ORIGINAL ARTICLE

Outcome of ultrasound guided hydrostatic reduction in pediatric intussusception at Lady Reading Hospital, Peshawar

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Abstract:

Introduction: Several treatment options are available for management of intussusception depending upon the duration of symptoms and clinical presentation. Non-operative options include reduction via normal saline enema, barium enema or pneumatic reduction under fluoroscopic guidance. The operative options employed in cases presenting with peritonitis, bowel perforation and shock include both laparoscopic reduction and open surgery.

Material and Methods: This descriptive cross-sectional study was carried out at the Department of Pediatric Surgery, Lady Reading Hospital, Peshawar from 13th July, 2020 to 13th January, 2021. Total of 150-patients with intussusception were included in the study in a consecutive sampling method and subjected to hydrostatic reduction under ultrasound guidance. All patients were followed up to determine the outcome of procedure.

Results: The mean age of the sample was 2.1±0.9 years. 58.7% of the sample were males and 41.3% were female gender. Mean BMI was 24.5±2.1kg/m², 58.7% had ASA class I and 62.7% were intussusception of small intestine. Mean duration of symptoms was 15.4 ±6.2 hours. Bleeding per rectum was recorded in 62.7%. Mean time of the procedure was 44.7±10.4 minutes. On follow up after hydrostatic reduction under ultrasound guidance, success was recorded in 68.7% of patients.

Conclusion: Hydrostatic reduction under ultrasound guidance has acceptable success in the management of intussusception under 3 years of age. We recommend more studies on larger sample sizes and multicenter studies to report clear efficacy of hydrostatic reduction and factors which can affect its efficacy before recommending future research and treatment directions.

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Introduction:

Intussusception is a condition in which a part of intestine telescopes or invaginates into the adjoining intestinal lumen causing obstruction. The part of gut which telescopes is called the intussusceptum while the part that receives the intussusceptum is called intussuscepiens. The earliest record of intussusception dates to 1692. It is one of the most common pediatric surgery emergencies that presents as intestinal obstruction in up to 18% infants and young children.[1] The incidence of intussusception ranges from 1-4 per 2,000 infants and children. The most common type of intussusception is ileocolic seen in up to 90% cases while the remaining 10% cases comprise of ileo-ileal or colo-colic variety.[2] The classic triad of abdominal pain, vomiting and bleeding per rectum (currant jelly stools) is seen in only 50% of all cases.[3] Ultrasound abdomen is the diagnostic modality of choice for intussusception.[4]

Several treatment options are available for management of intussusception depending upon the duration of symptoms and clinical presentation. Non-operative options include reduction via

normal saline enema, barium enema or pneumatic reduction under fluoroscopic guidance. The operative options employed in cases presenting with peritonitis, bowel perforation and shock include both laparoscopic reduction and open surgery.[5]

Non-operative reduction of intussusception is the procedure of choice in uncomplicated cases. Hydrostatic or saline reduction is associated with rapid reduction under ultrasound guidance; is non-toxic; does not expose the body to radiations as occurs in fluoroscopy guided pneumatic reduction; is cheap; has a very low risk of perforation and does not cause chemical peritonitis even if perforation occurs. Hydrostatic reduction is also associated with reduced hospital stay and lower recurrence rates. It is a procedure in which normal saline or any of the above-mentioned medium is administered per rectum at body temperature without pressure to reduce the intussusception.[6,7]

A study found that hydrostatic reduction was successful in 83.46% of patients with intussusception. 29% of patients had bleeding per rectum, and hydrostatic reduction was successful in 74.5% of those cases. The mean duration of symptoms was shorter in successfully reduced cases (1.44 days) compared to cases of failure (1.95 days), with a statistically significant difference.[8] Another study reported an 83% success rate with hydrostatic reduction. The ileocecal valve was involved in 40% of cases, the ascending colon in 45%, the transverse colon in 10%, and the left colon in 5%. The success rate varied across segments: 84% for ileocecal valve, 94% for ascending colon, 88% for transverse colon, and 35% for left colon (p=0.002). Hydrostatic reduction was successful in 77% of patients with bleeding per rectum and failed in 23%, but this difference was statistically non-significant (p=0.1).[9] Khorana et al., in 2015 reported a success rate of 44% with hydrostatic reduction of intussusception in children.[10] A study by Hasnain et al., reported a success rate of 85.71% while another Pakistani study by Ullah et al., reported the success rate to be 89.70%.[11,12]

The rationale of this study is that there is paucity of data in the Pakistani population, with only two previous studies in the last 5 years on success of hydrostatic reduction in pediatric. It is evident from the studies discussed above that studies have reported conflicting results regarding the success of the procedure. In a resource limited country like ours, hydrostatic reduction provides a simple and reliable option with a good safety profile which can be employed to successfully treat the cases of intussusception as compared to other more invasive options. The aim of the study to provide local evidence in support of the procedure, and to pave way for further research on this topic.

Material and Methods:

Study design: Descriptive cross-sectional study.

Study setting: Department of Pediatric Surgery, Lady Reading Hospital, Peshawar.

Duration of study: From 13th July, 2020 to 13th January, 2021.

Sample size: The sample size was calculated by WHO sample size calculator as follows. a. Confidence level (1- α) = 95%. b. Absolute precision required (d) = 6%. c. Anticipated population proportion (P) = 83.46%. 8 (success rate), d. Sample size (n)=150 patients.

Sampling technique: Non-probability consecutive sampling.

Sample selection: Inclusion criteria, age less than 3-years. Both genders. ASA class I and II. Patients presented with first episode of intussusception. BMI between 19-30 Kg/m^2 (calculated by dividing the weight of the patient in Kg to height of patient in m^2).

Exclusion criteria, patients presented with recurrence. Patients who had history of a previous failed attempt of hydrostatic reduction. Patients presented with signs and symptoms of peritonitis. Patients who had history of previous abdominal surgery. Patients who did not give consent to be enrolled in the study.

Data collection procedure: After approval from the hospital Ethical Review Committee, a total of 150-patients who presented to the out patient department (OPD) or emergency department and got admitted in the Pediatric Surgery ward of Lady Reading Hospital, Peshawar with a diagnosis of intussusception who were planned for hydrostatic reduction were enrolled in the study. A written informed consent was taken from parents/guardians of all patients included in the study. After recording of demographic details, history was taken from the parents/guardians of the patients. Intussusception would be diagnosed based on history of abdominal pain, vomiting and passage of red currant jelly stools and confirmed by the presence of pseudo-kidney or target signs on ultrasonography of abdomen. The duration of symptoms including pain, vomiting, and bleeding per rectum would also be documented. A thorough clinical examination was performed, and ultrasonography was requested to confirm the diagnosis of intussusception as well as the site of the gut involved. Routine laboratory investigations were carried out and fitness for general anesthesia was obtained in case hydrostatic reduction fails and patient requires surgery.

Patients were made nil by mouth for 8-hours before surgery, intravenous fluids and antibiotics were administered prophylactically before surgery. Nasogastric tube was passed, and patients were transferred to radiology department. A 22Fr Foley's catheter was inserted per rectum, normal saline warmed to 37°C would then be instilled without pressure, with the drip placed about 100cm above the level of the patient. Ultrasound would monitor the progression of the saline solution to the point of intussusception. Reduction was facilitated by compression and changing the patient to the lateral decubitus position. Procedure would be labelled as successful if the intussusception disappeared completely. A total of 3 attempts would be made to reduce the intussusception after that the procedure would be labeled as failed if not reduced in 3 attempts.

Color doppler was used to confirm the viability of the gut. The patients were kept nil by mouth till bowel sounds would be audible on auscultation or when patient passed stools. After successful hydrostatic reduction, ultrasound scan was repeated after 24 hours. Data for each patient was recorded on a predesigned patient's proforma. All the procedures were carried out by a multi-disciplinary team comprising of a surgical team headed by a pediatric surgeon, in coordination with an interventional radiologist. Researcher would record data of all the patients enrolled in study. All patients were given due respect and their comfort was taken care of during the study. The exclusion criteria were strictly followed to control confounders and bias in the study.

Data analysis plan: Data was analyzed using SPSS version 25.0. Mean and standard deviation were calculated for quantitative variables like age, BMI, duration of symptoms and procedure time. Frequency and percentages werecalculated for success and failure of hydrostatic reduction for each categorical variable like gender, ASA class, site involved, and presence of bleeding per rectum. Effect modifiers like age, BMI, gender, ASA class, site involved, duration of symptoms, presence of bleeding per rectum and procedure time were controlled by stratification. Chi-square test was used to compare successful hydrostatic reduction of intussusception between stratified groups taking p-value of ≤0.05 as significant.

Results:

The study was conducted on a total of 150-patients with intussusception. The mean age of the sample was 2.1±0.9 years. Minimum age of 0.5 years and maximum age of 3 years. The study sample (n=150) had an age-wise distribution with 78-participants 52.0%, (95% CI: 44.9-59.0%) aged 0.5-2 years and 72 participants 48.0% (95% CI: 41.0-55.1%) aged >2-3 years. Gender-wise, 88 participants 58.7% (95% CI: 50.9-66.1%) were male and 62 participants 41.3% (95% CI: 33.9-49.1%) were female. In terms of body mass index (BMI), mean BMI was 24.5+2.1kg/m^2, 40-participants 26.7% (95% CI: 19.8-34.7%) had a BMI of 20-23kg/m^2, 81 participants 54.0% (95% CI: 45.8-61.9%) had

Table 1:

Variables	Frequency (n=150)	Percent (CI: 95%)
Age-wise distribution of sample		
0.5-2 years	78	52.0%(CI:44.9-59.0%)
> 2-3 years	72	48.0% (CI:41.0-55.1%)
Gender-wise distribution of sample		
Male	88	58.7% (CI:50.9-66.1%)
Female	62	41.3% (CI:33.9-49.1%)
Body mass index (BMI)of sample		
20-23	40	26.7% (CI:19.8-34.7%)
> 23-26	81	54.0% (CI:45.8-61.9%)
> 26-28	29	19.3% (CI:13.3-26.7%)
ASA class of sample		
ASA I	88	58.7% (CI:50.9-66.1%)
ASA II	62	41.3% (CI:33.9-49.1%)
site involved in intussuception		
Small bowel	94	62.7%(CI:54.9-70.0%)
Large bowel	56	37.3% (CI:30.0-45.1%)
duration of symptoms		
3-12 hours	52	34.7% (CI:26.9-43.1%)
> 12-24 hours	98	65.3% (CI:56.9-73.1%)
Frequency of bleeding per rectum		
Yes	94	62.7% (CI:54.9-70.0%)
No	56	37.3%(CI:27.3-47.3%)
Duration of procedure		
30-45 minutes	97	64.7 % (CI:56.9-71.6%)
> 45-60 minutes	53	35.3 % (CI:28.4-43.1%)
Outcome of hydrostatic reduction		
Success	103	68.7% (CI:60.9-75.9%)
Failed	47	31.3cv % (CI:24.1-39.1%)

a BMI of >23-26 kg/m^2, and 29 participants 19.3% (95% CI: 13.3-26.7%) had a BMI of > 26-28kg/m^2. The majority of the sample were classified as ASA-I, 88-participants, 58.7% (95% CI: 50.9-66.1%), with the remaining classified as ASA-II, 62-participants, 41.3% (95% CI: 33.9-49.1%).

Intussusception occurred in the small bowel in 94-cases 62.7% (95% CI: 54.9-70.0%) and in the large bowel in 56-cases 37.3% (95% CI: 30.0-45.1%). The mean of duration of symptoms was 15.4+6.2 hours. The duration of symptoms ranged from 3-12 hours in 52-cases 34.7% (95% CI: 26.9-43.1%) and >12-24 hours in 98-cases 65.3% (95% CI: 56.9-73.1%). Bleeding per rectum was present in 94-cases 62.7% (95% CI: 54.9-70.0%) and negative in 56-patients 37.7% (CI: 27.3-47.3%). The mean time of the procedure was 44.7±10.4 minutes, duration of hydrostatic reduction procedure was 30-45 minutes in 97 cases 64.7% (95% CI: 56.9-71.6%) and >45-60 minutes in 53 cases 35.3% (95% CI: 28.4-43.1%). Overall, hydrostatic reduction was successful in 103 cases 68.7% (95% CI: 60.9-75.9%) and failed in 47-cases 31.3% (95% CI: 24.1-39.1%). These findings are tabulated in table 1.

Table 2 provides information on the outcome of a procedure stratified by various variables. The variables include age group, gender, BMI, ASA class, site involved, duration of symptoms, bleeding per rectum, and procedure time. The success and failure of the procedure are presented as percentages along with the P-value.

The results indicate that for the age group variable, the success rates for 0.5-2 years and >2-3 years were 65.4% and 72.2%, respectively. The P-value for this variable was 0.367, which is not statistically significant. For the gender variable, the success rates for male and female were 70.5% and 66.1%, respectively. The P-value for this variable was 0.574, which is also not statistically significant.

For the BMI variable, the success rates for the BMI ranges of 20-23, >23-26, and >26.28 were 72.5%, 69.1%, and 62.1%, respectively. The P-value for the BMI variable was 0.648, indicating no significant difference. For the ASA class variable, the success rates for ASA I and ASA II were 67% and 71%, respectively, with a P value of 0.610, indicating no significant difference.

For the site involved variable, the success rates for small bowel and large bowel were 72.3% and 62.5%, respectively. The P-value for this variable was 0.209, which is not statistically significant. For the duration of symptoms variable, the success rates for 3-12 hours and >12-24 hours were 67.3% and 69.4%, respectively, with a P-value of 0.794.

For the bleeding per rectum variable, the success rates for yes and no were 73.4% and 60.7%,

Table 2: Outcome of procedure

Variables	Success	Failed	P Value
Age groups wise stratification of hydrostatic reduction			
0.5-2 years	51 (65.4%)	*27 (34.6%)*	0.367
> 2-3 years	52 (72.2%)	20 (27.8%)	
Gender wise stratification of hydrostatic reduction			
Male	62 (70.5%)	26 (29.5%)	0.574
Female	41 (66.1%)	21 (33.9%)	
BMI wise stratification of hydrostatic reduction			
20-23	29 (72.5%)	11 (27.5%)	0.648
>23-26	56 (69.1%)	25 (30.9%)	
>26.28	18 (62.1%)	11 (37.9%)	
ASA class wise stratification of hydrostatic reduction			
ASA I	59 (67%)	29 (33%)	0.610
ASA II	44 (71%)	18 (29%)	
Site involved wise stratification of hydrostatic reduction			
Small Bowel	68 (72.3%)	26 (27.7%)	0.209
Large Bowel	35 (62.5%)	21 (37.5%)	
Duration of symptoms wise stratification of hydrostatic reduction			
3-12 hours	35 (67.3%)	17 (32.7%)	0.794
>12-24 hours	68 (69.4%)	30 (30.6%)	
Bleeding per rectum wise stratification of hydrostatic reduction			
Yes	69 (73.4%)	25 (26.6%)	0.105
No	34 (60.7%)	22 (39.3%)	
Procedure time wise stratification of hydrostatic reduction			
30-45 minutes	68 (70.1%)	29 (29.9%)	0.608
>45-60 minutes	35 (66%)	18 (34%)	

respectively. The P-value for this variable was 0.105, indicating no significant difference. Lastly, for the procedure time variable, the success rates for 30-45 minutes and >45-60 minutes were 70.1% and 66%, respectively, with a p-value of 0.608, indicating no significant difference.

Discussion:

The aim of this study was to evaluate the outcome of ultrasound-guided hydrostatic reduction (USGHR) in pediatric intussusception at Lady Reading Hospital, Peshawar. The results of the study showed that the overall success rate of the procedure was 68.7%, with a failure rate of 31.3%. The success rate was not affected by age, gender, BMI, ASA class, site involved, duration of symptoms, or bleeding per rectum. The success rate of hydrostatic reduction in this study is consistent with previous studies that have reported success rates ranging from 65% to 90%. A study by Liu et al. (2020) reported that success rate of USGHR was 95.80%, higher than that of the fluoroscopy-guided air reduction (FGAR) 93.13%, with low recurrence rate in USGHR i.e., 9.28%, lower than that of FGAR group which was 10.65%.[13]

In terms of the variables analyzed in this study, none of them had a significant effect on the success rate of hydrostatic reduction, this finding is consistent with the study done by Kusmayadi DD et al, who reported that failure or success was not affected by any of the variables like age, gender, duration of surgery, or duration of symptoms. However, the failure rate in our study was higher than some previous studies, as several studies have shown higher success rate.[13-15]

Non-operative reduction of intussusception using barium, saline or air enema under ultrasound or fluoroscopic guidance has now become the gold standard treatment of intussusception in the developed world. With the wide spread adoption of hydrostatic reduction under ultrasound guidance, reported data indicates colossal success rates commensurate to, or superior than barium or pneumatic reduction under fluoroscopic guidance. The acceptance of ultrasound-guided hydrostatic reduction (USGHR) as the treatment of choice has been lagging in many developing countries including Pakistan due to delayed patient presentation, mis-management of patients at peripheral health care facilities due to lack of equipment and expertise to undertake the procedure.[16] Moreover, surgical treatment in developing countries is associated with high mortality rate in comparison to its developed counter parts, thus emphasizing the need for more developing nations to adopt ultrasound-guided hydrostatic reduction.[18]

To benefit from non-operative reduction, health care professionals need to have high index of suspicion in addition to public awareness so that mis-diagnosis and delayed presentation can be prevented. In this study, ultrasound-guided hydrostatic reduction was successful in 68.7%, which is commensurate to that obtained by Wakjira et al, In the present series, success is

comparable to the data of other workers who reported success rate of ultrasound-guided hydrostatic reduction to be more than 82%.[19] A low success rate of 55.6% for ultrasound-guided hydrostatic reduction was found by Ogundoyin et al, in Nigeria whereas Wakjira et al. recently recorded an 87.2% reduction rate in their series.[20-24] A 100% success rate for hydrostatic reduction with saline was achieved by Sanchez et al, in their series of 14 children. Recurrence rate following successful non-operative reduction of intussusception varies in literature from 5 to 20%, with a greater incidence in those with pathological lead point.[25,26]

Majority of the recurrences primarily occur within the first 48 hours but recurrences as late as 1.5 years afterwards have been reported.[27-29] Recurrent intussusception, even if it occurs multiple times, is responsive to treatment with ultrasound-guided hydrostatic reduction.[26]

In our study, age and gender of the patients had no effect on the successful outcome of hydrostatic reduction, which is commensurate with most studies.[23,30] Nonetheless, Nayak et al, and Eklof et al, noticed a lower rate of successful reduction in young infants in comparison to older children.[21,27] They opined that this could be due to greater competency of ileo-caecal valve in the very young, which impedes the flow of contrast into the terminal ileum there by lowering the rate of successful reduction. In addition, duration of symptoms of the patient is also an important prognosticator of the outcome in non-operative reduction of intussusception.

Wong et al, in their series of non-operative reduction of intussusception found that a mean duration of 2.3 days had no influence on the successful outcome of reduction.[29] This is in contra distinction to the study done by Chung et al. who found that long duration of symptoms (>24 hour) was a harbinger of surgical reduction. Khorana et al, reported that intestinal viability in lieu of long standing duration of symptoms is an important prognostic factor for failed reduction.[30,31]

In our series, the duration of symptoms had no influence on the successful outcome of non-operative reduction of intussusceptions, which is in resonance with some series.[30,32] Bowel perforation, as a complication of ultrasound-guided hydrostatic reduction, has a low incidence in the literature, ranging from 0 to 10%.[19-22] Over distension of the bowel with fluid is always a risk factor for perforation, however, majority cases of perforation with ultrasound-guided hydrostatic reduction are believed to have happened before the procedure, making it unavoidable.[21] This pertinent finding emphasizes the need for proper patient selection clinically along with the use of color Doppler ultrasound to evaluate the vascularity of the bowel antecedent to reduction. Nonetheless, bowel perforation due to over distension or overlooked intestinal gangrene should not deter the application of ultrasound-guided hydrostatic reduction of in limited resource hospitals with no facilities for hydrostatic pressure control.

Ultrasound-guided hydrostatic reduction of intussusceptions using normal saline is an effective non-operative method of treating intussusceptions in children with a successful outcome of 68.7% in our study. The procedure is safe, simple, and economical in a limited resource setting. Authors recommend that ultrasound-guided hydrostatic reduction should be adopted as the procedure of choice for the management of intussusceptions in children in health care facilities where amenities and expertise are at one's disposal.

Overall, the results of this study suggest that ultrasound-guided hydrostatic reduction is a safe and effective treatment option for pediatric intussusception. However, further studies are needed to identify predictors of success and failure of the procedure and to compare its efficacy with other treatment options such as surgery.

Conclusion:
Hydrostatic reduction under ultrasound guidance has acceptable success in the management of intussusception under 3 years of age. We recommend more studies on larger sample sizes

and multicenter studies to report clear efficacy of hydrostatic reduction and factors which can affect its efficacy before recommending future research and treatment directions.

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Role and contribution of authors:

Naseem Khan, collected the data, references and did the initial writeup.

Khawar Saeed, collected the data and helped in introduction writing.

Amir Mohammad, collected the data, references and helped in introduction and discussion writing.

Ubaid Ullah Khan, collected the data, references and helped in discussion and result writing.

Nazeer Hussain, critically review the article and made the final changes.

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