

# Bowel plication in neonatal high jejunal atresia

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## Abstract

This study aimed to evaluate the efficacy of bowel plication as a part of the surgical treatment in neonatal high jejunal atresia.

Between January 2013 and December 2016, 43 neonates with high jejunal atresia underwent surgical treatment at the Children's Hospital of Fudan University. According to the surgical procedures the patients underwent, the neonates were divided into a bowel plication group and a nonplication group. Eighteen neonates underwent proximal bowel plication after atretic segment resection and primary anastomosis. The other 25 neonates were in the nonplication group and underwent enteroplasty after atretic segment resection. Data were retrospectively analyzed, including gestational age, birth weight, concomitant diseases, age at surgery, duration of operation, length of total parenteral nutrition (TPN), postoperative intestinal function recovery (i.e., the time of the 1st oral feeding and when the oral feeding volume reached 40 mL/kg/3h), length of hospital stay, growth and development, complications, and reoperations.

No differences in gestational age, birth weight, concomitant disease, age at surgery, or duration of operation were found between the 2 groups. The time of the 1st oral feeding, the time when oral feeding volume reached 40 mL/kg/3h, and duration of TPN for the bowel plication group were shorter than those for the nonplication group ( $9.4 \pm 3.1$ ,  $14.6 \pm 2.3$ ,  $9.2 \pm 2.7$  days, respectively, vs  $13.5 \pm 2.6$ ,  $17.6 \pm 2.8$ ,  $14.3 \pm 2.4$  days, respectively,  $P < .05$ ). The length of the hospital stay for the bowel plication group was significantly shorter than for the nonplication group ( $15.3 \pm 3.1$  days vs  $18.5 \pm 3.6$  days, respectively,  $P < .05$ ). In the bowel plication group, 1 patient (5.6%) underwent reoperation for intestinal stenosis resulting from neonatal necrotizing enterocolitis 1 year after the initial surgery. However, in the nonplication group, 5 patients (20%) underwent reoperation, including 3 for anastomotic stenosis and 2 for adhesive intestinal obstruction. Follow-up visits occurred for an average period of 2.8 years (6 months to 4.5 years). All infants thrived, and no differences in growth and development were found between the 2 groups.

Bowel plication after atretic segment resection and primary anastomosis improves the clinical outcome for neonates with high jejunal atresia.

**Abbreviations:** NEC = necrotizing enterocolitis, TPN = total parenteral nutrition.

**Keywords:** bowel plication, high jejunal atresia, neonate

## 1. Introduction

Congenital intestinal atresia is a common digestive tract malformation in neonates. It is also a common cause of neonatal intestinal obstruction. Its incidence is approximately 1/5000, and the incidence in males and females is similar. Surgical treatment is currently the only way to save the life of a child with intestinal atresia. Due to proximal bowel dilatation, bowel wall thickening, differences in the proximal and distal anastomosis diameter ratio, and other factors, postoperative children with high jejunal atresia show high occurrence of slow peristalsis, early enteral feeding

disorders and difficulty in postoperative intestinal function recovery. Bowel plication is a technique of folding in the antimesenteric portion of the proximal bowel wall to reduce the circumference to a normal diameter. Some scholars have suggested that for children with high jejunal atresia, bowel plication can be performed at the proximal end of the anastomosis after intestinal end to end anastomosis, which is expected to improve intestinal function recovery after operation.<sup>[1]</sup>

In recent years, we performed plication on the proximal dilated bowel in children with high intestinal atresia and achieved definitive therapeutic effects. This study retrospectively analyzed the clinical features of children with high jejunal atresia at the Children's Hospital of Fudan University from January 2013 to December 2016, and evaluated the feasibility, safety, and prognosis of bowel plication of high jejunal atresia in neonates.

## 2. Materials and methods

The clinical data of children with high jejunum atresia were collected from January 2013 to December 2016 in our hospital. The inclusion criteria were newborns with high jejunum atresia who were treated surgically and had complete clinical data. Exclusion criteria were newborns with other intestinal diseases or complicated and serious malformations in other systems, neonates who were automatically discharged from the hospital without operation or without criteria after operation, or those

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with incomplete clinical data, such as incomplete surgical records. A total of 43 neonates with high jejunum atresia met the criteria for admission. Among them, there were 17 males and 26 females. The average gestational age was  $36.5 \pm 2.1$  weeks, the average birth weight was  $2.9 \pm 0.6$  kg, and the average age at the time of operation was  $31 \pm 5$  hours.

The range of bowel plication was from 2 to 3 cm above the anastomosis to the Treitz ligament, and the bowel diameter after plication was approximately 1.5 to 2 cm (Fig. 1). For children whose intestinal atresia was <15 cm below the Treitz ligament, the blind end was resected and anastomosed to the distal end, as the proximal intestine was too short to be partially resected.

Retrospective analysis was performed on children with high jejunal atresia who met the inclusion criteria. The Institutional Review Board of Children's Hospital of Fudan University approved this retrospective study. According to whether proximal bowel plication had been performed, children were divided into a proximal bowel plication group or a nonplication group. Gestational age, birth weight, age at surgery and duration of surgery, concomitant diseases, duration of total parenteral nutrition (TPN), intestinal function recovery time (i.e., time of postoperative oral feeding and time at which postoperative oral feeding volume reached 40 mL/kg/3 h), and hospitalization time were recorded. Meanwhile, the growth and development of the children, and whether there was reoperation or complications (adhesive ileus, intestinal obstruction, anastomotic fistula, intestinal perforation, intestinal volvulus) were followed up. The 2 groups were then compared. The recovery time for intestinal function was determined according to the time of oral feeding after operation and the time at which the feeding volume reached 40 mL/3 h. Growth and development indexes were measured using the recommended height and weight according to the "Reference standard for the growth and development of children under 7 years of age in China" by the Ministry of Health of China in 2009<sup>[2]</sup> and compared between the 2 groups for 2.5- to 3-year-old children.

The data were processed by SPSS 20 statistical software. Student *t* test was used to compare the data between groups. The Fisher exact probability method was used to compare the data between groups. A *P* value <.05 was considered statistically significant.

### 3. Results

Laparotomy was performed in all children, and high jejunum atresia was confirmed during the operation. Among them,



**Figure 1.** A case of bowel plication in high jejunal atresia.

18 cases were treated with proximal bowel plication (fold group), and 25 cases were treated without proximal bowel plication (nonplication group), of which 11 cases of type I atresia underwent septum resection and enteroplasty and 14 cases (3 type II cases and 11 type III cases) underwent blind end resection and anastomosis. In the fold group, there were 8 males and 10 females. The length of folded intestine was between 3 and 12 cm in 11 cases of type I atresia, 5 to 7 cm in 2 type II cases, 7 to 12 cm in 4 type III cases, and 9 cm in 1 type IV case. The flowchart showing surgery treatments with the number of subjects is summarized in Figure 2.

The average gestational age of the fold group was  $36.5 \pm 3.4$  weeks, the average birth weight was  $3.1 \pm 0.6$  kg, the average age at the time of surgery was  $28.0 \pm 7.2$  hours, and the average operation time was  $1.3 \pm 0.3$  hours. The average gestational age of the nonplication group was  $36.9 \pm 2.9$  weeks, the average birth weight was  $2.9 \pm 0.4$  kg, the average age at the time of surgery was  $34.0 \pm 6.5$  hours, and the average operation time was  $1.4 \pm 0.3$  hours. The difference between the 2 groups in this criterion was not statistically significant (Table 1). Concomitant diseases included wet lung (1 case in the fold group and 3 cases in the nonplication group), congenital intestinal malrotation (1 case in the fold group and 2 cases in the nonplication group), meconium peritonitis (0 case in the fold group and 2 cases in the nonplication group), annular pancreas (0 case in the fold group and 1 case in the nonplication group), Meckel diverticulum (1 case in the fold group and 1 case in the nonplication group), congenital heart disease (1 case in the fold group and 2 cases in the nonplication group), and polydactyly (1 case in fold group and 0 case in nonplication group). There was no significant difference between the 2 groups in concomitant diseases ( $P > .05$ ).

The TPN duration, time to 1st postoperative oral feeding, and time at which oral feedings reached 40 mL/3 h was  $9.2 \pm 2.7$ ,  $9.4 \pm 3.1$ , and  $14.6 \pm 2.3$  days, respectively, for the fold group. The corresponding times for the nonplication group were  $14.3 \pm 2.4$ ,  $13.5 \pm 2.6$ , and  $17.6 \pm 2.8$  days, respectively, which were significantly longer than those for the fold group. The hospitalization time for the fold group and nonplication group was  $15.3 \pm 3.1$  and  $18.5 \pm 3.6$  days, respectively, and was significantly different ( $P < .05$ ) (Table 2).

One year after the operation, 2 cases of intestinal obstruction were admitted to the hospital from the fold group; 1 case was treated successfully, while exploratory surgery found that the other case was caused by intestinal stenosis after necrotizing enterocolitis (NEC). The stenosis was located 35 to 50 cm from the distal end of the anastomosis. In the nonplication group, 5 cases underwent reoperation within 1 year, including 3 cases of anastomotic stenosis and 2 cases of adhesive intestinal obstruction. There was no significant difference in the incidence of intestinal obstruction within one year after operation between the 2 groups ( $P = .86$ ).

Postoperative follow-ups occurred from 6 months to 4 years and 6 months after the initial procedures with a mean follow-up time of 2.8 years. The height and weight indexes of both groups were within the reference standards for children under 7 years of age formulated by the Ministry of Health in 2009. The height and weight indexes of 2.5- to 3-year-old children in the fold group were  $94.8 \pm 3.6$  cm and  $14.1 \pm 1.5$  kg, respectively, and for the nonplication group, they were  $95.1 \pm 3.2$  cm and  $13.9 \pm 1.8$  kg, respectively; there was no statistically significant difference between the 2 groups ( $P > .05$ ).

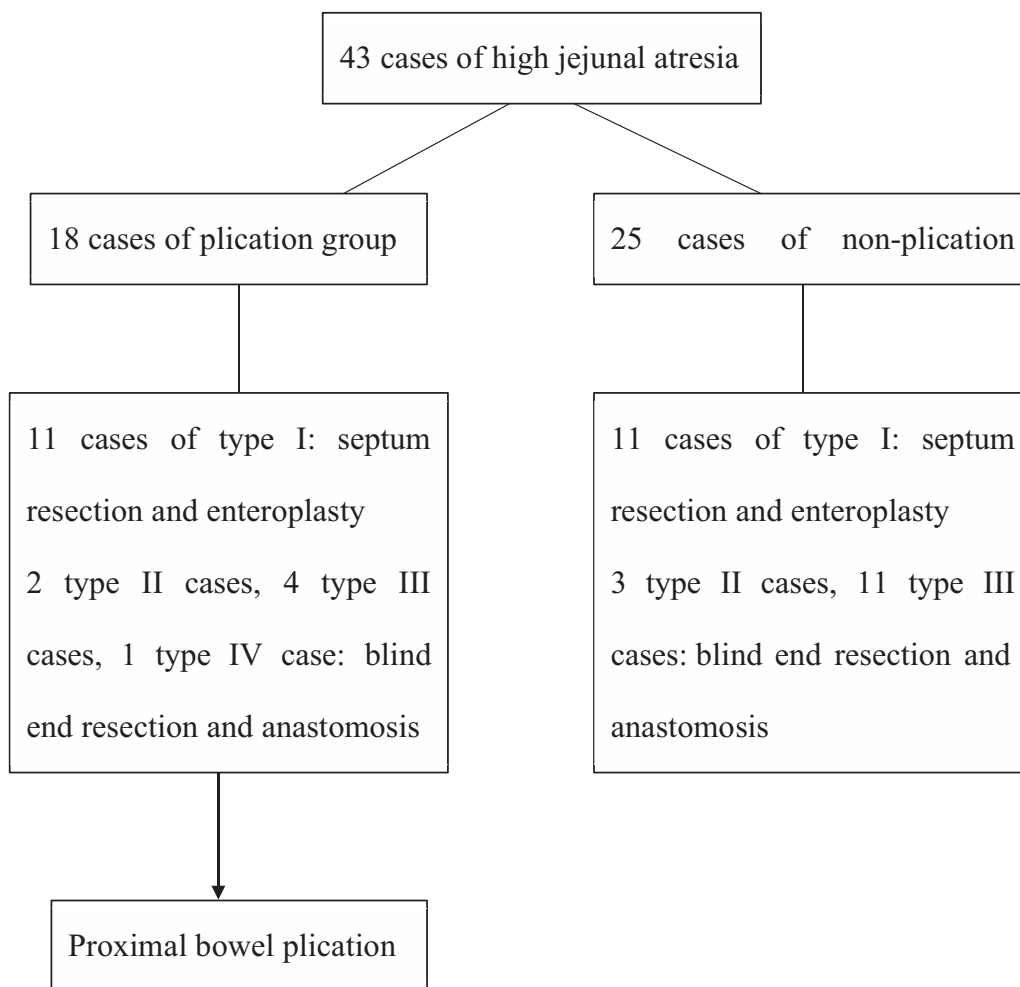


Figure 2. The flowchart shows surgery treatments with the number of subjects.

**4. Discussion**

Congenital intestinal atresia is a continuous interruption of the intestinal canal due to inborn factors. It is an important cause of intestinal obstruction in newborns. High jejunum atresia refers to atresia in the small intestine <30cm below the Treitz ligament. The survival rate in the past for those diagnosed with jejunal

atresia was approximately 75%, but in recent years, with the improvement of prenatal screening, operation methods, and the progress of neonatal intensive care, the survival rate has been significantly improved.<sup>[3]</sup> Surgery is currently the only way to treat the disease, though operation methods are diverse.<sup>[4-6]</sup> Each method has its advantages and disadvantages, but the traditional

**Table 1**

Comparison of gestational age, birth weight, operation age, and operation time.

Group	Gestational age, wk	Birth weight, kg	Surgical age, h	Operation time, h
Fold group	36.5±3.4	3.1±0.6	28.0±7.2	1.3±0.3
Nonplication group	36.9±2.9	2.9±0.4	34.0±6.5	1.4±0.3
P value	.65	.47	.83	.28

**Table 2**

Comparison of TPN duration, time to oral feeding, time to oral feeding reaching 40mL/3h, and hospitalization time.

Group	TPN duration, d	Time to oral feeding, d	Time to oral feeding 40 mL/3 h time, d	Hospitalization time, d
Fold group	9.2±2.7	9.4±3.1	14.6±2.3	15.3±3.1
Nonplication group	14.3±2.4	13.5±2.6	17.6±2.8	18.5±3.6
P value	.032	.008	.027	.046

TPN= total parenteral nutrition.

end-to-end anastomosis (also known as the end to back anastomosis) is still the preferred operative method.

Currently, I-phase end-to-end anastomosis is the recommended surgical procedure for blind and near-distal dilatation of the bowel whenever conditions allow.<sup>[7,8]</sup> The recovery of intestinal function as soon as possible after reconstruction of the intestinal segment is the primary goal of the treatment. However, the proximal intestine is highly dilated, resulting in the loss of motor function. There is a great difference in the caliber of the proximal and distal bowel canals, and the lack of effective peristalsis to push intestinal contents through the anastomosis is a major cause of postoperative intestinal dysfunction.<sup>[9]</sup> Children with functional intestinal obstruction cannot eat and rely on TPN, which can cause a series of complications and pose a great challenge for clinicians.<sup>[10,11]</sup> Most researchers believe that it is necessary to resect the proximal dilatation and hypertrophic intestinal canal when the ratio of the diameters of the proximal dilated bowel and distal small intestinal canal is more than 7:1, to avoid postoperative intestinal dysfunction.<sup>[12,13]</sup> Some scholars also propose excising the mesenteric contralateral wall of the dilated intestinal canal for longitudinal oblique enteroplasty.<sup>[14]</sup> Yamataka et al<sup>[1]</sup> introduced bowel plication in the proximal dilated bowel of jejunal atresia to solve bowel dysfunction. He proposed that bowel plication increases the contraction amplitude and intraluminal pressure of the proximal dilated bowel, to improve intestinal motor function and promote the passing of intestinal contents. Decreasing the difference between the proximal and distal anastomosis diameters is conducive to the recovery of intestinal function. If a large portion of the proximal dilated bowel is resected in a patient with a short bowel, the remaining intestinal tract is further shortened, and the absorption area of the mucosa is compromised. This outcome may lead to short bowel syndrome, which seriously affects the absorption of nutrients and the growth and development of the child.<sup>[15]</sup> For cases in which the remaining intestine would be of inadequate length, bowel plication has the advantage of preserving the intestinal mucosa. In recent years, we have performed bowel plication in some children with high jejunal atresia to investigate its effect.

Postoperative intestinal recovery is reflected in this group of children by the duration of TPN, the time to oral feeding and the time needed for oral feedings to reach 40 mL/3 h. Since the birth weight of neonates is generally 3 kg, an intake of 40 mL/3 h of milk can meet their basic physiological needs; thus, oral feeding of 40 mL/3 h was selected as one of the standard for recovery of intestinal function. The results showed that there was no significant difference between the group undergoing plication or the nonplication group in gestational age, weight, concomitant diseases, age at the time of operation, or duration of the operation. However, the length of the hospital stay for the bowel plication group was significantly shorter than for the nonplication group. Postoperative oral feeding time and the time at which oral feeding reached 40 mL/3 h for the bowel plication group was earlier than for the nonplication group, and the duration of TPN was significantly shorter than for the nonplication group. This suggests that recovery of intestinal function in children with bowel plication was superior to the nonplication group. Bowel plication can narrow the circumferential diameter of the proximal dilated intestinal cavity to reach the circumferential diameter of the distal intestine. Therefore, the change in intestinal caliber is complete, but the smooth muscle and enteric nerves of the intestinal wall are left undamaged. Only

the caliber of the intestine is changed, and a decrease in the diameter of the intestine theoretically helps increase the pressure within the intestinal cavity, which improves intestinal power and motility. Additionally, bowel plication preserves the intestinal mucosa, aiding in the absorption of nutrients. Therefore, bowel plication in the proximal dilated bowel effectively avoids resection of large portions of the bowel and reduces surgical trauma. The procedure ensures intestinal retention and functional recovery as early as possible, and is also an effective means to prevent intestinal functional obstruction from congenital intestinal atresia. The follow-up results 1 year after initial surgery showed that no functional intestinal obstruction occurred in the bowel plication group. The average 2.8-year follow-up results indicated that the height and weight indexes of the 2 groups were within the standards for children under 7 years old formulated by the Ministry of Health in 2009, suggesting that postoperative intestinal function met the needs for proper growth and development as long as the intestine survived the difficult recovery period.

To conclude, bowel plication for intestinal anastomosis in high jejunal atresia is less invasive, which helps to promote intestinal function recovery, shorten the time of intravenous nutrition, and reduce complications. This procedure is an effective treatment for the dilated intestine in intestinal atresia. However, the long-term effect of bowel plication is unclear, as the number of cases is limited and needs further study.

## Author contributions

**Conceptualization:** Chun Shen.

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**Methodology:** Shaobo Yang.

**Supervision:** Chun Shen.

**Validation:** Shaobo Yang, Min Wang.

**Writing – original draft:** Shaobo Yang, Min Wang.

**Writing – review & editing:** Shaobo Yang.

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