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The Applications and Clinical Outcomes of T-Type Enterostomy in Infantile Gastrointestinal Diseases

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Abstract

Objectives: Explore the applications and clinical outcomes of T-type enterostomy in infantile gastrointestinal diseases.

Methods: Collecting the patient characteristics and clinical data that had received the T-type enterostomy from January 2016 to January 2021. Analyzing the patient clinical characteristics based on the different groups of operative indications. Retrospectively study the application and efficacy of infantile gastrointestinal diseases treated by T-type enterostomy.

Results: Nineteen cases received the T-type enterostomy totally. According to the different reasons for surgery, the patients were divided into congenital malformation group (N1=5), intestinal dysfunction related to premature infants group (N2=5), and distal intestinal dysfunction after primary gastrointestinal operations group (N3=9). Seven cases received the Bishop-Koop ostomy, 12 cases received the Santulli ostomy. All patients were alive after T-type enterostomy treatment. The results of barium enema in 8 cases showed the narrow colorectum before the T-type enterostomy, the mean diameter of the colon raised to 2.26 ± 0.49 cm from the preoperative 1.06 ± 0.40 cm ($p<0.001$). Twelve cases appeared with barium residue before the enterostomy, the residual rate dropped to 21.43% after the surgery from the original 85.71%. The albumin level raised to 39.81 ± 5.83 ng/ml after the enterostomy from preoperative 33.16 ± 5.14 ng/ml ($p<0.001$) and the rate of electrolyte disturbance dropped to 0 from preoperative 36.84%. Z scores after the T-type enterostomy rose to -1.49 ± 1.47 from preoperative 2.97 ± 2.38 ($p=0.027$).

Conclusion: T-type enterostomy is an effective measure to treat infantile gastrointestinal diseases with high survival rates and fewer postoperative complications; it can improve intestinal function and nutrient status.

Keywords: T-type enterostomy; Clinical outcomes; Infant; Gastrointestinal diseases

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Introduction

The gastrointestinal tract is a complex organ system that provides neural, endocrine, exocrine, and immunologic functions, in addition to managing the digestion and absorption of nutrients [1]. Because of the immature development of the gastrointestinal tract or the congenital malformation, gastrointestinal diseases most frequently in infancy. The main clinical manifestations are vomiting, constipation, abdominal distension, feeding intolerance, weight loss and so on. Surgery may need to be considered if conservative treatment is not working. For those patients who can't tolerate the one-stage surgical operation for resection and anastomosis, they need to receive the enterostomy. It is more likely to receive a single cavity ostomy or loop ostomy internationally. In recent years there has been some advancement in the surgical treatment of infants with gastrointestinal disorders [2].

T-type enterostomy belongs to Ostomy in Continuity (OIC) that includes Bishop-Koop ostomy and Santulli ostomy. Sona Sebgal et al. [3] pointed out that OIC could be used to treat complex short bowel syndrome which improves intestinal autonomy and decreases the rate of enterocolitis.

There is little relevant research on T-type enterostomy in infantile gastrointestinal diseases. Therefore, this retrospective analysis was designed to evaluate the applications and clinical outcomes of T-type enterostomy.

Patients and Methods

Patients

All hospitalized patients between January 2016 and January 2021 receiving the T-type

enterostomy were reviewed and followed up until June 2021. All patients underwent T-type enterostomy surgical treatment in the Children's Hospital of Fudan University. According to the different reasons for surgery, the patients were divided into three groups of congenital malformation (group 1), intestinal dysfunction related to premature infants (group 2), and distal intestinal dysfunction after primary gastrointestinal operations (group 3) respectively. This research got ethical approval from hospital ethics board.

Treatments

Conservative treatments: The conservative treatments included anti-infective therapies, fasting, gastrointestinal decompression, nutrition support, and the drugs that promoted gastrointestinal peristalsis.

Surgery: The neonatal intestinal obstruction such as intestinal atresia, meconium ileus, malrotation of the intestine and et al. were the indications of the surgical emergency. Exploratory laparotomy was used to exclude mechanical obstruction for those intestinal dysfunction patients who had no improvement after the conservative treatments or for those patients who developed complications after the primary gastrointestinal surgery. The options depended on the intra-operative findings.

In our study, all patients who had the operation indications received the T-type enterostomy consisted of Bishop-Koop ostomy and Santulli ostomy, the operative approaches were shown in Figure 1. The decision to perform one type or the other depended on the condition of the proximal and distal intestines [3].

The indications of T-type enterostomy were as follows, large diameter ratio of the proximal and distal lumens, unusual dynamics of the intestine, distal intestinal dysfunction.

Observation index

Abdominal X-rays were performed for 18 patients before the surgery. The presence of air-fluid level, dilated bowel, abdominal distension, and other signs could be observed.

Fifteen patients finished the Barium Enema (BE) before the T-type enterostomy and enterotomy closure. All the examinations of BE were performed under the supervision of the same medical team. Barium sulfate was injected by a thin rectal probe with no balloon inflation from the anus. The followed-up abdominal X-ray after 24 h was used to observe the intestinal morphology, movement, and evacuation. Thin colorectum and barium residue presented the distal colorectum dysfunction. To observe the change of intestinal morphology, we measured the diameters of ascending colon, transverse colon, descending colon respectively at filling state (before the T-type enterostomy and enterostomy closure) and calculated the mean values. Both rectum and sigmoid colon were easily affected by the enema; we didn't count their diameter in average value.

The pathological diagnosis was obtained from the postoperative paraffin section examinations based on the number and development of ganglion cells in nerve plexuses.

Laboratory indices were used for detecting blood electrolytes and albumin. These indicators reflected the nutritional status.

The condition of growth and development was measured by the weight and age expressed by Z scores, using the WHO growth data. Weight for age Z score less than minus 2 was considered to low weight [4-5]. It was also used to measure nutriture.

Statistical analysis

Statistical analysis was performed using SPSS 23.0 statistical software; numerical data are shown using mean, standard deviation, or median. Measurement data comparing between the two groups was analyzed by T-test or Mann-Whitney U test; measurement data comparing between the multiple groups was analyzed by ANOVA test or Kruskal-Wallis H test. The T-test and ANOVA test were used to determine statistical significance for data that were normally distributed, the Mann-Whitney U test and Kruskal-Wallis H test were used to compare data that were not normally distributed. Statistical significance was defined as $P<0.05$. Using GraphPad Prism to draw graphs.

Results

Patients general characteristics

Nineteen patients received the surgery of Bishop or Santulli ostomy during the study period. The total patient characteristics were listed in Table 1. The median age of the children at admission was 47 days. The median weight of the patients at admission was 3260 g. The male:female ratio of these patients was 3.75 (15:4). Four patients (21.05%) were term babies, 15 patients were preterm babies. The natural birth:cesarean birth ratio of patients was 0.58 (7:12). Eleven patients were associated with low birth weight. Five cases were congenital malformation, 5 cases were intestinal dysfunction related to premature infants, and 9 cases suffered from diatal intestinal dysfunction after operations.

Grouping and clinical characteristics of each group

Group 1 consisted of 5 cases including 2 cases of jejunal atresia with meconium peritonitis, 1 case of meconium peritonitis with intestinal volvulus, 1 case of omphalocele with intestinal perforation, and 1 case of congenital intestinal malrotation. Group 2 consisted

Table 1: Patients characteristics in total.

Item	n (%)
Sex	
Male	15 (78.95%)
Female	4 (21.05%)
Gestational age	
<37 weeks	15 (78.95%)
≥ 37 weeks	4 (21.05%)
Delivery pattern	
Natural pattern	7 (36.84%)
Cesarean birth	12 (63.16%)
Birth weight	
<2500 g	11 (57.89%)
2500-4000 g	8 (42.11%)
Age at admission (days)	
Median(range)	47 (0-352)
Weight at admission (g)	
Median(range)	3260 (720-8450)
Groups	
Congential malformation	5 (26.32%)
Intestinal dysfunction related to premature infants	5 (26.32%)
Distal intestinal dysfunction after primary gastrointestinal operation	9 (47.37%)

Table 2: Patients characteristics in the group of congenital malformation.

Item	n (%)
Sex	
Male	4 (80.00%)
Female	1 (20.00%)
Age at admission (days)	
Median(range)	1 (0-25)
Weight at admission (g)	
Median(range)	2760 (2230-3580)
Manifestations of abdominal X-rays before T-type enterostomy	
uneven distribution of gas	1 (20.00%)
dilated bowel	2 (40.00%)
air-fluid level	4 (80.00%)
abdominal distension	1 (20.00%)
The primary diseases	
Jejunal atresia with meconium peritonitis	2 (40.00%)
Meconium peritonitis with intestinal volvulus	1 (20.00%)
Omphalocele intestinal perforation	1 (20.00%)
Congenital intestinal malrotation	1 (20.00%)
Symptoms	
Vomiting	2 (40.00%)
Abdominal distension	5 (100.00%)
Abnormal prenatal test	1 (20.00%)
Fecal blood	1 (20.00%)
Types of surgery	1 (20.00%)
Bishop-Koop	
Santulli	4 (80.00%)
Biopsies after surgery	
Well-developed ganglion cells	5 (100.00%)

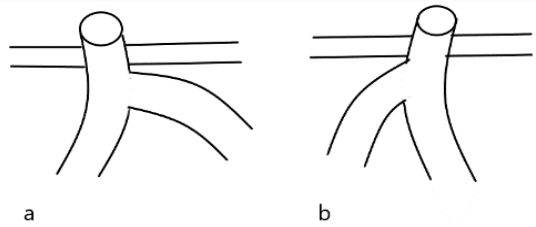

Figure 1: a) Santulli. B) Bishop-Koop.

of 5 cases that were diagnosed as intestinal dysfunction related to premature infants. Group 3 had 9 cases that had received the gastrointestinal operations, 7 cases were necrotizing enterocolitis, and 2 cases was chronic intestinal pseudo-obstruction.

There were 5 patients diagnosed with congenital malformation including 4 male and 1 female with a median admission age of 1 day. The main symptoms were vomiting, abdominal distension, abnormal prenatal test and, fecal blood. The manifestations of abdominal X-rays before T-type enterostomy included uneven distribution of gas (1, 20.00%), dilated bowel (2, 40.00%), air-fluid level (4, 80.00%), abdominal distension (1, 20.00%). Considered with the large diameter ratio of the proximal and distal lumens that could not did the one-stage surgery, 4 patients received the Santulli stoma, 1 patient

Table 3: Patients characteristics in the group of intestinal dysfunction related to premature infants.

Item	n (%)
Sex	
Male	3 (60.00%)
Female	2 (40.00%)
Age at admission (days)	
Median(range)	29 (0-154)
Weight at admission (g)	
Median(range)	2065 (720-5100)
Symptoms	
Vomiting	1 (20.00%)
Abdominal distension	5 (100.00%)
Feeding intolerance	2 (40.00%)
Constipation	1 (20.00%)
Diarrhea	1 (20.00%)
Manifestations of abdominal X-rays before T-type enterostomy	
Abdominal distension	2 (40.00%)
Dilated bowel	5 (100.00%)
Air-fluid level	5 (100.00%)
Uneven gas distribution	3 (60.00%)
Types of surgery	
Bishop-Koop	2 (40.00%)
Santulli	3 (60.00%)
Biopsies after surgery	
Well-developed ganglion cells	5 (100.00%)

received Bishop Stoma. All cases' biopsies showed well-developed ganglion cells after the T-type enterostomy. The related information was summarized in Table 2.

There were 5 premature infants including 3 males and 2 females in group 2 with a median admission age of 29 days. The main symptoms were vomiting, abdominal distension, feeding intolerance, constipation, and diarrhea. The manifestations of X-rays before T-type enterostomy included uneven distribution of gas (3, 60.00%), dilated bowel (5, 100.00%), air-fluid level (5, 100.00%), abdominal distension (2, 40.00%). Considered with the unusual dynamics of the intestine in surgery, 5 cases received the Santulli stoma. All patients received intestinal biopsies, the microscopic analysis showed well-developed ganglion cells. The related information was summarized in Table 3.

There were 9 patients including 8 male and 1 female diagnosed with distal intestinal dysfunction after primary gastrointestinal operations with an admission age of 6.03 ± 4.17 months. Seven cases suffered from the NEC and 2 cases suffered from Chronic Intestinal Pseudo-Obstruction (CIPO). One patient had received the jejunostomy, 6 patients had received the ileostomy, 1 patient had received the double-barrel ileostomy and 1 patient received exploratory laparotomy. The main symptoms were the abnormal results of BE (6, 66.67%), abdominal distension with prolapse intestine (1, 11.11%), infection (1, 11.11%) and dehydration (1, 11.11%). Eight patients completed the examination of abdominal X-rays before the surgery. The manifestations of X-rays before T-type enterostomy included uneven distribution of gas (6, 75.00%), dilated bowel (2,

Table 4: Patients characteristics in the group of intestinal dysfunction after primary gastrointestinal operations.

Item	n (%)
Sex	
Male	8 (88.89%)
Female	1 (11.11%)
Age at admission(months)	
Mean ± SD	6.03 ± 4.17
Weight at admission(kg)	
Mean ± SD	4.88 ± 2.20
Primary disease	
NEC	7 (77.78%)
CIPO	2 (22.22%)
Operation History	
Jejunostomy	1 (11.11%)
Ileostomy	6 (66.67%)
Double-barrel ileostomy	1 (11.11%)
Exploratory laparotomy	1 (11.11%)
Symptoms	
Prolapse intestine	1 (11.11%)
Infection	1 (11.11%)
Dehydration	1 (11.11%)
Abnormal result of BE	6 (66.67%)
Manifestations of abdominal X-rays before T-type enterostomy	
Dilated bowel	2 (25.00%)
Air-fluid level	4 (50.00%)
Uneven gas distribution	6 (75.00%)
Types of surgery	
Bishop-Koop	5 (55.56%)
Santulli	4 (44.44%)

25.00%), air-fluid level (4, 50.00%). Eight patients finished the rectal suction biopsy before the surgery and the results were normal. Distal intestinal dysfunction was observed during the surgery that could not receive the one-stage surgery. Four cases received the Santulli stoma, 5 cases received Bishop Stoma. All patients received intestinal biopsies after the surgery, the results showed well-developed ganglion cells. The related information was summarized in Table 4.

The differences between the three groups related to the T-type enterostomy

The intraoperative findings of T-type enterostomy at surgery is shown in Figure 2. In this study, the median age at T-type enterostomy of groups 1 to 3 were 0.27, 3.03, and 6.77 months respectively (p=0.004). The mean operation time at T-type enterostomy for groups 1-3 was 1.67 ± 0.51 h, 1.83 ± 0.72 h, 3.11 ± 0.82 h respectively (p=0.003). The median periods of PN before surgery of groups 1 to 3 were 0, 28, and 8 days (p=0.028). The median periods of PN after the enterostomy for groups 1 to 3 were 29, 14, 14 days respectively (p=0.837). Meanwhile, the median length of resuming enteral feeding for groups 1 to 3 was 7, 7, and 9 days respectively (p=0.403) (Table 5).

The outcomes of T-type enterostomy

Survival rate and complication: Follow-up continued until June 2021 with a median follow-up period of 16 months (range 2 to 56 months). All patients were alive, no unplanned reoperation occurred. One patient group 3 developed short bowel syndrome after the proximal jejunal stoma (Santulli) with a distance of 60 cm from Treitz. He received the long term PN support and presented with growth retardation.

Figure 2: The operative result in T-type enterostomy.

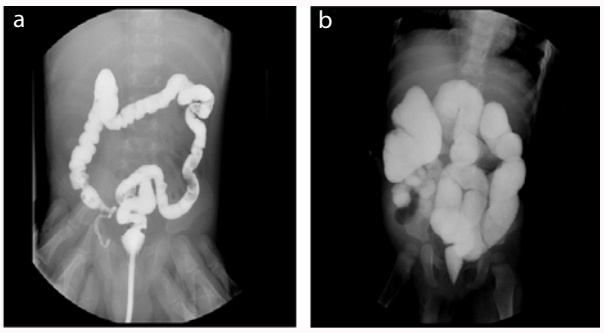

Figure 3: a, b) This patient came from group 3 that underwent ileostomy because of NEC. 3a showed the narrow colon before enterostomy, 3b showed the diameter of the colon was increased before enterostomy closure.

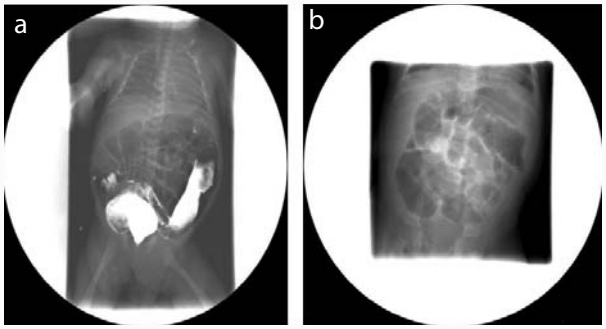

Figure 4: a, b) This patient came from group 2 that was diagnosed as intestinal dysfunction related to premature infants. 4a showed the barium residue before T-type enterostomy, 4b showed no barium residue before enterostomy closure.

The examinations of barium enema: BE was important to examine the morphology and dynamic property of the colorectum. In this study, 14 cases completed the examination before the T-type enterostomy and enterostomy closure. Four cases didn't finish the BE before the enterostomy because of the emergency surgeries. One patient didn't complete the enterostomy closure insufficient recovery time. Eight cases appeared with thin colorectum before the enterostomy, it may be related to the colorectal function degeneration because of long-term non-use. The median follow-up period was 6 months. To observe the change of intestinal morphology, we

Table 5: The differences between the groups of T-type enterostomy.

	group 1	group 2	group 3	P-value
Age (months) Median (Q1-Q3)	0.27 (0.03-0.68)	3.03 (1.47-4.63)	6.77 (2.75-10.62)	p=0.004
Operation time(hours) Mean ± SD	1.67 ± 0.51	1.83 ± 0.72	3.11 ± 0.82	p=0.003
The period of PN before surgery (days) Median (Q1-Q3)	0.00 (0-3.50)	28.00 (5.50-64.50)	8.00 (6.00-21.00)	p=0.028
The period of PN after surgery(days) Median (Q1-Q3)	29.00 (12.50-49.50)	14.00 (6.60--23.00)	14.00 (7.00-58.00)	p=0.837
The length of resuming enteral feeding (days) Median (Q1-Q3)	7.00 (5.00-7.50)	7.00 (4.00-8.50)	9.00 (5.50-15.00)	p=0.403

Table 6: The diameter change of barium enema.

Mean diameter	Before T-type enterostomy	After T-type enterostomy	p-value
Mean ± SD (cm)	1.06 ± 0.40	2.26 ± 0.49	<0.001

Table 7: The variation in Z score.

Patient	Weight for age Z score (before T-type enterostomy)	Follow-up duration (months)	Weight for age Z score (after T-type enterostomy)
1	-3.09	4	-2.5
2	-2	5	1.57
3	-1.35	1	-2
4	-1.19	6	0.38
5	-2	6	-0.55
6	-4.63	5	-0.63
7	-3.43	7	-2.35
8	-7.14	8	-1.08
9	-0.1	9	-0.67
10	-2.71	6	-2.09
11	-5.26	6	-2
12	-2.68	3	-4.29
13	-3	4	-3.38
14	-1.75	5	-2.5
15	-4.14	10	0
16	0.95	2	0.26
17	0.63	6	-1.13
18	-6.2	6	-2.11
19	-7.33	8	-3.25

measured the diameters of ascending colon, transverse colon, descending colon respectively (before the T-type enterostomy and before enterostomy closure) and calculated the mean values and the results were as Table 6.

After the BE examination, the follow-up abdominal X-ray was used to observe the barium residue. Twelve cases appeared with barium residue before the enterostomy, it may be related to the poor intestinal peristalsis. Nine cases returned to normal after the surgery, the rested 3 cases had small amounts of residue that were limited to the rectum and sigmoid colon. The median follow-up time was 6 months and the residual rate dropped to 21.43% from 85.71%. We listed 2 cases' BE results as followed in Figure 3, 4.

Laboratory indices: Many patients who suffered from gastrointestinal diseases couldn't tolerate normal oral feeding which leads to severe malnutrition and electrolyte disturbances. In this study, we compared the change of Albumin (Alb) and blood electrolytes. Alb level after the T-type enterostomy rose to 39.81 ± 5.83 ng/ml from 33.16 ng/ml ± 5.41 ng/ml (p<0.001). The box plot was shown in Figure 5. Seven cases (36.84%) were accompanied by electrolyte disorders at admission including hyponatremia and hypocalcemia, all patients returned to normal after the enterostomy.

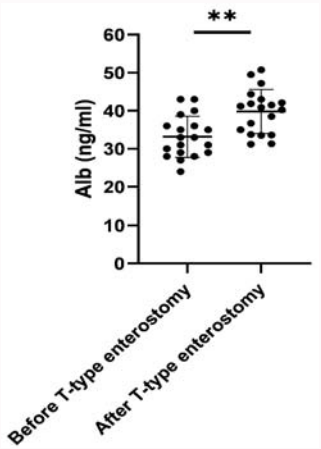

Figure 5: The change of Alb (**means p<0.001).

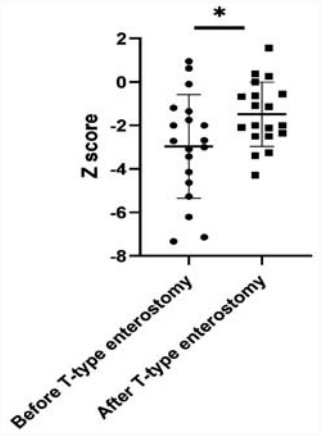

Figure 6: The change of Z score (*means p<0.05).

The Z score: The condition of growth and development in this study was measured by the weight and age expressed by Z scores. The variation in Z score was as followed in Table 7. Z scores after the T-type enterostomy rose to -1.49 ± 1.47 from 2.97 ± 2.38 (p=0.027). The box plot was shown in Figure 6.

T-type enterostomy closure: Eighteen patients finished the

Table 8: The differences in T-type enterostomy closure and hospital stays.

	group 1	group 2	group 3	P-value
Age (months) Mean ± SD	4.36 ± 2.48	7.90 ± 2.68	14.50 ± 3.79	p<0.001
Operation time (hours) Mean ± SD	1.52 ± 0.90	1.30 ± 0.76	1.39 ± 0.57	p=0.892
The period of resuming the enteral feeding (days) Median (Q1-Q3)	5.00 (5.00-7.00)	5.00 (4.00-6.50)	6.00 (5.00-6.75)	p=0.594
The period of PN after surgery (days) Medain (Q1-Q3)	10.00 (8.00-12.50)	6.00 (3.00-10.00)	4.50 (4.00-6.75)	p=0.077
The period of resuming defecation after surgery (days) Median (Q1-Q3)	2.00 (1.50-5.50)	2.00 (1.50-4.50)	2.00 (1.25-4.25)	p=0.864

Figure 7: The intraoperative findings at T-type enterostomy closure.

Figure 8: The occluder of T-type enterostomy.

enterostomy closure before the follow-up time deadline by evaluating the physical recovery. Intraoperative findings in enterostomy closure are shown below Figure 7. All patients from groups 1 and 2 had completed the closure, 1 patient from group 3 hasn't received the enterostomy because of the short recovery time. We compared the differences of three groups at the enterostomy closure listed in the Table 8. The age at T-type enterostomy closure of groups 1 to 3 were 4.36 ± 2.48 months, 7.90 ± 2.68 months, and 14.50 ± 3.79 months respectively (p<0.001). The mean operation time at T-type enterostomy closure for groups 1 to 3 was 1.52 ± 0.90 h, 1.30 ± 0.76 h, 1.39 ± 0.57 h respectively (p=0.892). Meanwhile, the median length of resuming enteral feeding for groups 1 to 3 was 5, 5 and 6 days respectively (p=0.594). The median periods of PN after the surgery for groups 1 to 3 were 10 days, 6 days, and 4.5 days respectively (p=0.077). The median length of resuming defecation for groups 1 to 3 was 2, 2 and 2 days respectively (p=0.864).

Discussion

Therapeutic methods of infantile gastrointestinal diseases include conservative treatments and operative treatments. The conservative treatments include pharmacological treatments, physical therapies, and nutrition supports. Pharmacological treatment for patients aims to avoid bacterial overgrowth, gain gastrointestinal motor function, and enable oral intake [6].

For the patients with operation indications, correct operation treatment may increase cure rate, reduce death rate and improve survival quality. The operation treatments are composed of one-stage surgical operation for resection and anastomosis or enterostomy. For those patients who can't tolerate the one-stage surgical operation for resection and anastomosis, they need to receive the enterostomy which consists of single-lumen enterostomy, double-lumen enterostomy, loop enterostomy, and T-type enterostomy.

In the study, all cases treated by T-type enterostomy. The principle of treatment for the congenital malformation is to relief obstruction; severe cases who can't tolerate the one-stage operation require the enterostomy after having been removed obstruction. T-type enterostomy could reduce the dilated proximal intestinal canal and utilize distal intestinal canal. For the premature infants suffered from the intestinal dysfunction, treatment is usually conservative such as fasting, nutrition support, and antibiotic therapy. But surgery may need to be considered if conservative treatment is not working. In our study, the conservative treatment time in group 2 was longer than one month at least. A prolonged intestinal dysfunction will result in malnutrition, electrolyte disturbance, even intestinal failure. Intestinal failure results from insufficient or functionally inadequate bowel and can lead to failure of neonatal growth and development [7]. For the cases of distal intestinal dysfunction after primary gastrointestinal operations. T-type enterostomy could also reduce the dilated proximal intestinal canal and utilize distal intestinal canal, it helps to promote the resumption of gastrointestinal function.

T-type enterostomy maintains intestinal continuity that reduces the incidence rates of disorder of hydroelectrolyte balance. We can observe the intestinal morphology and movement at the surgery, the decision whether to perform either a Santulli or Bishop-Koop ostomy depends on patients' intestinal function. In our study, the intraoperative findings that took us to do the T-type enterostomy can be grossly divided into the reasons as follows, dilation of the proximal small bowel, stenosis of distal bowel, and weak intestine peristalsis. Santulli stoma could decrease the pressure of the proximal intestine, if there is no significant difference in the diameter between the proximal and distal intestine, it is an effective way to use bishop stoma for utilizing the distal intestine. The important features to be considered during the operation include the vascularity, significant disparity in the size of intestinal ends, the increased wall thickness and the intestinal dysmotility with decreased peristalsis in the proximal bowel [8].

The pathological examinations need to be completed during the surgery, Hirschsprung's disease could be excluded by the intestinal biopsies. Meanwhile, strictly intestinal exploration is required to conform to the surgical principle that we should preserve the functional bowel as long as possible.

Compared with the T-type enterostomy, single-lumen enterostomy disrupts the continuity of intestine, the intestine of distal stoma performs within the useless state which is easy to result in fluid and electrolyte imbalance and disuse atrophy. Prolapse intestine often happens after the single-lumen enterostomy because separating

the mesentery promotes the movement of the small intestine. In the period of infant children mainly by abdominal breathing, crying causes the abdomen pressure to increase [9]. T-type enterostomy could efficiently prevent the prolapse because the drag force of distal intestine.

Kumar et al. [10] reported that Santulli ileostomy had lower morbidity and complication rates especially skin excoriation, ostomy prolapsed, and failure to thrive as compared to loop ileostomy. Illya et al. [11] indicated that Bishop Surgery was a safe, reliable, and suitable technique in neonatal surgery with low complications rate. Shahnam et al. [12] found Santulli ileostomy is better than loop ileostomy due to significantly less frequency of surgical site infection, skin excoriation, and prolapse of ostomy, ileostomy volume output, and hospitalization time in neonates with meconium ileus.

In our study, all patients were alive, no anastomotic leakage and anastomotic stenosis occurred after the T-type enterostomy. Enteral feeding and defecation was resumed as early as possible. One patient suffered from the short bowel syndrome after the Santulli ostomy with a distance of 60 cm from Treitz.

To verify the function of the distal bowel, we used a closure device developed by ourselves to block off the stoma before the enterotomy closure (Figure 8). The device was used to discern whether appeared distensible abdomen and vomiting after blocking. All patients should complete the examination of BE before enterostomy closure. The defecation function was recovered after T-type enterostomy, before the enterostomy closure, only air and intestinal juice were eliminated from the stoma.

As an ostomy in continuity, T-type enterostomy makes use of the distal intestine. Because of intestinal dysfunction and disuse, the colorectum might present functional stenosis before the enterostomy. We could see that the mean diameter of ascending colon, transverse colon, and descending colon is increased with the follow-up.

Vomiting, long-term PN, diarrhea, feeding intolerance are easy to result in electrolyte disturbances and poor nutrition. T-type enterostomy maximizes the length of intestine, reduces the loss of intestinal juice, and promotes intestine development.

There were also differences in the three groups. For group 1, prenatal diagnosis or developed symptoms rapidly after birth ensured the early treatment that could require emergency surgery. The T-type enterostomy operation time in group 3 was longer and older than group 1 and 2, it may be related to the post-operative peritoneal adhesion, also the age at enterostomy closure in group 3 was older than the other groups. The premature infants from group 2 received the conservative treatment for a long time which resulted in long-term PN.

In a word, T-type enterostomy is a safe and reliable surgical option for treating specific infantile gastrointestinal diseases. But this research was restricted by the number of samples; our results should be conducted in some multicenter studies.

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