significance was considered as 0,05.

RESULTS

Demographic information, laboratory findings, and hospital stay durations of UGHR procedure patients (n = 31) and OMR patients (n = 32) are shown in Table 1. The duration of the procedure was a minimum of 20 minutes, a maximum of 95 minutes, and a median of 23 minutes. The OMR had a minimum of 40 minutes, a maximum of 100 minutes, and a median of 58 minutes. The process time is less in UGHR. This finding was statistically significant (p<0,001).

Intussusception was localized in region of ileocolic in patients with successful reduction in both groups.

The serum potassium level (mmol/L) from the laboratory findings was a minimum of 3.6 mmol/L, a maximum of 4.7 mmol/L and a median of 4 mmol/L in patients undergoing UGHR procedure. In patients with OMR, the minimum was 3.6 mmol/L, the maximum was 5.3 mmol/L and the median was 4.2 mmol/L. Serum potassium levels were higher in OMR patients during admission. This finding was statistically significant (p<0,001).

Table 1. Comparison of demographic and laboratory findings of intra-operative manual reduction with ultrasound guided hydrostatic reduction

	Hydrostatic reduction (n=31)			Manual reduction (n=32)			P Value
	Median	Min.	Max.	Median	Min.	Max.	
Age(Month)	13	5	124	27	5	156	0.09
Operation time (min)	23	20	95	58	40	100	**<0.001**
Weight (Kg)	10	5	35	13	5	60	0.109
WBC(10^9/L)	18.4	11.9	28	18	9.6	26.5	0,173
NEU(%)	70	65	85	75	46,4	86	0.628
NA(mmol/L)	139	135	148	139	135	142	0.64
K(mmol/L)	4	3.6	4.7	4.2	3.6	5.3	**<0.001**
CL(mmol/L)	103	98	108	104	1.6	110	0.412
Length of stay (hour)	52	47	156	73	66	160	**0.001**
Gender	Male	19 (61.3%)		Male	24 (75.0%)		0.369
	Female	12 (38.7%)		Female	8 (25.0%)		

The length of stay at the hospital was 47 hours minimum, maximum 156 hours, median 52 hours in patients undergoing UGHR procedure. OMR patients had a minimum of 66 hours, a maximum of 160 hours, and a median of 73 hours. Patients undergoing the UGHR procedure were less likely to stay in the hospital. This finding was statistically significant (p<0,001).

A comparison of the success status and clinical findings of UGHR-treated patients and OMR-treated patients is shown in Table 2.

Table 2. Comparison of success status and clinical findings of intra-operative manual reduction with ultrasound-guided hydrostatic reduction

		Hydrostatic reduction (n=31)	Manual reduction(n=32)	P Value
Success Status	Positive	24 (77.4%)	28 (87.5%)	0.47
	Negative	7 (22.6%)	4 (12.5%)	
Rectal hemorrhage	Positive	4 (12.9%)	4 (12.5%)	1
	Negative	27 (87.1%)	28 (87.5%)	
Abdominal mass	Positive	4 (12.9%)	4 (12.5%)	1
	Negative	27 (87.1%)	28 (87.5%)	
Diarrhea	Positive	4 (12.9%)	0 (0%)	0.238
	Negative	27 (87.1%)	32 (100%)	
Recurrences	Negative		Negative	
Constipation	Negative	31 (100%)	32 (100%)	
Abdominal pain	Positive	31 (100%)	32 (100%)	
Vomiting	Positive	31 (100%)	32 (100%)	

The success status was positive in 24 patients (77.4%) and negative in 7 patients (22.6%) in UGHR. The success status in OMR was found to be positive (87.5) in 28 patients and negative (12.5%) in 4 patients. In terms of success, there was no difference between UGHR and OMR (p<0,005). There was no difference between UGHR and OMR in terms of clinical findings and recurrence (p<0,005).

The demographic information of the patients who failed to reduce by both procedures is shown in Table 3.

There was no statistically significant difference between the two groups (UGHR and OMR) in terms of the time of first application after the appearance of intussusceptions Table 4. However, when patients were divided into two groups (Successful and Unsuccessful) in terms of reduction success, there was a statistically significant difference Table 5. Two patients who were diagnosed with Meckel diverticulitis were excluded from this analysis because the treatment of the Meckel diverticulum was resection-anastomosis.

The relationship between the time of first admission of patients and the time of symptoms onset and reduction success was statistically analyzed. This analysis was performed between those who succeeded in reduction and those who failed in reduction. The time between the start of first symptom onset of reduction and the time of onset of reduction was median 6 hours (minimum 4 - maximum 12 hours). In patients with failed reduction, initial symptom onset-reduction start time, median duration was 38 hours (minimum 36- maximum 48 hours). This difference was statistically significant (p <0.001) (Table 5). Statistical analysis revealed that the time was important in the success of the reduction. At this time, the result of statistical analysis was determined to be 24 hours (Table 5). If the first application time is shorter than 24, the reduction success is positively affected.

Table 3. Demographic information of patients with failed reduction

Reduction Failed Patients	Age(Month)	Gender	Etiology	Type of surgery	The region of Invagination
Hydrostatic reduction	9	F	Meckel's diverticulum	Resection-Anastomosis	Ileo-ileal
Hydrostatic reduction	8	M	Delay	Resection-Anastomosis	Ileo-colic
Hydrostatic reduction	10	F	Delay	Resection-Anastomosis	Ileo-colic
Hydrostatic reduction	13	F	Delay	Resection-Anastomosis	Ileo-colic
Hydrostatic reduction	36	M	Delay	Resection-Anastomosis	Ileo-colic
Hydrostatic reduction	18	M	Delay	Resection-Anastomosis	Ileo-colic
Hydrostatic reduction	5	M	Delay	Resection-Anastomosis	Ileo-colic
Manual reduction	42	M	Delay	Resection-Anastomosis	Ileo-colic
Manual reduction	11	M	Delay	Resection-Anastomosis	Ileo-colic
Manual reduction	10	M	Delay	Resection-Anastomosis	Ileo-colic
Manual reduction	128	M	Meckel's diverticulum	Resection-Anastomosis	Ileo-ileal

Table 4. UGHR and OMR groups were statistically analyzed for the relationship between initial admission times after intussusception

	UGHR (n=31)	OMR (n=30)	P Value
After the symptoms have started, the time to first application (hours)	8 (4-48)	38 (36-48)	0.066

*Data expressed as Median (min. – max.)

Table 5. Statistical analysis of the relationship between initial admission time and reduction success

	Success Status		
	Positive (n=52)	Negative (n=9)	P Value
After the symptoms have started, the time to first application (hours)	6 (4-12)	38 (36-48)	<0.001

The best cut-off value was determined as equal to or lower than 24 hours Specificity=1.00 sensitivity=1.00.

*Data expressed as Median (min. – max.)
Determination of the best cut-off value for success due to the time to first application (hours) after the symptoms have started was performed by ROC analysis. The best cut-off value was determined as equal to or lower than 24 hours. This cut-off value yielded the perfect diagnostic performance as Specificity=1.00 and sensitivity=1.00.

DISCUSSION

In a patient with intussusception, the main treatment approach is divided into operative and non-operative (5). Operative treatments are divided into manual reduction and resection-anastomosis. (5). Non-operative treatments are divided into Hydrostatic and pneumatic reduction (5). Both of these can be done under the guidance of the scope. Hydrostatic reduction can be done by ultrasound guidance (5).

Different studies have been done on each treatment method. There are different conclusions about the success of different methods in the literature.

The first study to report that intussusception was manually reduced in children is the Hutchinson et al. Study in 1871 (6). Gross described the technique for manual reduction (7).

Sharp et al reported an 82% success rate of manual reduction in the study they performed (1). They reported that 30% of patients required resection-anastomosis (1).

In their study Ocal et al, they evaluated the success of the UGHR and OMR (8). They found that UGHR on reduction success was 72.3% in their study (8). They found that the reduction success of OMR was 62.5% (8). They have found that the length of hospitalization of UGHR is shorter (8).

In another study, Niramis et al., Intussusceptions also investigated the post-treatment recurrence rate (9). They found that the recurrence rate was 8% in their study (9). In hydrostatic reduction, they found that the recurrence rate was 15.8% (9). They found that the recurrence rate of Barium enema and reduction was 11.4% (9). They found no difference statistically.

Karadag et al, have conducted a study that examines the success of UGHR (11). They found that the reduction of UGHR was 83.46% (11). They found a recurrence rate of 7.6% in their study (11). They found that 74.5% of UGHR's success in delayed cases (11).

Xie et al examined the success rate of UGHR with pneumatic reduction in studies (3). They found 96.7% of UGHR's success and 83.87% of pneumatic reduction (3). They found that the success of UGHR was statistically better (3). They found that the recurrence rate was 4, 84% in UGHR and 3, 23% in pneumatic reduction (3).

In this study, we found that the reduction success rate was 77.4% in UGHR and 87.5% in OMR. We have found that this difference is not statistically significant. There was no recurrence in both groups. The hospital stay was shorter in UGHR (median 52 hours). The duration of the procedure was shorter in UGHR (median: 23 minutes).

CONCLUSION

When we evaluated our results, we found that the factor affecting the reduction success in a patient with intussusception was not the method of reduction. We found that the most important factor affecting reduction success was the time between onset of symptoms and initiation of reduction. If this is less than 24 hours, we have found that the reduction success is very good.

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