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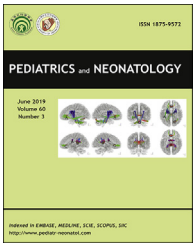

Original Article

Transumbilical minilaparotomy in low-birthweight newborns for complicated conditions

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Key Words
meconium peritonitis;
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transumbilical laparotomy

Background: The purpose of this study is to examine the outcome of transumbilical minilaparotomy for infants and compare the results between normal birthweight (NBW) and low birthweight (LBW).
Methods: Between July 2010 and March 2017, infants who underwent abdominal surgery through transumbilical minilaparotomy were enrolled. Medical records were retrospectively reviewed. Patients were divided into two groups, NBW and LBW. Complexity was defined as complicated conditions other than intestinal atresia and malrotation.
Results: Totally, 16 patients were included. The diagnosis included intestinal atresia (n = 3), meconium peritonitis (n = 4), bowel infarction/necrosis (n = 4), spontaneous intestinal perforation (n = 2), segmental volvulus and necrosis (n = 1), necrotizing enterocolitis (n = 1), and malrotation (n = 1). The median gestational age and body weight were 32 (24–40) weeks and 1731 (560–4200) grams respectively. The median age at operation was 3 (1–41) days. The surgical procedure included primary repair of the intestine (n = 14), ileostomy (n = 1) and Ladd's procedure (n = 1). Postoperative complications included anastomotic leakage (n = 2), adhesion ileus (n = 1), and missed rectal atresia (n = 1). There was one mortality due to extremely low birthweight and poor lung maturation. Re-operation was required in 3 patients for anastomotic leakage (n = 2) and missed rectal atresia (n = 1). Mean birthweight was 2932 ± 97 and 1263 ± 667 g in NBW (n = 5) and LBW (n = 11), respectively ($p < 0.01$). Complexity rate was 40% and 90.9%, respectively ($p = 0.034$). The mean operation time was 139.4 ± 65.8 and 124.3 ± 46.1 min, respectively ($p = 0.60$). The complicated rate and reoperation rate were similar.

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Conclusions: Transumbilical minilaparotomy is technically feasible and an alternative option of minimally invasive surgery for LBW infants and complex conditions.

1. Introduction

The proposal of circumumbilical incisions in 1986 opened the era of minimally invasive abdominal surgery in infants.[1] In the 2000s, the minimal access approaches were divided into two domains. Soutter et al. first published transumbilical laparotomies through only a periumbilical incision for a variety of neonatal intestinal abnormalities. In 2004, Yamataka et al. utilized laparoscopy-assisted transumbilical surgery for small bowel atresia. In the past decade, both techniques have continued to expand and have been successfully applied in numerous neonatal conditions, such as intestinal atresia, intussusception, malrotation, and ovarian cyst.[4–9] However, the progression ceases in the face of complex situations, e.g., acute inflammations, perforations, adhesions, and low bodyweight. Patients with those factors were rarely included in the reported literature.

We started to perform transumbilical minilaparotomy for neonatal abdominal surgeries from 2010. The purpose of this study is to examine the outcomes of the transumbilical minilaparotomy and compare the results between patients with normal birthweight and low birthweight.

2. Methods

With the approval of the Institutional Review Board, infants who underwent abdominal surgery through transumbilical minilaparotomy between July 2010 and March 2017 were enrolled. Medical records were retrospectively reviewed. Parameters investigated included gender, gestational age, age and body weight at operation, diagnosis, operative findings, surgical procedures, and postoperative complications. Based on the birth bodyweight (BBW), patients were divided into two groups, normal birthweight (NBW) and low birthweight (LBW). LBW was defined as less than 2500 g. According to the operative findings, complexity was defined as complicated conditions, which was characterized by infections, bowel necrosis or perforations, other than intestinal atresia and malrotation.

2.1. Surgical techniques

A longitudinal hemi-circumferential incision was made around the umbilicus. The adhesion between small bowel and abdominal wall, if there was any, was lysed by finger dissection. The small bowel was fully exteriorized through the umbilical wound to identify the lesion. In case of severe adhesions or difficult exploration, the wound could be extended upward or downward. The distal bowel was irrigated with warm saline to confirm the patency. Based on each patient's situation, primary anastomosis or stoma creation was performed the same as open method.

3. Results

3.1. Overall demographics

Totally, 16 patients were included. The diagnosis included intestinal atresia in 3 patients, meconium peritonitis (MP) in 4 patients (Fig. 1), bowel infarction/necrosis in 4 patients, spontaneous intestinal perforation (SIP) in 2 patients, segmental volvulus and necrosis in 1 patient, necrotizing enterocolitis (NEC) in 1 patient, and malrotation with midgut volvulus in 1 patient (Table 1). There were 9 females and 7 males. The median gestational age was 32 weeks, with a range between 24 and 40 weeks. The median age at operation was 3 days, with a range between 1 and 41 days. The median weight at operation was 1731 g, with a range between 560 and 4200 g. The mean operation time was 116 min, with range between 60 and 210 min. The operation was performed under the assistance of laparoscopy in 3 patients and purely through transumbilical approach in 13 patients. The involved intestinal segment was located in jejunum in 2 patients, ileum in 13 patients, and midgut in 1 patient. The surgical procedures comprised primary repair of intestine in 9 patients, primary repair plus intestinal tapering in 4 patients, primary repair plus ileostomy in one

Figure 1 Operative findings. Meconium peritonitis (patient No. 15).

Table 1 Demographics of patients.

	GA (week)	Age (day)	BW (gram)	OP time (min)	Preop diagnosis	Postop diagnosis/ location	Operation	Complication
1	27	5	858	210	Intestinal obstruction	Segmental volvulus and necrosis/ileum	Primary repair	
2	24	37	560	115	Intestinal perforation	Spontaneous intestinal perforation/ileum	Primary repair	Leakage, Death
3	40	3	2800	160	Intestinal obstruction	Bowel necrosis/ileum	Primary repair, ileostomy[a]	
4	39	3	3150	205	Intestinal obstruction	Intestinal atresia/ ileum	Primary repair, tapering[a]	Adhesion ileus
5	28	39	1342	92	Necrotizing enterocolitis	Necrotizing enterocolitis/ileum	Ileostomy	
6	24	15	625	77	Intestinal perforation, hemorrhage	Spontaneous intestinal perforation with hemorrhage/ ileum	Primary repair	
7	38	3	2712	60	Intestinal obstruction	Intestinal atresia/ ileum	Primary repair, tapering[a]	
8	33	1	2088	187	Meconium peritonitis	Meconium peritonitis, segmental volvulus, atresia/jejunum	Primary repair, tapering	Leakage, Short bowel
9	25	1	2000	116	Intestinal atresia	Intestinal atresia/ jejunum	Primary repair, tapering	Missed rectal atresia
10	32	2	2850	192	Meconium peritonitis	Meconium peritonitis, bowel perforation/ ileum	Primary repair	
11	32	3	680	123	Intestinal perforation	Bowel infarction/ ileum	Primary repair	
12	34	3	2480	105	Intestinal atresia	Bowel infarction/ ileum	Primary repair	
13	27	5	850	72	Intestinal perforation	Bowel necrosis and perforation/ileum	Primary repair	
14	30	1	1380	175	Meconium peritonitis	Meconium peritonitis, segmental volvulus/ ileum	Primary repair	
15	32	2	1461	95	Meconium peritonitis	Meconium peritonitis, segmental volvulus, perforation, atresia/ ileum	Primary repair	
16	36	41	4200	80	Malrotation	Malrotation, midgut volvulus/midgut	Ladd procedure	

[a] With the assistance of laparoscopy.

patient, ileostomy in one patient and Ladd's procedure in one patient. No conversion to traditional laparotomy was required. Postoperative complications occurred in 4 patients, comprising anastomotic leakage in 2 patients, adhesion ileus in one patient, and missed rectal atresia in one patient. There was one mortality due to extremely low bodyweight and poor lung maturation, which resulted in severe respiratory distress syndrome. Re-operation was required for the 3 patients with anastomotic leakage and one patient with missed synchronous rectal atresia. The cosmetic result of the wound was satisfactory in all except for patient No. 9 (Fig. 2).

3.2. NBW vs. LBW

There were 5 and 11 patients in NBW and LBW, respectively (Table 2). The mean BBW was 2932 ± 97 and 1263 ± 667 g in NBW and LBW, respectively ($p < 0.01$). The complexity rate was 40% and 90.9%, respectively ($p = 0.034$). Laparoscopy was used in 3 (60%) and 0 (0%) patients, respectively ($p < 0.01$). The mean operation time was similar in both groups (139.4 ± 65.8 vs. 124.3 ± 46.1 min, $p = 0.60$). The complication rate was not significantly different (20% vs. 27.3%, $p = 0.76$). The re-operation rate was similar (0% vs. 27.3%).

Figure 2 Wound cosmesis. Patient No.12, 1 month postoperatively.

Table 2 Comparison of NBW and LBW.

	NBW (n = 5)	LBW (n = 11)	*p*
GA (week)	37.0 ± 3.2	28.7 ± 3.7	<0.01
BBW	2932 ± 97	1263 ± 667	<0.01
Complexity	2 (40%)	10 (90.9%)	0.03
Laparoscopy	3 (60%)	0	<0.01
OP time (min)	139.4 ± 65.8	124.3 ± 46.1	0.60
Complication	1 (20%)	3 (27.3%)	0.76
Re-operation	0	3 (27.3%)	0.21

GA = gestational age; BBW = birth bodyweight.

4. Discussion

Since the introduction of transumbilical surgery, a variety of incisions around the umbilicus have been proposed, which included supra- or infra-umbilical, 350°, 270°, and longitudinal incisions (Table 3).[2–8] In this study, we used hemi-circumferential periumbilical incisions on the right side of the umbilicus. The choice depends on the clinical impression of the disease and location of lesions. Thirteen out of 16 patients in our series had ileal lesions that were mostly on right side abdomen. A right side periumbilical incision makes the distance between the incision and the lesion shorter than the other side. This hemi-circumferential incision can also be extended superiorly or inferiorly when necessary.

There are several reasons that make periumbilical incisions suitable for newborns. Firstly, the umbilical complex accounts for a larger proportion of abdomen in infants compared to adults.[3] An incision around the umbilical ring provides better surgical exposure than expected. Secondly, the abdominal wall of infants is thin and soft, and the peritoneal cavity is small with the result that it is easy to explore the majority of peritoneal cavity by retracting the abdominal wall.[4] With growth, the scar on abdomen usually grows in size as well. In contrast, the scar of periumbilical incisions sticks closely around and sometimes sinks deeply into the umbilicus.[2]

As a result of the limitations of image studies in newborns, it is not always easy to make the exact final diagnosis preoperatively, as shown in Table 1. A thorough preoperative assessment of radiographs is essential to identify the most likely location of the pathological bowel segment involved. Lesions in small bowels are suitable for the transumbilical approach, since exteriorization of the entire small intestine through an umbilical wound is simple and

Table 3 Review of literature.

Research	n	Age	BW (kg)	Approach (n)	Incision	Indications	Complication (n)
Soutter 2003	29 13 3	Newborn 1—9 m 13—24 m	na	TL	350° Omega	Intestinal atresia Malrotation Intussusception	Wound infection (2) Leakage (1) Reoperation (1)
Yamataka 2004	3	Newborn	Median: 3.1 2.9—3.5	LAS	180° Supraumbilical	Intestinal atresia	Conversion (1)
Banieghbal 2007	16	1—8 d	na	TL	270°	Jejunal atresia	Stricture (2) Reoperation (2)
Abhyankar 2011	3	Newborn	Median: 2.65 2.4—3.9	LAS	180° Supraumbilical	Intestinal atresia	
Li 2012	35	Newborn	Mean: 2.7	LAS	Longitudinal Midline	Intestinal atresia	Leakage (1) Adhesion (4) Reoperation (2)
Leva 2013	14	3.1 d	Mean: 2.65	TL	180° Supraumbilical	Intestinal atresia	Stricture (2) Reoperation (2)
Wei Current study	16	3 d (1—41 d)	Median: 1.73 0.56—4.20	LAS (3) TL (13)	180° Right hemiumbilical	MP SIP Bowel infarction/necrosis NEC Malrotation Intestinal atresia	Adhesion (1) Leakage (2) Missed atresia (1) Reoperation (3)

TL = transumbilical laparotomy; LAS = laparoscopy-assisted surgery; na = not available.

has been widely used.[2–8] Intraoperative irrigation of distal bowel, including small bowel and colon, is strongly advised. It is helpful to empty distal segments and decrease the tension of the anastomosis. By witnessing meconium passage through the anus, it is sure that there is no atresia in distal bowels. Additionally, the placement of a rectal tube, which is palpable intraoperatively, is also helpful to exclude the rare instance of a synchronous stenosis in the rectum.

By reviewing the literature, we noted that the majority of patients reported were full term and had normal birthweight (Table 3).[2–4,6–8] Small bowel atresia in infants with bodyweight above 2000 g are the best candidates for initial attempt of the transumbilical approach. Due to non-inflammatory, healthy and hypertrophic tissues, bowel tailoring and anastomosis can be performed in a fashion similar to the classic transverse supraumbilical laparotomy without sophisticated laparoscopic skills being required.[3] Nevertheless, this approach has rarely been utilized in complicated conditions. It has been shown in this study that the LBW is associated with higher complexity rate. We adopted transumbilical technique instead of traditional laparotomy for this cohort. SIP usually occurs in extremely-low-birthweight infants. Gentle tissue handling and meticulous techniques are required but difficult. MP is the most challenging condition that the authors have experienced. Severe adhesions, inflammations, and potential coagulopathy usually led surgeons away from minilaparotomy. The most difficult part of the operation was to separate the bowel from the inferior liver surface. This was where the problematic intestinal segment, e.g., perforated or necrotic, was tightly attached. It was generally necessary to extend the wound slightly superiorly to obtain a better surgical exposure. Caution must be taken not to injure the liver capsule which may lead to catastrophic hemorrhage.

Laparoscopy was utilized in 3 patients of NBW but none of LBW. This reflects the fact that in newborns with low body weight, small working space is the key factor that affected our decision against laparoscopy. Furthermore, our results show that LBW is highly associated with complexity. In the literature, non-urgent and non-inflammatory conditions have been widely accepted as indication for laparoscopy and with good results.[3,6,7,9] However, NEC, SIP and MP are usually contraindicated for laparoscopy because of adhesions and low birthweight. In contrast, the transumbilical approach can be flexibly adapted in various difficult situations. We have accomplished bedside surgeries in the NICU for three patients with extremely low birthweight. The small peritoneal cavity in very- or extremely-low-birthweight infants makes the exploration through a paraumbilical incision technically feasible.

The complication rate of this study is 25%, which is relatively higher than the rate of 6.7%—14.3% in the literature (Table 3).[2,4,7,8] The re-operation rate ranges from 2.2% to 14.2% in the literature,[2,4,7,8] and it was required in three patients (18.8%) in our cohort. Although there was no significant difference between complication and re-operation rates of NBW and LBW, the high proportion of LBW and complexity are considered as important risk factors for the increasing complication rate. Patient No. 2 was a premature infant with extremely low birthweight who had advanced pulmonary hypertension secondary to immature lung. Anastomotic leakage was caused by failing to empty distal bowels by saline irrigation, which in turn created pressure at the anastomotic site. Deterioration of lung functions led to the eventual mortality. Patient No. 8 was found to have congenital short length of small bowel (55 cm) intraoperatively. In order to preserve as much bowel as possible, the anastomosis was performed on the part of bowel with suboptimal perfusion, which was considered as the main reason for leakage. In patient No. 9, though distal bowel irrigation was performed, synchronous atresia in middle rectum was missed. As reported in the literature, re-operations were accomplished through the same incision without further complications.[2,4,7,8] In patient No. 9, the incision was extended inferiorly to allow pelvis exploration, which resulted in a more prominent scar. The missed synchronous rectal atresia implies that the transumbilical approach is less favorable for rectal or pelvic lesions. This complication is preventable by placing a rectal tube and distal bowel irrigation, as mentioned above.

The role of laparoscopic surgery for malrotation has been well established with good prognosis.[10] However, in a severely dehydrated patient with prerenal acute kidney injury, such as patient No. 15, pneumoperitoneum raises the concern that an increase in intraabdominal pressure may impair venous returns, which may subsequently worsen tissue perfusion. Through minilaparotomy, this concern was alleviated. The malrotated bowel structures can be fully visualized by exteriorization. Ladd's procedure can be performed exactly in the same way as open surgery.

We recommend starting minilaparotomy from simple cases, such as intestinal atresia, to become familiar with this approach. After gaining experiences, the surgeon will be prepared for advancement to complicated situations. Based on our results, there is a trend of decreasing operation time. Meanwhile, our results show that LBW does not prolong the operation time despite the higher complexity rate. At present, the authors prefer transumbilical minilaparotomy as the first choice for neonatal abdominal surgery.

In conclusion, transumbilical minilaparotomy is technically feasible and an alternative option for minimally invasive surgery in newborns. It is practically applicable in a variety of diseases and diverse settings. With appropriate patient selection, it can be applied to term and premature infants with low bodyweights. With experience, surgeons will be able to perform complicated cases through a transumbilical incision.

Conflict of interest

The authors declare that they have no conflict of interest.

References

1. Tan KC, Bianchi A. Circumumbilical incision for pyloromyotomy. *Br J Surg* 1986;**73**:399.
2. Soutter AD, Askew AA. Transumbilical laparotomy in infants: a novel approach for a wide variety of surgical disease. *J Pediatr Surg* 2003;**38**:950—2.

3. Yamataka A, Koga H, Shimotakahara A, Urao M, Yanai T, Kobayashi H, et al. Laparoscopy-assisted surgery for prenatally diagnosed small bowel atresia: simple, safe, and virtually scar free. *J Pediatr Surg* 2004;**39**:1815—8.
4. Banieghbal B, Beale PG. Minimal access approach to jejunal atresia. *J Pediatr Surg* 2007;**42**:1362—4.
5. Tajiri T, Ieiri S, Kinoshita Y, Masumoto K, Nishimoto Y, Taguchi T. Transumbilical approach for neonatal surgical diseases: woundless operation. *Pediatr Surg Int* 2008;**24**:1123—6.
6. Abhyankar A, Mukhtar Z. Laparoscopy-assisted surgery for neonatal intestinal atresia: single-center experience. *Asian J Endosc Surg* 2011;**4**:90—3.
7. Li B, Chen WB, Wang SQ, Liu SL, Li L. Laparoscopy-assisted surgery for neonatal intestinal atresia and stenosis: a report of 35 cases. *Pediatr Surg Int* 2012;**28**:1225—8.
8. Leva E, Parolini F, Zanini A, Morandi A, Farris G, Franzini S, et al. Supra-transumbilical laparotomy (STL) approach for small bowel atresia repair: our experience and review of the literature. *Afr J Paediatr Surg* 2013;**10**:222—5.
9. Burgmeier C, Schier F. The role of laparoscopy in the acute neonatal abdomen. *Surg Innov* 2016;**23**:635—9.
10. Ferrero L, Ben Ahmed Y, Philippe P, Reinberg O, Lacreuse I, Schneider A, et al. Intestinal malrotation and volvulus in neonates: laparoscopy versus open laparotomy. *J Laparoendosc Adv Surg Tech A* 2017;**27**:318—21.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.pedneo.2018.07.014.