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Open transumbilical intussusception reduction in children: A prospective study☆,☆☆,★

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ABSTRACT

Purpose: Manual intussusception reduction can sometimes be accomplished through the existing umbilical incision after a laparoscopic attempt has failed. We compared the safety and efficacy of open transumbilical intussusception reduction (OTIR) and laparoscopic reduction (LAP).
Methods: We prospectively enrolled children diagnosed with intussusception at our hospital from June 2014 to December 2018. Clinically stable patients who failed pneumatic intussusception reduction were randomly assigned to the OTIR or LAP group. We compared reduction rates, complications, operative times, and surgery costs between the two groups.
Results: Fifty-one of 451 patients with an intussusception met the study criteria. In the OTIR group ($n = 27$), 22 intussusceptions were successfully reduced, and 5 required incision extension. The mean operative time was 47.7 ± 10.5 min, and mean surgery cost was 1259.74 ± 46.24 US dollars. In the LAP group ($n = 24$), 5 patients required conversion to open surgery. Three of the 5 cases were resolved by OTIR, while the other 2 needed incision extension. The mean operative time was 68.63 ± 17.13 min, and mean surgery cost was 1750.63 ± 106.98 US dollars. Severe complications did not occur in either group.
Conclusions: OTIR was as safe and effective as LAP and had a shorter operative time and lower surgery cost. OTIR is a good option for intussusception reduction in children.
Type of study: Treatment study.
Levels of evidence: Level I.

Intussusception is a common disorder in young children. Approximately 80% of cases can be reduced by the administration of an enema [1]. However, a small number of patients will still require operative intervention. Laparoscopic intussusception reduction (LAP) has been performed since the early 2000s [2] and is associated with less surgical trauma and shorter operative time than is open reduction [3–5]. However, the laparoscopic approach to pediatric intussusception reduction is still uncommonly used and results in a high rate of conversion to open surgery [6].

We incidentally discovered that in some cases manual intussusception reduction was easily accomplished directly through the existing umbilical incision after a laparoscopic attempt had failed. Further, our preliminary study [7] indicated that this transumbilical procedure was safe and had a high rate of successful reduction.

In this prospective study, we compared the efficacy and safety of the transumbilical and LAP procedures to evaluate the feasibility, advantages, and disadvantages of open transumbilical intussusception reduction (OTIR).

1. Materials and methods

The study was preregistered at www.chictr.org.cn (ChiCTR-TRC-13004571). The protocol was approved by the Medical Ethic Committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (Approved No. 20140301-04). The parents were given informed consent for participation in the study and for all medical care their children received.

1.1. Patients

We performed a prospective, randomized study in all children less than 14 years of age diagnosed with intussusception at Department of Pediatric Surgery, Tongji Hospital, Tongji Medical College, Huazhong

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University of Science and Technology, from June 2014 to December 2018. Patients were included if they met the following criteria:

1. Clinical symptoms and ultrasonography findings consistent with a diagnosis of intussusception
2. An air enema failed to reduce the intussusception and its apex was located at the ascending colon or ileocecal junction (in patients who underwent multiple enemas, we considered the last one)
3. The patient's parents or guardian consented to study participation

Children meeting one or more of the following criteria were excluded:

1. The diagnosis was uncertain
2. More than 48 h had elapsed between symptom onset and presentation
3. The patient was clinically unstable, was severely dehydrated, or had peritonitis or another sign of intestinal perforation
4. The intussusception apex was at the distal hepatic flexure and did not change position after an enema

1.2. Randomization

We randomly divided the patients into two groups by random number table. The study group underwent OTIR as the primary surgical treatment, while the control group underwent LAP initially.

1.3. Air enema

We use air enema under X-ray surveillance to reduce intussusception in our department. The highest air pressure was about 100–110 mmHg. The enema time for each patient was up to 30 min, and we would try a second time half to one hour later if the parents consent. External manual pressure was applied if needed.

1.4. Surgical procedures

OTIR was performed with the patient in the supine position. A 2–2.5-cm incision was made along the inferior edge of the umbilicus, the subcutaneous tissue was divided, and the peritoneum was opened across the linea alba. The rectus muscle was cut laterally on both sides, and the rectus muscle incision was usually larger than the skin incision. The terminal ileum was brought out through the incision, and the first assistant gently pulled the ileum distally to bring the section of bowel involved in the intussusception to a point just below the opening. The surgeon then inserted his right index finger into the abdomen and advanced it to the intussusception apex while fixing the mass in place with his left hand placed on the patient's abdomen. The intussusception was reduced by squeezing its apex between the surgeon's index finger and the patient's abdominal wall. After the intussusception was reduced, the ileum and ileocecal junction (if possible) were externalized and evaluated for necrosis, rupture, and a lead point. Finally, the incision was closed with absorbable suture and skin glue (Figs. 1 and 2). We extended the transumbilical incision laterally if the reduction was difficult to accomplish (Fig. 3b).

LAP was performed as previously described by Bailey et al. [3]. If intussusception reduction could not be accomplished laparoscopically, we attempted an OTIR as described above. We extended the incision laterally if transumbilical reduction failed.

All the surgeries were performed by Ning Li or Wen Zhang. Both have been pediatric surgeon for more than 10 years.

1.5. Evaluation parameters

The reduction rate, operative time, postoperative length of stay, complications, and cost of care were recorded and compared between the two groups by t-test and $p < 0.05$ was considered significant.

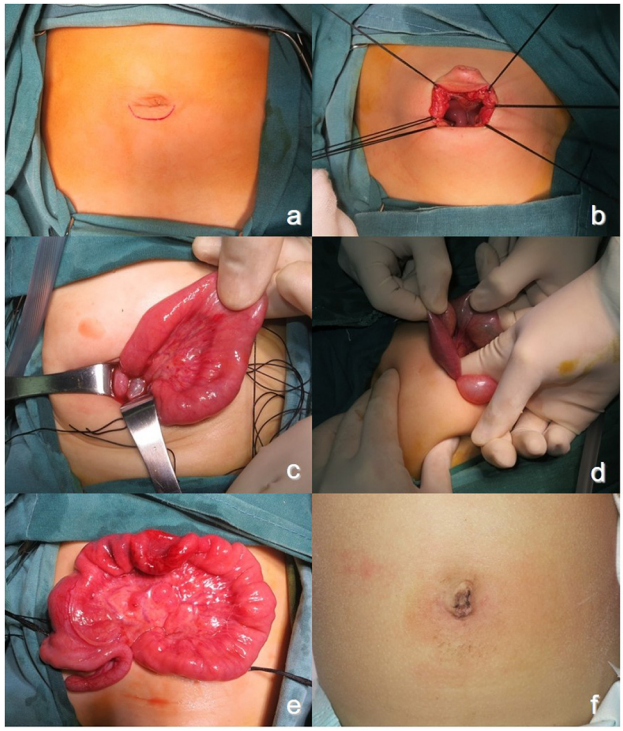

Fig. 1. Open transumbilical intussusception reduction: An arc-shaped surgical incision is made along the inferior umbilical skin fold (a and b). The distal ileum is pulled out to position the intussuscepted segment below the incision (c). The surgeon's right index finger is placed into the abdominal cavity to reduce the intussusception as the assistant holds the bowel outside the abdomen (d). The ileum and ileocecal junction are pulled out of the abdominal cavity to confirm the reduction (e). The umbilical scar one month postoperatively (f).

2. Results

2.1. Patients

During the study period, 451 children were diagnosed with intussusception at our hospital. Seven children underwent traditional open surgery directly because of clinical instability or signs of peritonitis. Intestinal resection and anastomosis were performed in 2 of these 7 cases because of bowel necrosis and perforation. A total of 444 children underwent air enema, of which 393 children were successfully treated with an air enema. The remaining 51 patients required surgical intervention and were enrolled in this study. Thirty-four of the 51 patients tried a second air enema (Fig. 4).

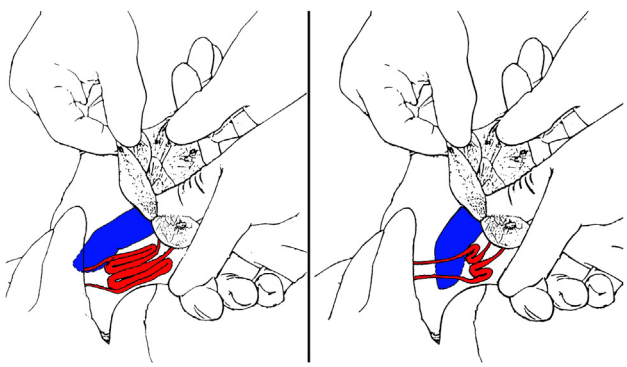

Fig. 2. The intussusception is reduced by squeezing its apex between the surgeon's index finger and the patient's abdominal wall.

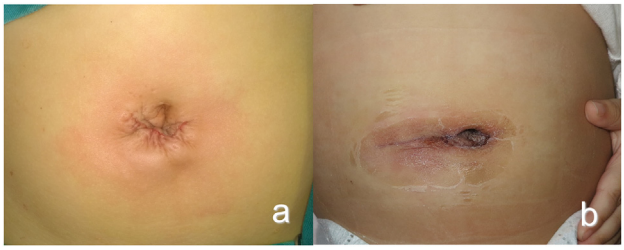

Fig. 3. The incision is minimized after tightening the 4-0 barbed suture closure (a). Lateral incision extension can be seen in this image (b).

2.2. Surgical outcome

After randomization, 27 patients (male, 18; age, 8.74 ± 4.42 months) underwent OTIR and 24 (male, 14; age, 9.38 ± 5.13 months) underwent LAP. In the study group, OTIR resulted in 22 intussusception reductions, and 5 cases required incision extension. The mean operative time was 47.70 ± 10.47 min, and mean surgery cost was 1259.74 ± 46.24 US dollars. The mean postoperative length of stay was 5.56 ± 1.15 days. In the control group, 19 out of 24 children were reduced by LAP, while 5 patients need conversion to open surgery. Of the 5 patients, OTIR successfully treated 3 cases, and the other 2 required incision extension and reduced by traditional open surgery. The mean operative time was 68.63 ± 17.13 min, and mean surgery cost was 1750.63 ± 106.98 US dollars. The mean postoperative length of stay was 5.54 ± 1.22 days. Two cases of patent processus vaginalis were identified during LAP surgery, and ligations were performed laparoscopically. No intussusception lead point was found in this study, and no patient in either group required an intestinal resection.

All patients were followed for 3–12 months postoperatively. One case of Henoch–Schönlein purpura was reported two days after OTIR. No other complications such as wound infection, recurrent intussusception, intestinal perforation, or intraabdominal infection were reported (Table 1).

Table 1
Clinical information of the patients.

	OTIR	LAP
Gender (male/female)	18/9	14/10
Age (months)	8.74 ± 4.42	9.38 ± 5.13
Weight (kg)	9.45 ± 1.79	9.82 ± 1.96
Time between symptom onset and hospitalization (h)	23.59 ± 10.15	22.71 ± 9.08
Operative time (min)	47.70 ± 10.47*	68.63 ± 17.13*
Reduction rate	22/27	19/24
Postoperative length of stay (days)	5.56 ± 1.15	5.54 ± 1.22
Surgery cost (US dollar)	1259.74 ± 46.24*	1750.63 ± 106.98*
Complications and incidental findings	1 Henoch–Schönlein purpura	2 cases of patent processus vaginalis

OTIR, open transumbilical intussusception reduction; LAP, laparoscopic intussusception reduction
* $p < 0.001$.

3. Discussion

In this prospective randomized study, we found that compared to LAP, OTIR has a similar success rate, shorter operative time, and lower cost. Further, the postoperative scar is almost invisible as it is concealed in the umbilicus. Thus, OTIR provides an excellent cosmetic result.

Children have thin abdominal walls, shallow abdominal cavities, and intestines associated with a relatively low amount of fatty tissue. Moreover, children with intussusception typically exhibit a high level of mesenteric mobility and untethered cecum. As a result, a child's small intestine, including the ileum and cecum, can be easily extracted through an umbilical incision. These provide an anatomic basis for intussusception reduction through an umbilical incision. The difficult component of OTIR is the complete reduction of the intussusception with a single finger through a small incision, and the first few cases may be challenging. Therefore, we suggest beginning with those where an enema can move the area of intussusception to a position

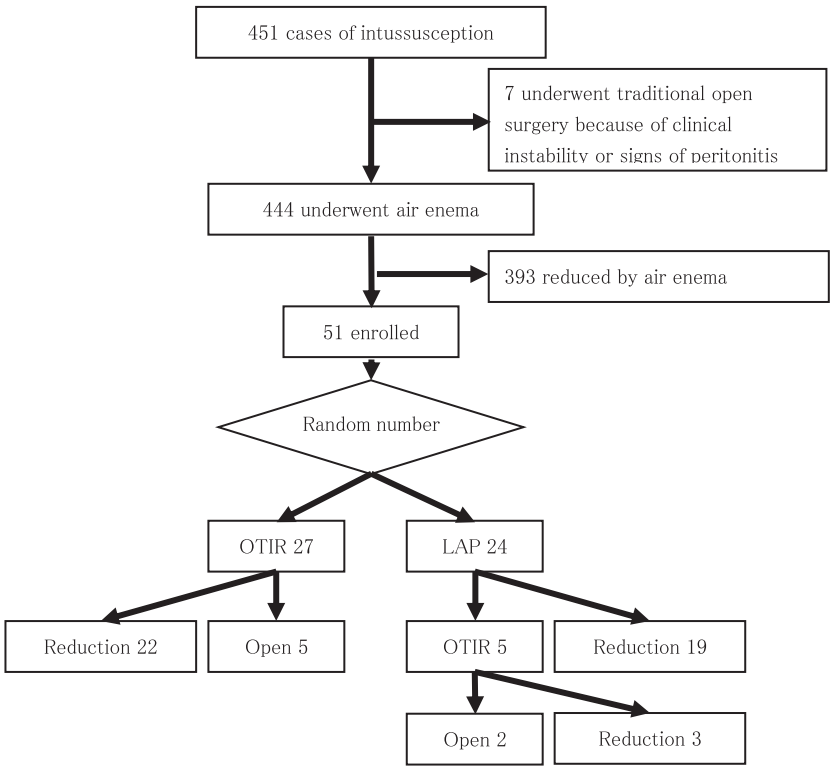

Fig. 4. Flow diagram for case selection and grouping.

near the ileocecal valve, and those involving a short interval between symptom onset and diagnosis, and the time to operate needs to be as quick as possible, since the edema makes it more difficult. Sometimes successful reduction can be accomplished simply by gently sliding the finger over the intussuscepted intestine. After a few straightforward cases, the surgeon can apply this method to more complex intussusceptions. In this analysis and our preliminary study [7], most cases of pediatric intussusception could be successfully reduced by OTIR.

After reduction, the distal ileum, and sometimes the ileocecal region, can be drawn through the incision to check the bowel for necrosis, serosal laceration, and a lead point such as a Meckel's diverticulum. These complications, if present, can be managed during the same operation. In our preliminary study, we successfully treated a case of pediatric intussusception caused by a Meckel's diverticulum by OTIR, and resection of the diverticulum was also completed through the umbilical incision. The umbilical incision can be extended laterally on both sides in cases where the intussusception cannot be reduced, or resection of necrotic intestine is required. This procedure is similar to conventional surgery and does not increase the level of difficulty.

When performing OTIR, the umbilical incision should be large enough to allow the passage of a finger and part of the intestine and its mesentery, usually about 2–2.5 cm in diameter. The rectus muscle should be cut laterally on both sides, and usually larger than the skin incision. In patients with a tiny umbilicus, the incision can be slightly enlarged instead of placed very close to the umbilical edge. When closing the incision, the peritoneum and muscle layer can be closed by 3-0 barbed suture, and the inner circle of skin can be trimmed to minimize the incision length and 4-0 barbed suture used for subcutaneous and skin closure. The incision can be further minimized by tightening the suture (Fig. 3a).

OTIR is not suitable for all children, and patient selection is critical to a successful reduction. Theoretically, OTIR increases the risk of bowel wall laceration or perforation because this approach requires the application of force to lift, pull, and squeeze the intestine. Therefore, a conventional incision should be chosen for children in poor condition and those with severe abdominal distension or signs of peritoneal irritation or other complications. If the intussusception is not amenable to reduction or bloody ascites or other adverse conditions are identified during surgery, then OTIR should be abandoned, and the incision lengthened for further exploration (Fig. 3b). Theoretically, one could also try LAP after OTIR fails. But we think the chance is very low, and would cost more time and money, so we do not recommend it.

To our knowledge, we are the first to report intussusception reduction through an umbilical incision. This approach has a success rate similar to that of LAP, requires no laparoscopic instruments, and can be attempted in cases that are not amenable to the laparoscopic approach. Further, the cost of OTIR is less than that of LAP. The key to success is appropriate patient selection after a thorough preoperative evaluation. Further, the surgeon should not hesitate to abandon the transumbilical approach in cases that prove difficult or complicated.

References

[1] Edwards EA, Pigg N, Courtier J, et al. Intussusception: past, present and future. Pediatr Radiol. 2017;47:1101–8.
[2] Spinoit AF, Hoebeke P. Paediatrics: urinary flow rate after TIP urethroplasty for hypospadias. Nat Rev Urol. 2015;12:477–8.
[3] Bailey KA, Wales PW, Gerstle JT. Laparoscopic versus open reduction of intussusception in children: a single-institution comparative experience. J Pediatr Surg. 2007;42:845–8.
[4] Hill SJ, Koontz CS, Langness SM, et al. Laparoscopic versus open reduction of intussusception in children: experience over a decade. J Laparoendosc Adv Surg Tech A. 2013;23:166–9.
[5] Sklar CM, Chan E, Nasr A. Laparoscopic versus open reduction of intussusception in children: a retrospective review and meta-analysis. J Laparoendosc Adv Surg Tech A. 2014;24:518–22.
[6] Bonnard A, Demarche M, Dimitriu C, et al. Indications for laparoscopy in the management of intussusception: a multicenter retrospective study conducted by the French Study Group for Pediatric Laparoscopy (GECI). J Pediatr Surg. 2008;43:1249–53.
[7] Qiao B, Ning L, Xuefeng Z, et al. Open reduction of acute pediatric intussusception through inferior umbilical skin fold incision. Chinese J Pediatr Surg. 2015;36:68–70.