Original Article

Management of Intussusception in Children: A Comparative Study of Hydrostatic Reduction with Saline under Ultrasound Guidance versus Laparoscopic Assistance

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Abstract

Introduction: Intussusception is a common cause of intestinal obstruction in infants and children. Ultrasound-guided hydrostatic reduction (USGHR) with saline is considered the gold standard with a success rate of more than 90%. Hydrostatic reduction with laparoscopic assistance has its own advantage of direct visualisation, assessment of bowel vascularity and controlled distension. The choice of procedure depends on available resources and surgeon's preference. This study aims to compare the outcomes of the two methods, i.e., laparoscopic-assisted hydrostatic reduction (LAHR) and USGHR under general anaesthesia (GA). **Materials and Methods:** This was a prospective study carried out at two different centres over a 3-year period. All patients of intussusception were managed by either hydrostatic reduction with saline under ultrasound guidance or hydrostatic reduction with laparoscopic assistance. Both the procedures were done in operation theatre under GA. The operating time and amount of fluid used for reduction were noted. **Results:** There were 27 patients in Group 1 (USGHR) and 20 patients in Group 2 (LAHR). The two groups were similar in terms of demographic parameters. The various outcomes such as number of attempts for reduction, fluid required for reduction, time to start oral feeds, complication and length of stay were similar in both the groups. The mean operating time for Group 1 was 19.4 ± 4.5 min and for Group 2 was 34.9 ± 4.8 min ($P < 0.001$). **Conclusion:** Both the procedures fare equally in terms of outcome except mean operating time, therefore, LAHR is a good alternative to USGHR in resource-poor nations where logistics of intraoperative ultrasound may not be present.

Keywords: Hydrostatic reduction, intussusception, laparoscopic assistance

Introduction

Intussusception is the telescoping or invagination of a portion of intestine (intussusceptum) into an adjacent segment (intussuscipiens). It is a common cause of intestinal obstruction in infants and children. Ultrasonography (USG) has a high sensitivity and specificity in diagnosing this condition.[1,2] Management of intussusception varies between centres and surgeons. Non-invasive methods such as hydrostatic reduction and pneumatic reduction under ultrasound guidance or fluoroscopy guidance are preferred options. Ultrasound-guided hydrostatic reduction (USGHR) with saline is considered the gold standard with a success rate of more than 90%.[3] Laparotomy is reserved for complications such as perforation peritonitis or haemodynamic instability. Laparoscopic reduction has been utilised for cases where non-invasive methods of reduction have failed or are likely to fail due to delayed presentation, recurrent cases and those with a pathological lead point.[4] It has also been used as a primary modality for reduction of intussusception.[5] Laparoscopy has its unique advantage of real-time visualisation of reduction and ability to ascertain bowel vascularity and also perform resection anastomosis if required. However, it is not the first choice amongst most of the surgeons due to fear of bowel injury

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due to traction on the bowel during reduction. In order to avoid any such injury, hydrostatic reduction performed under laparoscopic assistance has been proposed as a safe and effective alternative.[6] This method has all the benefits of laparoscopy and also avoids the risk of any bowel injury due to minimal bowel handling. This study compared the outcomes of the two methods, i.e., laparoscopic-assisted hydrostatic reduction (LAHR) and USGHR under general anaesthesia (GA) in operation theatre (OT).

Materials and Methods

This is a prospective non-randomised comparative study of two different techniques of management, both of which are established methods of treatment depending upon the surgeon's preference and available resources. This study was carried out at two tertiary care hospitals over a 3-year period. One centre routinely performed hydrostatic reduction under ultrasound guidance and the other centre carried out hydrostatic reduction with laparoscopic assistance. Both the procedures were done by paediatric surgeons with the help of radiologists for ultrasound guidance. Institutional ethics committee approval was obtained prior to the conduct of the study.

Inclusion criteria

All children presenting with intussusception who underwent hydrostatic reduction under ultrasound guidance or LAHR were included in the study.

Exclusion criteria

The exclusion criteria of this study were as follows:

1. Any evidence of perforation/peritonitis
2. Small-bowel intussusception
3. Failure of reduction or recurrence (in follow-up USG) after successful hydrostatic reduction.

The procedure and associated risks were explained to the parents, and informed written consent was obtained. The patients were resuscitated with IV fluids. In addition, intravenous ceftriaxone and metronidazole were given and consent was taken for open surgery in the case of failure of reduction or any complication arising during the procedure. After induction of GA, an initial abdominal ultrasound scan was done again by a radiologist to confirm the presence of intussusception and rule out any free air in peritoneal cavity. A well lubricated 16–20-Fr Foley catheter was inserted into the rectum for a distance of 7–10 cm from anal verge, and the balloon of the catheter inflated with 15–20 ml saline to make it fit snugly in the rectum thereby preventing any leak of saline from rectum. A 500ml bottle of normal saline was connected to the Foley catheter and the bottle was hung at a height of 3 feet above the operation table to exert adequate hydrostatic pressure [Figure 1]. The advancing column of saline inside the colon was seen on ultrasound as it moved upward through the lumen of the colon and exerted pressure on the intussusceptum to reduce it. In case the reduction was not achieved in the first attempt, this procedure was repeated three times, each for 5–10-min duration of water head pressure. Failure of complete reduction even after three attempts was an indication for surgery [Figure 2a-d].

The intussusception was only said to have been reduced if the following criteria were met:

1. Disappearance of the intussusceptum on sonography
2. Visualisation of reflux of fluid and air bubbles across the ileocaecal valve into terminal ileum
3. Demonstration of fluid distended ileum.

On completion of the procedure, the fluid was evacuated. USG also checked for the presence of any free fluid or inter-bowel fluid suggestive of perforation. After successful reduction, the patient was kept nil orally for 6–12 h after which a repeat USG was done to exclude recurrence and then oral feeds were gradually started. Patients were discharged only when they tolerated a normal diet.

Patients who underwent laparoscopic guidance underwent a similar hydrostatic reduction under GA without any ultrasound guidance. A 5-mm telescope was inserted through an umbilical port, and two more 5-mm working ports were used. The reduction was said to be complete when the ileocaecal junction was clearly seen without any invaginating bowel. Port site was infiltrated with local anaesthetic, and analgesics were given for the first 24 h and then as required.

Operating time was calculated in the USGHR as the time between insertion of Foley catheter in the rectum and the time of catheter removal. In the second group, the operating time was calculated from the time of insertion of catheter in the rectum to the time of closure of the port sites. The amount of fluid used for reduction was also noted after completion of procedure.

Results

During the study period, 52 cases of intussusceptions were managed. Twenty-nine patients were taken up for USGHR, of which 27 underwent successful hydrostatic reduction with ultrasound guidance. Twenty-one patients were taken up for hydrostatic reduction with laparoscopic assistance and 20 underwent successful reduction with laparoscopic assistance. There were two cases where USGHR failed. In the first case, reduction could not be achieved due to oedematous bowel

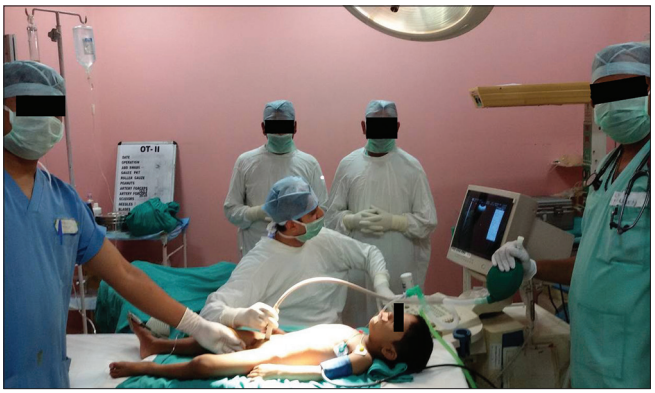


Figure 1: Patient position with anaesthetist at the head end, surgeon at the foot end and radiologist to the right of the patient

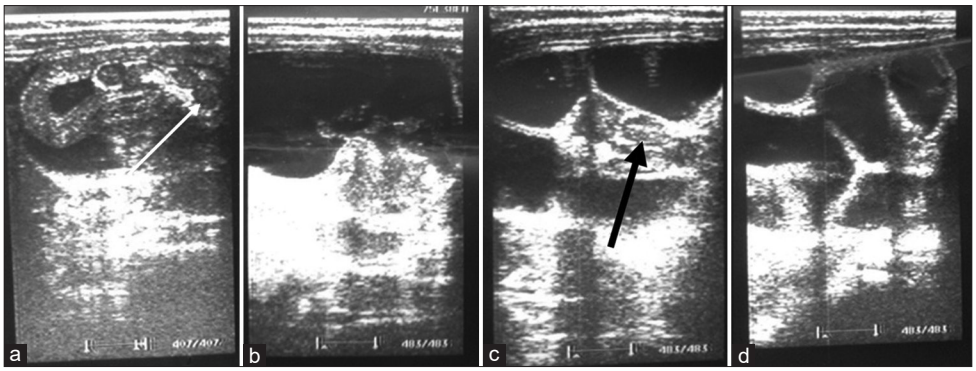


Figure 2: Ultrasound picture of stages of reduction of intussusception (a) Intussusception with mesenteric nodes shown with white arrow. (b) Reducing intussusception as seen during hydrostatic reduction. (c) Reduced intussusception with mesenteric nodes shown with black arrow. (d) Free flow of saline through ileocaecal junction into small bowel after complete reduction

Table 1: Comparison of demographic parameters

Demographic characteristics	Group 1 – USGHR (*n*=27)	Group 2 – LAHR (*n*=20)	*P*
Mean age (months) (range)	11.6±5.4 (6-54)	9.7±4.8 (5-60)	0.641
Sex (male: female)	17:10	13:7	0.512
Mean duration of symptoms (h) (range)	26.4±20.7 (6-96)	23.6±15.3 (8-48)	0.659

USGHR: Ultrasound-guided hydrostatic reduction, LAHR: Laparoscopic-assisted hydrostatic reduction

Table 2: Comparison of outcomes between the two groups

	Group 1 (*n*=27)	Group 2 (*n*=20)	*P*
Attempt	One-24	One-18	0.326
	Two-1	Two-2	
	Three-2	Three-0	
Mean fluid requirement (ml)	690±370	800±300	0.361
Time to oral feeds (h)	<24=18	<24=10	0.885
	24-36=6	24-36=9	
	>36=3	>36=1	
Post-operative complication	3	1	1.000
LOS (h)	46.4±6.4	51±5.2	0.610
Operating time (min)	19.4±4.5	34.9±4.8	<0.001

LOS: Length of stay

and undergoing open surgery. The second case of failed USGHR had a pathological lead point (Meckel's diverticulum). One patient underwent upfront exploratory laparotomy for peritonitis and intraoperatively was found to have perforation due to intussusception. One patient developed recurrence after successful USGHR; this was detected in the follow-up ultrasound done the next day. This patient underwent repeat USGHR and recovered completely. These four cases have been excluded from the study. In the 21 patients who underwent hydrostatic reduction with laparoscopic assistance, 20 were successfully reduced. One case was found to have gangrenous bowel for which an open resection and anastomosis was done by extending the umbilical port. This patient was also excluded from the study.

There were 27 patients in Group 1 (USGHR) and 20 patients in Group 2 (LAHR). The demography of patients in both the groups is shown in Table 1 and outcomes have been compared in Table 2.

In Group 1, 24 (89%) patients required a single attempt for reduction, one patient required two attempts and two patients required three attempts to reduce the intussusception. The average amount of fluid required was 690 ± 370 ml. Post-operative complication was seen in three cases. Ileus was seen in two cases and haematochezia in one. All three resolved with conservative management and delaying of oral feeds. The time to oral feeds was <24 h in 18 cases and between 24 and 36 h in 6 cases, and only 3 cases (two with ileus and one with haematochezia) required withholding of feeds for 36 h. The mean operating time was 19.4 ± 4.5 min. The average length of stay (LOS) was 46 ± 6.4 h.

In Group 2, 18 patients required a single attempt for reduction and two patients required two attempts to reduce the intussusception. The mean fluid requirement was 800 ± 300 ml. Post-operative complication in the form of ileus was seen in one patient, which resolved with conservative management. The time to oral feed was up to 24 h in ten cases and between 24 and 36 h in nine cases, and only one case required withholding of feeds for 48 h. The mean operating time was 34.9 ± 4.8 min. The average LOS was 51 ± 5.2 h.

Discussion

In this study, intussusception was managed by two established techniques. The results show that the two groups were similar in terms of age at presentation, sex distribution and duration of symptoms. The mean age of presentation in this study was similar to that described by Fahiem-Ul-Hassan *et al*.,[3] and sex distribution in our study was similar to other studies on

the subject.[7-9] The mean duration of symptoms as seen in our study is similar to those reported by Flaum *et al*.[9] and Xiaolong *et al*.[10]

Ninety per cent of the reductions were achieved in single attempt in both the groups; this is slightly less than the value of 93%–95% reported in the literature.[9] The two study groups did not show any significant difference in number of attempts taken to reduce the intussusception, mean fluid required for reduction and time required to start oral feeds. The time to start oral feeds was <24 h in 67% (Group 1) and 50% (Group 2). Nearly all patients could be started on orals within 36 h of either procedure except for those who developed ileus or haematochezia. The time to oral feed was slightly higher due to the protocol of repeating the ultrasound after 6–12 h. Only one patient showed recurrence on repeat USG (excluded from the study). Although repeating an USG is common practice to detect early recurrence, some recent studies have found that it may not be necessary and orals can be started early.[11] The complications and recurrences after hydrostatic reduction are rare; patients can be safely discharged once they are pain free and have resumed oral feeds.[12,13]

The length of hospital stay (LOS) was slightly higher in Group 2, but this difference was not statistically significant. LOS in our study for USGHR was almost 48 h which was slightly higher than other studies.[3,14] This was again attributed to the practice of post-operative check USG and discharge only after satisfactory oral intake. LOS for laparoscopic reduction varies between 3 and 5 days as per various studies.[14-16] We had a shorter hospital stay (51 h) in the laparoscopy group as compared to the above studies. Our LOS was closer to the 2.1 days mentioned by Chandrasekharam *et al*.[6]

The mean operating time in Group 1 was 19.4 ± 4.5 min and in Group 2 was 34.9 ± 4.8 min. This difference was significant ($P < 0.001$). The laparoscopy-assisted group took almost twice the time as compared to USG-guided reduction. The time taken for the procedures in our study was similar to other studies.[6,17,18] The volume of fluid infused for achieving reduction did not show any significant variation between the two groups and was similar to that observed by other authors.[18]

Both the procedures were equally safe and well tolerated with minor complications such as post-operative ileus and haematochezia which resolved spontaneously. There was no case of bowel perforation or injury in either of the two groups.

USG-guided hydrostatic reduction has often been referred to as a gold standard procedure as it is simple, non-invasive, has no radiation hazard compared to fluoroscopy and takes less time.[4,18-20] Performing the procedure under GA by paediatric surgeons ensures absolute patient comfort and allays parental anxiety. Several studies have shown the beneficial effects of sedation/GA in achieving reduction.[21-23] Wiersma and Hadley,[24] Chandrasekharam *et al*.[6] and Chand *et al*.[25] have observed that there is a definite advantage of reduction in a controlled environment in the operating theatre under GA. The child is totally relaxed and pain free, which abolishes the negative effects of straining by the child, allowing the hydrostatic force within the lumen to act unopposed. This may help in increasing the chances of reduction. Since the procedure was done under GA and in the OT, it had flexibility of converting into a surgical procedure immediately in the case of any complication arising during the procedure or any failure of reduction. However, the drawback of this procedure is requirement of additional logistics of intraoperative ultrasound and the presence of a trained radiologist throughout the procedure. This may not be feasible at all centres and resource-poor nations.

LAHR has all the benefits of hydrostatic reduction and does not require any additional logistics as the procedure is entirely performed by paediatric surgeons. Various studies have shown the safety and efficacy of laparoscopy in intussusception.[14,26,27] Laparoscopy combined with air or saline enema has also been seen to increase the rates of reduction.[26,28,29] It has the advantage of direct visualisation of reduction, and amount of bowel distension can be seen real time, thereby risk of inadvertent perforation is reduced. Vascularity of the bowel can also be assessed along with completeness of reduction with laparoscopic assistance, and gentle traction can be applied if needed to aid reduction.[30,31] As compared to USGHR, laparoscopy is an invasive procedure and may not be possible in the presence of gross abdominal distension and duration of surgery is significantly increased.

Since both the procedures fare equally in all other aspects, LAHR can be used as a safe alternative when USGHR is not feasible or not available.

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Conflicts of interest

There are no conflicts of interest.

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