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Comparative Study between Ultrasound-Guided and Laparoscopic-Guided Hydrostatic Reduction of Pediatric Intussusception: A Randomized Clinical Trial

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ABSTRACT

Background: Ileocolic intussusception is the highly prevalent reason of intestinal obstruction in children < 2 years. In the majority, ileocolic intussusception treatment involves imaging-guided hydrostatic or pneumatic reduction.

Objective: This study aimed to evaluate laparoscopic-guided hydrostatic reduction (LGHR) and ultrasound-guided hydrostatic reduction (UGHR) safety and efficacy in management of pediatric intussusception.

Methods: This randomized clinical prospective trial enrolled 60 children who had intussusception at General Surgery Department, Tanta University Hospitals. By employing a computer-generated list of random numbers, they were divided randomly into two equal groups of patients. Group A had USGHR and group B had LGHR. Comprehensive clinical examination, laboratory investigations, and history-taking were done to all patients.

Results: Regarding the outcome, the oral feeding was significantly earlier in group A (USGHR group) than in group B (LGHR group) (8.97± 2.04 hrs. vs. 17.37± 3.2 hrs. P<0.001). The successful reduction rate (96.67% vs. 90%) and recurrence rate within 24 h (3.33% vs. 6.67%) were insignificantly different between both groups. No mortality was reported in the current study.

Conclusions: We concluded that USGHR is a harmless, effective, and less invasive approach for pediatric intussusception management compared to LGHR. The success rate was insignificantly different but USGHR associated with short hospital stays, earlier initiation of feeding and less complications. However, LGHR, despite being slightly less successful overall in this study, had provided unique advantages.

Keywords: Ultrasound-guided, Laparoscopic-guided, Hydrostatic, Reduction, Pediatric, Intussusception.

INTRODUCTION

The ileocolic intussusception is the most common cause of intestinal obstruction in infants and children below 2 years old, which occurs when terminal ileum passes through the ileocecal valve and enters the colon [(1)]. The vascular supply of the bowel is frequently impaired by the small intestine invagination into the large bowel, followed by ischemia that can result in necrosis and maybe intestinal perforation, peritonitis, shock, and even mortality besides mechanical bowel obstruction [(2)]. The preservation of bowel integrity and the prevention of complications and mortality are contingent upon the early diagnosis and prompt intussusception treatment. Pneumatic or hydrostatic reduction under imaging guidance is the most prevalent treatment modalities for ileocolic intussusception [(3)].

Intussusception is often treated through surgical or non-surgical reduction. Non-operative pressure reduction is the preferred alternative in the absence of contraindications documented intestinal obstruction, bowel perforation, and peritonitis [(4)]. There is a risk of intestinal perforation and radiation exposure associated with the non-surgical hydrostatic reduction of an intussusception under fluoroscopic guidance using barium enema or pneumatic reduction [(5)]. Nevertheless, the use of barium contrast for reduction, which carries radiation risks, has been supplanted by ultrasound-guided hydrostatic reduction (USGHR) **[(6)]**.

Kim et al. **[(7)]** was the first to define hydrostatic reduction. The USGHR associated with minimal morbidity and mortality, which made it the best method for intussusception reduction in children, versus surgical treatment. The gold standard is USGHR with saline, which has a success rate exceeding 90% [(8)].

In situations where non-invasive reduction methods have failed or are at risk of failure due to recurrent cases, delayed presentation, or those with a pathological lead point, laparoscopic reduction has been implemented [(9)].

It has also been used as a primary modality for reduction of intussusception. Laparoscopy is distinguished by its capacity to perform resection anastomosis if required and to determine the vascularity of the bowel and real-time visualisation of reduction [(10)]. Nevertheless, it is not the preferred method among the majority of surgeons due to the potential for bowel injury, which may result from the traction on the intestine during the reduction process. Hydrostatic reduction is the secure and effective alternative to preventing a similar damage carrying out under laparoscopic assistance [(11)].

There is currently a scarcity of data available of the various reduction procedures complexity and the impact of success rate of the procedure. So, the objective of this trial was to compare laparoscopic-guided and ultrasound-guided hydrostatic reduction safety and efficacy of pediatric intussusception in order to clarify this understudied subject.

PATIENTS AND METHODS

This prospective randomized research study was conducted on 60 children who had intussusception at the General Surgery Department at Tanta University Hospitals throughout the 12-month period of January 2023 to December 2023.

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Inclusion criteria: Any pediatric patient diagnosed with intussusception by US presenting with intussusception hemodynamically stable and the start time of intussusceptions within the first 24-hour and patients who completed hydrostatic reduction under USGHR or LAHR.

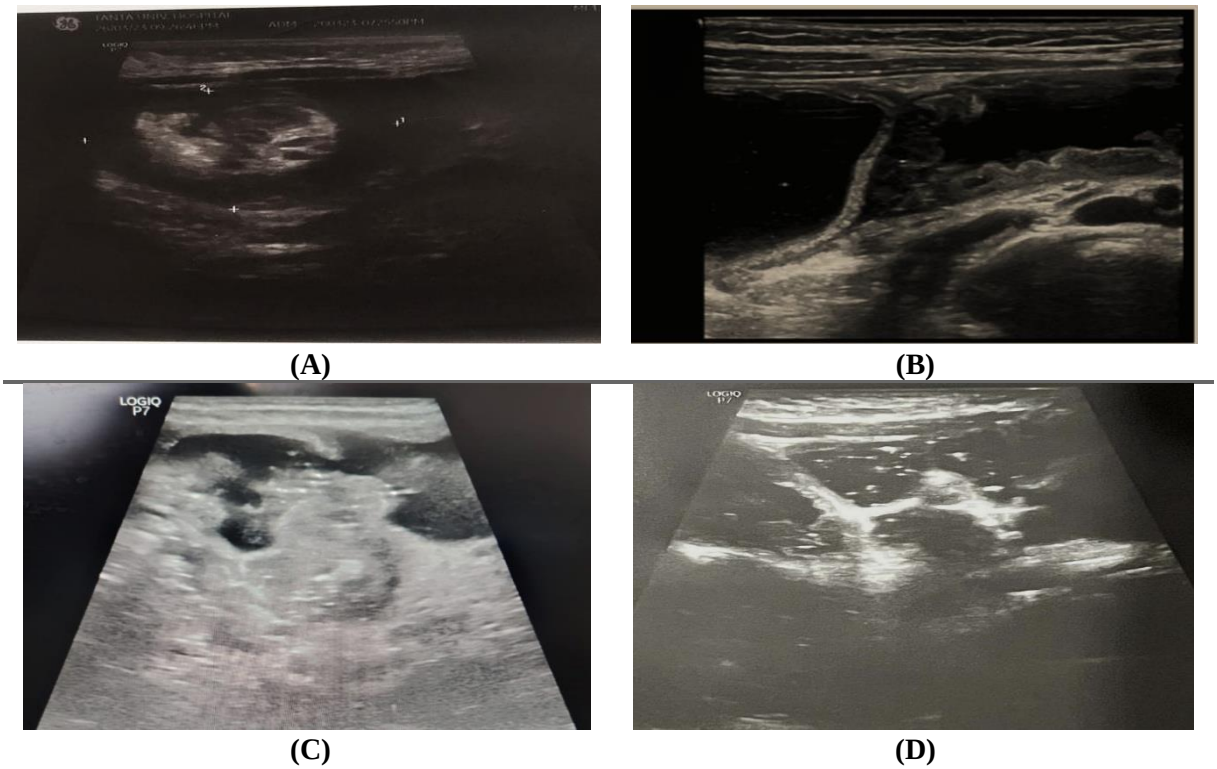
Exclusion criteria Children with timing of intussusception's symptom of bilious vomiting more than 24-hour and signs of peritonitis (either clinically suspected or radiologically suspected through pneumoperitoneum on X-ray), ascites on abdominal sonogram and impaired intestinal blood flow on ultrasound-Doppler. Additionally, associated comorbidity including type 1 diabetes mellitus (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.

Randomization: A computer-generated list of random numbers was used to randomly allocate the participants into two equal groups on a scale of 1:1. The list was enclosed in an opaque envelope.

- Group A included 30 patients had USGHR.
- Group B included 30 patients had LGHR.

A comprehensive history, clinical examination, and laboratory investigations, including a preoperative complete blood count (CBC), were administered to all patients.

Group A: The rectum is entered through a large-bore (24 French) Foley catheter, to ensure a seal, the catheter is gently pulled back against the anorectal junction and the balloon is inflated. The catheter is then taped in position and secured to the buttocks. The colon is then introduced to tepid saline at a rate of 50 ml/KG. To facilitate the reduction, the ultrasound machine is employed until the mass surpasses the ileocecal valve. Once the colonic fluid has been completely reduced, it is successfully evacuated. The intussusception is exclusively considered to have diminished if the following criteria are met: the intussusceptum has vanished, the ileocecal valve has allowed for ascending colon into the ileum and the reflux of air bubbles and fluid through the caecum, and the post-evacuation ultrasound examination has demonstrated a fluid-dilated ileum and the absence of the intussusceptum [(12)]. The fluid was evacuated upon the procedure's conclusion. Additionally, the USG examined for the presence of any unrestricted fluid or inter-bowel fluid that could indicate a perforation. Following effective reduction, the patient was maintained at a nil orally for 6–12 hours. Consequently, oral feeds were gradually initiated, and a subsequent USG was conducted to exclude the possibility of recurrence. Upon demonstrating the ability to tolerate a regular diet, patients were discharged (Figure 1 A –D).



(A) **(B)**

(C) **(D)**

Figure (1): (A) US showing the target sign of intussusception, (B) ilium and cecum filled with saline after successful USGHR, (C) Thickened Ileo-cecal valve after successful USGHR, (D) Ileal loops distended with fluid after successful USGHR

B: The Foley catheter was inserted into the anus and advanced slightly to ensure that it was placed above the anal sphincters and within the rectum after the patient was in a supine position and anaesthesia was inducted. In the Foley catheter a balloon was distended. A seal was maintained by gently pulling the catheter back against the anorectal junction, and it was then secured to the buttocks with tape. I then employed the open method to insert a 5 mm trocar through an umbilical incision.

Into the peritoneal cavity was inserted a 5 mm 30-degree telescope. The first step was to ascertain whether the intussusception was still present. After that, tepid saline (50 ml/KG) was permitted to enter the colon. If the bulk did not decrease, two 5 mm trocars were inserted in the left upper and lower quadrant upon confirmation of an existing intussusception. Two 5 mm trocars were implanted in the left lower quadrant and suprapubic area when the intussusceptum was situated in sigmoid colon or descending colon. At first, the intussusceptum's leading margin was identified. Gradually and gently squeeze the most distal portion of the intussusceptum back toward the cecum using two atraumatic graspers to the greatest extent feasible.

A meticulous examination was performed following the reduction to rule out the existence of a pathologic lead site and to evaluate for any signs of necrosis, perforation, or ischemia. A repeat USG was performed to rule out recurrence, and oral feeds were progressively initiated after the patient was kept nil orally for 12–24 hours. Patients were discharged only after they were able to tolerate the typical diet (Figure 2).

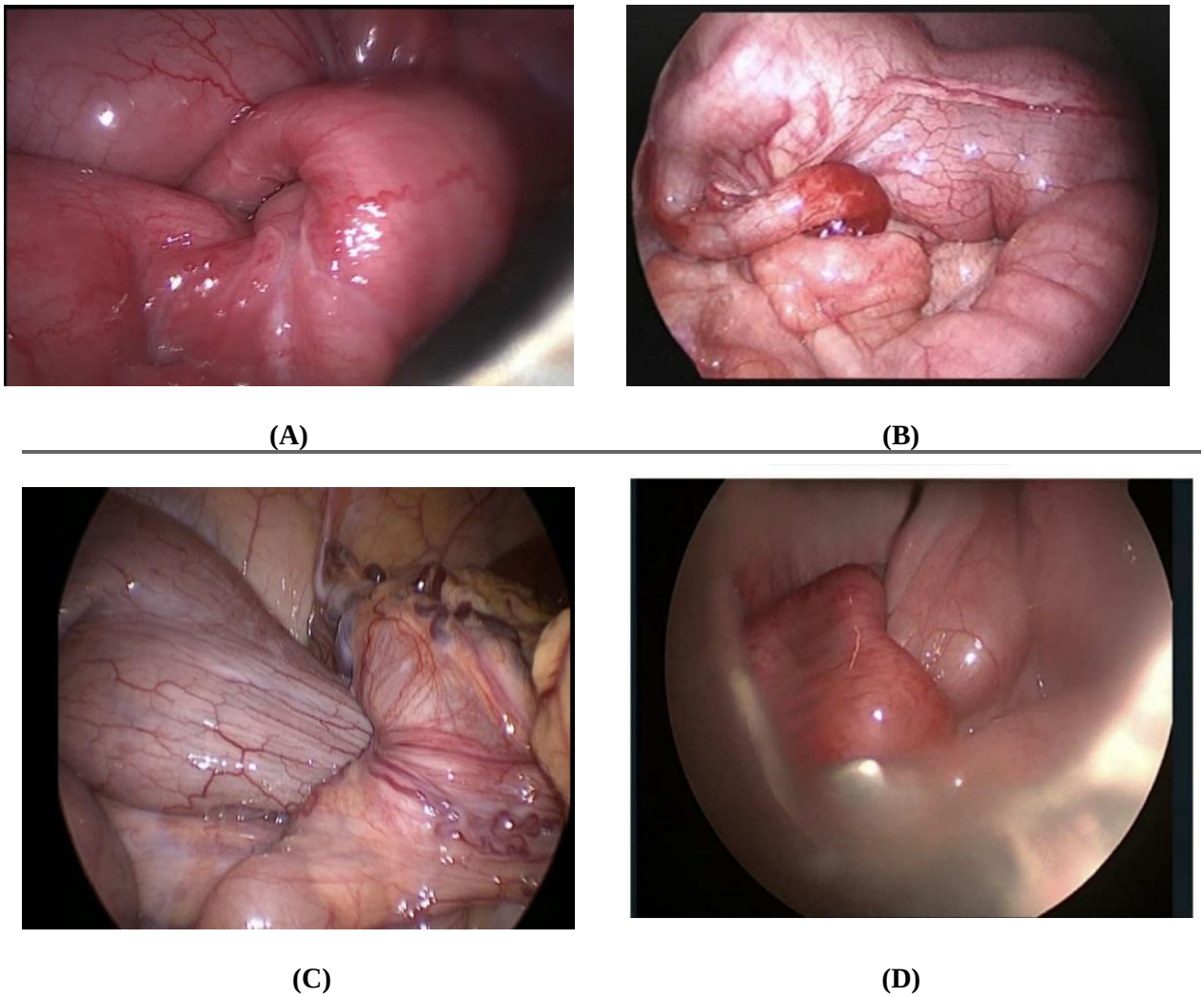


Figure (2): (A, B) Ileocecal intussusception, (C) intussusception due to inverted Meckel's diverticulum, (D) Ilium and cecum distended with saline after successful LGHR and inflamed appendix.

Outcome: Effective hydrostatic reduction, unsuccessful hydrostatic reduction with later on surgical intervention, and recurrence of intussusception following successful reduction were the outcome measures. The definition of successful reduction was the complete desertion of the intussusceptum, which was achieved by passing saline into the ileum. In the event that the intussusceptum could not be completely reduced or the procedure was exacerbated by perforation, the authors defined failed reduction as a situation that necessitated a mid-course abandonment [13].

Ethical approval: The investigation was approved by the Ethical Committee of Tanta University Hospital with the approval code 36264MS48/1/23. Parents of patients were granted informed consent prior to their enrolment in this investigation. The Declaration of Helsinki was adhered to during the research. This investigation comports with the CONSORT recommendations.

Statistical analysis

We utilized SPSS version 28 (IBM Inc., Armonk, NY, USA) for this statistical analysis. When comparing the two groups on the quantitative variables means and SD were used. This study utilized an unpaired Student's t-test. Fractions and percentages were used to represent qualitative factors. Fisher's exact test and Chi-square were mainly used for data analysis. When the two-tailed P value was ≤ 0.05, we knew that we had reached statistical significance.

RESULTS

93 patients were evaluated for eligibility in this study; 24 patients did not satisfy the criteria, and 9 patients declined to participate. The remaining 60 patients were randomly assigned to two categories, with 30 patients in each. The statistical analysis and follow-up of all allocated patients were conducted (Figure 3).

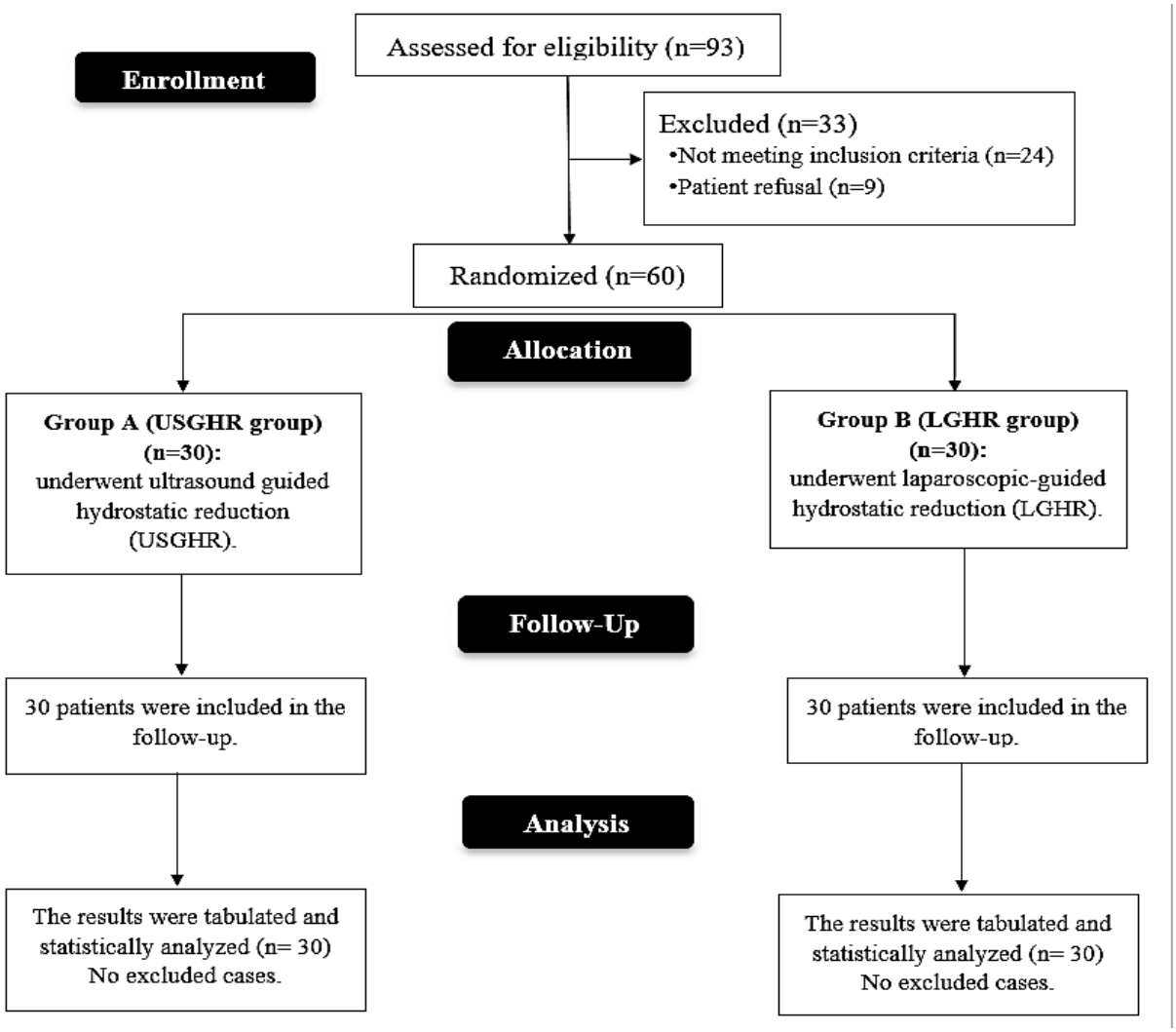


Figure 3: CONSORT flowchart of the enrolled patients.

Table **(1)** demonstrated that the duration of symptoms, sex, age, and weight were insignificantly different between the 2 groups.

Table (1): Baseline characteristics of the studied groups

		Group A (USGHR group) (n=30)	Group B (LGHR group) (n=30)	P value
Age (months)		19.37± 7.41	18.1± 7.12	0.502
Sex	**Male**	21 (70%)	17 (56.67%)	0.283
	Female	9 (30%)	13 (43.33%)	
Weight (kg)		18.27± 5.56	18.33± 5.76	0.964
Duration of symptoms (hrs.)		31.33± 12	27.57± 14.8	0.283

Data presented as mean ± SD or frequency (%), USGHR: ultrasound guided hydrostatic reduction, LGHR: laparoscopic-guided hydrostatic reduction.

The operative time was significantly shorter in group A (USGHR group) than in group B (LGHR group) (21.97± 4.66 min vs. 41.83± 9.23 min, P<0.001). The attempts number was similar between both groups (Table 2).

Table (2): Operative data of the studied groups

		Group A (USGHR group) (n=30)	Group B (LGHR group) (n=30)	P value
Operative time (min)		21.97± 4.66	41.83± 9.23	**<0.001***
No. of attempts	**One**	29 (96.67%)	27 (90%)	0.495
	Two	1 (3.33%)	2 (6.67%)	
	Three	0 (0%)	1 (3.33%)	

Data presented as mean ± SD or frequency (%), USGHR: ultrasound guided hydrostatic reduction, LGHR: laparoscopic-guided hydrostatic reduction, *: statistically significant as p value ≤0.05.

There was insignificant difference between both groups regarding the incidence of postoperative complications and the hospital stay (Table 3).

Table 3: Hospital stay and postoperative complications of the studied groups

	Group A (USGHR group) (n=30)	Group B (LGHR group) (n=30)	P value
Hospital stay (hrs.)	38± 8.54	41.07± 5.35	0.101
Postoperative complications	0 (0%)	1 (3.33%)	1.00

Data presented as mean ± SD or frequency (%), USGHR: ultrasound guided hydrostatic reduction, LGHR: laparoscopic-guided hydrostatic reduction, *: statistically significant as p value ≤0.05.

Regarding the outcome, the oral feeding was significantly earlier in group A (USGHR group) than in group B (LGHR group) (8.97± 2.04 hrs. vs. 17.37± 3.2 hrs, P<0.001). The successful reduction rate (96.67% vs. 90%) and recurrence rate within 24 h (3.33% vs. 6.67%) were insignificantly different between both groups. No mortality was reported in the current study (Table 4).

Table 4: Outcome of the studied groups

	Group A (USGHR group) (n=30)	Group B (LGHR group) (n=30)	P value
Oral feeding (hrs.)	8.97± 2.04	17.37± 3.2	**<0.001***
Successful reduction rate	29 (96.67%)	27 (90%)	0.612
Recurrence rate within 24 h	1 (3.33%)	2 (6.67%)	1.000
Mortality	0 (0%)	0 (0%)	---

Data presented as mean ± SD or frequency (%), USGHR: ultrasound guided hydrostatic reduction, LGHR: laparoscopic-guided hydrostatic reduction, *: statistically significant as p value ≤0.05.

DISCUSSION

The age was insignificantly different between the studied groups, where the mean age was 19.37 ± 7.41 months in USGHR group and was 18.1 ± 7.12 months in LGHR group. Nevertheless, **Moussa *et al.*** [14] reported that the ages of the children at the time of reduction in their study ranged from 6 to 9 months. In line with our findings, **Chandra *et al.*** [12] contrasted the results of LAHR and USGHR, under general anaesthesia (GA) and showed that two established techniques were effective in managing intussusception. The age at presentation and sex distribution were comparable in both groups.

The surgical duration was significantly shorter in group A (USGHR) than in group B (LGHR) (21.97± 4.66 min vs. 41.83± 9.23 min, P<0.001) in our study. **Wie *et al.*** [15] showed 23 and 35 patients in laparotomy and laparoscopic group, separately. The mean surgical duration in LAP group (70.4 ±37.7) was significantly longer. Moreover, **Chandra *et al.*** [12] reported that when compared to the mean operating time in LAHR, which was 34.9 ± 4.8 min and the mean operating time was 19.4 ± 4.5 min in USGHR, which was shorter. However, **Hill *et al.*** [16] in their examination of 92 patients who underwent intussusception treatment (65 in the LAP group and 27 in the OPEN group), the LAP group experienced a shorter operative time (50.3 ±35.1 min.).

In present investigation, the duration of hospitalization was comparable between the two groups. Similar to our findings, **Chandra *et al.*** [12] demonstrated that the duration of hospital stay (LOS) was slightly longer in the LAHR group, however this difference was insignificant. In USGHR study, the LOS was nearly 48 hours, which was slightly longer than that of a previous investigation [17]. LOS for laparoscopic reductions varies between three and five days, according to previous research [18, 19]. **Houben *et al.*** [20] reported similar outcomes. The study was conducted on patients who had undergone a laparoscopic reduction and reported a median LOS of 5 days (range 3-51). The remaining patients underwent a conversion direct open surgery to a laparoscopic approach, and they spent an average of 8 days in the hospital (range 3-14).

We found that success rate was insignificantly different between both groups (96.67% vs. 90%). **Apelt *et al.*** [21] showed that the success rate of the laparoscopic treatment of pediatric intussusception was over 70% among the total number of 276 patients who were treated laparoscopically, according to a systematic review of all publications concerning the subject. The rate of intraoperative (0.4%) and postoperative (2.9%) complications was low. However in study of **Hill *et al.*** [16] reported 70% of the 92 patients treated for intussusception who underwent laparoscopic reduction, which was successful in 68% of the cases.

Regarding the UGHR of intussusception success rate, it was 96.67% in the current study. **Shiekh *et al.*** [13] showed that intussusceptions in children can be effectively treated non-operatively through the use of USGHR with normal saline with a successful outcome of 81.8 % in their study. **Pušnik *et al.*** [6] discovered that ileocolic reduction success rate was 75.2%, which is consistent with the findings of other researchers who have performed intussusception reduction using US-guided enema (57–89%) [22-24]. The reason for this discrepancy may be that the overall success rate in their study was marginally reduced by a few complex cases that were referred from other hospitals. **Abdelmageed *et al.*** [25] demonstrated that reduction was effective in 89.2% of patients. These results were nearly identical to those of other researchers, whose ultrasonic-guided hydrostatic reduction success rate exceeded 84% [26, 27].

In the current study, the recurrence rate within 24 h (3.33% vs. 6.67%) was insignificantly different between both groups. **Abdelmageed *et al.*** [25] showed that The USGHR recurrence rate was 18.7%. The literature indicated that USGHR is a viable treatment option for recurrent intussusception, regardless of the number of occurrences [28]. **Pušnik *et al.*** [6] showed that the USGHR recurrence rate for non-pediatric radiologists 20.0%, pediatric radiologists 26.3%, and radiology residents 5.0%, was respectively. **Chandra *et al.*** [12] demonstrated that only one patient experienced recurrence during a subsequent USG (who was subsequently excluded from the investigation). Despite the fact that it is a common practice to repeat an ultrasound (USG) in order to detect early recurrence, recent research has indicated that it mayn't be essential and that orals can be initiated early [29].

Patients can be discharged safely once they resumed oral feedings and are pain-free. Complications and recurrences following hydrostatic reduction are exceedingly uncommon [30, 31]. Additionally, **Moussa *et al.*** [14] demonstrated that the success rate of hydrostatic reduction performed under general anaesthesia (GA) or muscle relaxant (97.3%) surpasses that of hydrostatic reduction conducted without GA or muscle relaxant (84%). This could be explained by the safety of administering GA to pediatric patients has significantly improved due to advancements in pediatric anaesthesia procedures. GA is capable of relaxing the abdominal muscle tone and reducing the voluntary pressure applied 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. It was capable of promptly transitioning into a surgical procedure in the event of any complications that occurred during the procedure or any reduction failure. Hence, it may be argued that GA is both a safer and more efficacious approach compared to sedation [32]. Similarly, **Chand *et al.*** [33] detected a distinct advantage for reducing the number of patients in a governed environment in operating room under GA. Due to the child's complete relaxation and absence of discomfort,

the hydrostatic force within the lumen is able to operate unopposed, as the adverse effects of exertion are eliminated.

We observed that the rates of reduction can be increased by combining laparoscopy with an air or saline enema. It has direct visualization of reduction advantage, and the extent of bowel distension can be observed in real time, thereby reducing the risk of inadvertent perforation. Laparoscopic assistance can also be used to evaluate the vascularity of the bowel and the extent of reduction. Gentle traction may be employed to facilitate reduction if necessary [(12)]. The study was restricted by a short-term follow-up, a single-center design, and a small sample size.

CONCLUSIONS

We concluded that USGHR is a safe, effective, and less invasive method for the management of pediatric intussusception compared to LGHR. There was no significant difference in success rate but USGHR associated with shorter hospital stays, earlier initiation of feeding and less complications. However, LGHR, despite being slightly less successful overall in this study, it provided unique advantages. Laparoscopy offered direct visualization of the bowel, allowed immediate confirmation of complete reduction & identification of residual or non-reduced segments and pathological lead point such as lymphoid hyperplasia or Meckel's diverticulum detection. Furthermore, if hydrostatic reduction failed, laparoscopy can be converted to definitive therapeutic intervention without the need for formal laparotomy, thereby minimizing surgical trauma and recovery time.

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REFERENCES

1. **Guo H, Lei H, Luo J *et al.* (2025):** Clinical manifestation and treatment of intussusception in children aged 3 months and under : a single centre analysis of 38 cases. BMC Pediatr., 25: 233.https://doi.org/10.1186/s12887-025-05410-4
2. **Williams J, Woodward C, Royall I *et al.* (2022):** Outcomes in pediatric patients with documented delays between ileocolic intussusception diagnosis and therapeutic enema attempt: evaluation of reduction efficacy and complication rate. Emerg Radiol.,29: 953-9.https://doi.org/10.1007/s10140-022-02079-5
3. **Hwang J, Yoon H, Kim P *et al.* (2023):** Current diagnosis and image-guided reduction for intussusception in children. Clin Exp Pediatr., 66: 12-21. https://doi.org/10.3345/cep.2021.01816
4. **Attoun M, Albalawi S, Ayoub A *et al.* (2023):** The Management of Intussusception: A Systematic Review. Cureus.,15: e49481.https://doi.org/10.7759/cureus.49481
5. **Chowdhury T, Ahsan M, Chowdhury M *et al.* (2021):** Hydrostatic reduction of intussusception with intermittent radiography: an alternative to fluoroscopy or ultrasound-guided reduction in low-income and middle-income countries. World J Pediatr Surg.,4: e000221.https://doi.org/10.1136/wjps-2020-000221
6. **Pušnik L, Slak P, Nikšić S *et al.* (2023):** Ultrasound-guided hydrostatic reduction of intussusception: comparison of success rates between subspecialized pediatric radiologists and non-pediatric radiologists or radiology residents. Eur J Pediatr.,182: 3257-64.https://doi.org/10.1007/s00431-023-04987-1
7. **Kim Y, Choi B, Yeon K *et al.* (1982):** Diagnosis and treatment of childhood intussusception using rea-time ultrasonography and saline enema: preliminary report. J Korean Soc Ultrasound Med.,1: 54-67
8. **Bandaranayake G, Erandika H, Hettiarachchi M (2023):** The success of ultrasound-guided hydrostatic reduction in managing delayed presentation of childhood intussusception: A single center experience. JPS Open,4: 100073.https://doi.org/https://doi.org/10.1016/j.yjpso.2023.100073
9. **Zhao J, Sun J, Li D *et al.* (2022):** Laparoscopic versus open reduction of idiopathic intussusception in children: an updated institutional experience. BMC Pediatr.,22: 44.https://doi.org/10.1186/s12887-022-03112-9
10. **Li S, Wu X, Luo C *et al.* (2022):** Laparoscopic approach for managing intussusception in children: Analysis of 65 cases. World J Clin Cases,10: 830-9.https://doi.org/10.12998/wjcc.v10.i3.830
11. **Chand K, Patcharu R, Parikh B *et al.* (2021):** Reduction of intussusception under general anesthesia by hydrostatic technique: the RIGHT technique. Ann Pediatr Surg., 17: 9-18.https://doi.org/10.1186/s43159-021-00076-w
12. **Chandra N, Dey SK, Narwar P (2023):** Management of intussusception in children: A comparative study of hydrostatic reduction with saline under ultrasound guidance versus laparoscopic assistance. Afr J Paediatr Surg.,20: 171-5.https://doi.org/10.4103/ajps.Ajps 20 22
13. **Shiekh Y, Khan A, Bhawani S (2019):** Ultrasound guided hydrostatic reduction of intussusception: Suitability and effectiveness with factors affecting its successful outcome. Int J Adv Med.,6: 1567–73
14. **Moussa M, Abdelmaksoud M, Hussien M (2024):** Comparative study between Ultrasound-guided hydrostatic reduction for ileo-caecal intussusception in pediatrics with versus without general anesthesia. Al-Azhar Intern Med J.,5: 1
15. **Wei C, Fu Y, Wang N *et al.* (2015):** Laparoscopy versus open surgery for idiopathic intussusception in children. Surg Endosc.,29: 668-72
16. **Hill S, Koontz C, Langness S *et al.* (2013):** Laparoscopic versus open reduction of intussusception in children: experience over a decade. J Laparoendosc Adv Surg Tech.,23: 166-9
17. **Fahiem-Ul-Hassan M, Mufti G, Bhat N *et al.* (2020):** Management of Intussusception in the Era of Ultrasound-Guided Hydrostatic Reduction: A 3-Year Experience from a Tertiary Care Center. J Indian Assoc Pediatr Surg.,25: 71-5.https://doi.org/10.4103/jiaps.JIAPS_208_18
18. **Pujar V, Joshi S (2013):** Role of laparoscopy in the management of intussusceptions in children. J Sci Soc.,40: 25-7
19. **Cheung S, Lee K, Yeung T *et al.* (2007):** Minimally invasive approach in the management of childhood intussusception. ANZ J Surg.,77: 778-81.https://doi.org/10.1111 /j.1445-2197.2007.04228.x

20. Houben C, Feng X, Tang S *et al.* (2016): What is the role of laparoscopic surgery in intussusception? ANZ J Surg.,86:504-8.https://doi.org/10.1111/ans.13435

21. Apelt N, Featherstone N, Giuliani S (2013): Laparoscopic treatment of intussusception in children: a systematic review. J Pediatr Surg.,48: 1789-93.https://doi.org/10.1016/j .jpedsurg.2013.05.024

22. Plut D, Phillips G, Johnston P *et al.* (2020): Practical Imaging Strategies for Intussusception in Children. Am J Roentgenol.,215: 1449-63.https://doi.org/10.2214/ajr .19.22445

23. Chand K, Patcharu R, Parikh B *et al.* (2021): Reduction of intussusception under general anesthesia by hydrostatic technique: the RIGHT technique. Ann Pediatr Surg.,17: 9.https:// doi.org/10.1186/s43159-021-00076-w

24. Flaum V, Schneider A, Gomes Ferreira C *et al.* (2016): Twenty years' experience for reduction of ileocolic intussusceptions by saline enema under sonography control. J Pediatr Surg.,51: 179-82.https://doi.org/10.1016/j.jpedsurg.2015.09.022

25. Abdelmageed H, Abdel Aziz S, Refaat M (2022): Ultrasound guided hydrostatic reduction of intussusception using saline enema in pediatric population, does it worth? Benha Med J.,39: 171-86.https://doi.org/10.21608/bmfj.2021.77129.1422

26. Gfroerer S, Fiegel H, Rolle U (2016): Ultrasound-guided reduction of intussusception: a safe and effective method performed by pediatric surgeons. Pediatr Surg Int.,32: 679-82.https://doi.org/10.1007/s00383-016-3898-x

27. Ahmad M, Wani M, Dar H *et al.* (2016): An experience of ultrasound-guided hydrostatic reduction of intussusception at a tertiary care centre. S Afr J Surg.,54: 10-3

28. Okimoto S, Hyodo S, Yamamoto M *et al.* (2011): Association of viral isolates from stool samples with intussusception in children. Int J Infect Dis.,15: e641-5.https://doi.org/10.1016 /j.ijid.2011.05.008

29. Forati S, Yaghmaii B, Allahverdi B (2017): The effect of early feeding after enema reduction of intussusception in order to investigate the rate of recurrence and side effects of reduction. Biomed Res-Tokyo,28: 5642-5

30. Gray M, Li S, Hoffmann R *et al.* (2014): Recurrence rates after intussusception enema reduction: a meta-analysis. Pediatrics,134: 110-9.https://doi.org/10.1542/peds.2013-3102

31. Chien M, Willyerd F, Mandeville K *et al.* (2013): Management of the child after enema-reduced intussusception: hospital or home? J Emerg Med.,44: 53-7.https://doi.org/10.1016 /j.jemermed.2012.02.030

32. Purenne E, Franchi-Abella S, Branchereau S *et al.* (2012): General anesthesia for intussusception reduction by enema. Paediatr Anaesth.,22: 1211-5.https://doi.org/10.1111 /pan.12035

33. Chand K, Patcharu R, Parikh B *et al.* (2021): Reduction of intussusception under general anesthesia by hydrostatic technique: the RIGHT technique. Ann Pediatr Surg.,17: 787-813.