

Original Article

Continuous tube feeding versus intermittent oral feeding for intermediate position enterostomy in infants

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Background and Objectives: The stoma of intermediate position enterostomy (IPE) often leads to high output, which is related to electrolyte abnormalities, and prolongs patient recovery post-operatively. The continuous nasogastric tube feeding method has the advantage of reducing the risk of feeding intolerance, and improves nutrient absorption. In the current study, we review our experience with continuous tube feeding and compare the clinical outcomes with intermittent oral feeding in patients with an IPE post-operatively. **Methods and Study Design:** This was a retrospective review of 118 infants with IPEs in our hospital. The infants were categorized into two groups (intermittent oral feeding [OF] group [n=68 infants, 1–14 days of age] and continuous tube feeding [TF] group [n=50 infants, 1–14 days of age]). Differences in stool volume, daily intravenous fluid infusion, weight gain, nutrition indices, and post-operative complications were reviewed. **Results:** The stool volume and intravenous fluid infusion in the TF group were less than the OF group from week 2. The weight gain was higher in the TF group than the OF group from week 3. The pre-albumin and retinol binding protein levels were significantly higher in the TF group than the OF group in weeks 3–4 post-operatively. The incidence of cholestasis and water-electrolyte disturbances in the TF group was significantly lower than the OF group, and the incidence of intestinal obstruction was lower than the control group, but the differences were not significant. **Conclusions:** Continuous tube feeding had better clinical outcomes than intermittent oral feeding in IPE patients.

Key Words: continuous tube feeding, intermittent oral feeding, enterostomy, infants, nutrition

INTRODUCTION

In recent years with the ever-improving survival rate in very low birth weight infants, the morbidity of intestinal disorders, such as necrotizing enterocolitis, atresia, Hirschsprung's disease, and malrotation with midgut volvulus, has increased.¹⁻⁴ These infants often need temporary enterostomies. We refer to enterostomies as an intermediate position enterostomy (IPE) when the enterostomy is located in the proximal ileum or distal jejunum. The stoma of an IPE is located in the small intestine, and often leads to high output and electrolyte abnormalities, thus prolonging patient recovery post-operatively.⁵⁻⁷ These patients need nutritional support, but often still encounter nutritional challenges. In adults, high output stomas (HOSs) are generally managed by treatment consisting of an intravenous and/or oral fluid infusion, electrolytes, and anti-diarrheal and anti-secretory medications.⁵ Management of HOSs is more difficult in infants, and additional ways to manage HOSs are needed.

There are several feeding patterns in infants, such as intermittent oral feeding (OF) and continuous nasogastric tube feeding (TF). Intermittent oral feeding consists of administering a prescribed volume of deep hydrolyzed formula milk over a short period of time (usually 15–20 min every 3 h) by oral feeding. This feeding pattern promotes the cyclical pattern of gastrointestinal hormones, such as gastrin, enteroglucagon, and gastric inhibitory peptide, is physiologic, and occurs in healthy infants.⁸

The continuous nasogastric tube feeding method for pre-term infants was first reported in 1972.⁹ Continuous tube feeding consists of administering a prescribed volume of deep hydrolyzed formula milk through a tube using a micro-pump for continuous infusion. This feeding pattern has the advantage of reducing the risk of feeding intolerance, improves nutrient absorption,¹⁰ improves energy efficiency, reduces energy expenditure,¹¹ strengthens duodenal function,¹² and reduces pulmonary complications.¹³

Given the advantages of continuous tube feeding, we have used the continuous nasogastric tube feeding method for IPEs in infants from February 2010. In the current study we review the experience of continuous tube feeding and compare the clinical outcomes with intermittent oral feeding in IPEs post-operatively.

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Manuscript received 21 August 2016. Initial review completed 24 October 2016. Revision accepted 08 November 2016.

doi: 10.6133/apjcn.032017.21

METHODS

Subjects

This was a retrospective review of 118 patients with IPEs in the Department of Pediatric Surgery at Children's Hospital of Nanjing Medical University between 1 February 2010 and 30 April 2016. The study was approved by the Ethics Committee (201312028) of Children's Hospital of Nanjing Medical University. All of the guardians of the patients consented to this study.

Intermittent oral feeding or continuous tube feeding

The patients were categorized into the following two groups: the intermittent OF group (n=68 patients; 38 males and 30 females; 1–14 days of age; median age=5.9 days) was diagnosed with necrotizing enterocolitis (n=37), extensive Hirschsprung's disease (n=18), intestinal atresia (n=10), and malrotation with midgut volvulus (n=3); and the continuous TF group (n=50 patients; 32 males and 18 females; 1–14 days of age; median age=6.2 days) was diagnosed with necrotizing enterocolitis (n=30), extensive Hirschsprung's disease (n=12), intestinal atresia (n=6), and malrotation with midgut volvulus (n=2).

Oral feeding consists of administering a prescribed volume of deep hydrolyzed formula milk (Alfaré, Nestle, Netherlands) over a short period of time (usually over 15–20 min every 2.5–3 h) by oral feeding.

Continuous TF consists of administering a prescribed volume of deep hydrolyzed formula milk (Alfaré, Nestle, Netherlands) through a tube using a micro-pump for continuous infusion. (Figure 1A and 1B)

Differences in stool volume, daily intravenous fluid infusion, weight gain, nutrition indices, and post-operative complications were reviewed. Cholestasis was defined as a conjugated bilirubin level ≥ 2.0 mg/dL.

Statistical Analysis

Statistical analysis was carried out using SPSS software (version 14.0; SPSS, Inc., Chicago, IL, USA). The differences in stool volume, daily intravenous fluid infusion, weight gain, and nutrition indices are expressed as the

mean \pm SD. Parameters were analyzed by Student's t-test. For the above parameters, a $p < 0.05$ was considered statistically significant. A Pearson chi-square test was used to compare the complications in the two groups.

RESULTS

The stool volume post-operatively

The stool volume of the TF group was 135 \pm 14 mL/d (week 1), 185 \pm 22 mL/d (week 2), 225 \pm 42 mL/d (week 3), 254 \pm 43 mL/d (week 4), 266 \pm 24 mL/d (week 5), 278 \pm 32 mL/d (week 6), 275 \pm 36 mL/d (week 7), and 290 \pm 33 mL/d (week 8). The stool volume of the OF group was 140 \pm 21 mL/d (week 1), 265 \pm 32 mL/d (week 2), 277 \pm 34 mL/d (week 3), 326 \pm 43 mL/d (week 4), 360 \pm 32 mL/d (week 5), 378 \pm 24 mL/d (week 6), 413 \pm 46 mL/d (week 7), and 430 \pm 55 mL/d (week 8). There was no statistically significant difference between the two groups at week 1, but the stool volume in the TF group was less than the OF group from week 2 (Figure 2A).

The daily intravenous fluid infusion post-operatively

The daily intravenous fluid infusion in the TF group was 120 \pm 12 mL/kg/d (week 1), 82 \pm 13 mL/kg/d (week 2), 57 \pm 14 mL/kg/d (week 3), and 30 \pm 12 mL/kg/d (week 4). The daily intravenous fluid infusion in the OF group was 123 \pm 13 mL/kg/d (week 1), 118 \pm 11 mL/kg/d (week 2), 85 \pm 12 mL/kg/d (week 3), and 70 \pm 15 mL/kg/d (week 4). There was no statistically significant difference between the two groups at week 1, but the daily intravenous fluid infusion in the TF group was less than the OF group from week 2 (Figure 2B).

Weight gain post-operatively

The weight gain in the TF group was 3 \pm 1 g/d (week 1), 7 \pm 2 g/d (week 2), 15 \pm 2 g/d (week 3), 15 \pm 3 g/d (week 4), 18 \pm 3 g/d (week 5), 20 \pm 2 g/d (week 6), 22 \pm 1 g/d (week 7), and 21 \pm 3 g/d (week 8). The weight gain in the OF group was 3 \pm 1 g/d (week 1), 6 \pm 2 g/d (week 2), 10 \pm 2 g/d (week 3), 8 \pm 4 g/d (week 4), 10 \pm 2 g/d (week 5), 11 \pm 2 g/d (week 6), 15 \pm 3 g/d (week 7), and 14 \pm 4 g/d (week 8). There was



Figure 1. A. and B. Infants undergoing continuous nasogastric tube feeding. C. Fistulas of the intermittent oral feeding group. D. Fistulas of the continuous nasogastric tube feeding group.

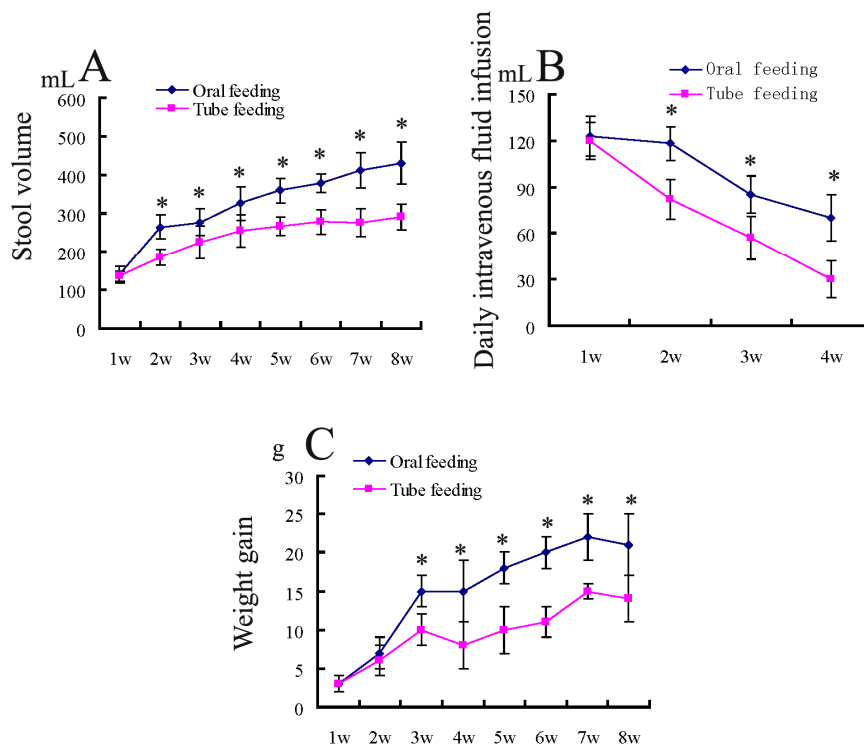


Figure 2. A. The stool volume of the two groups post-operatively. There was no statistically significant difference between the two groups at week 1, but the stool volume in the TF group was less than the OF from week 2. B. The daily intravenous fluid infusion post-operatively. There was no statistically significant difference between the two groups at week 1, but the daily intravenous fluid infusion in the TF group was less than the OF group from week 2. C. Weight gain post-operatively. There was no statistically significant difference between the two groups at weeks 1 and 2, but the weight gain in the TF group was less than the OF from week 3 (Figure 2). * $p < 0.05$.

no statistically significant difference between the two groups in weeks 1 and 2, but the weight gain in the TF group was greater than the OF group from week 3 (Figure 2C).

Nutrition indices

The levels of pre-albumin and retinol binding protein were not significantly different between the two groups in weeks 1 and 2 post-operatively, but were significantly higher in the TF group than the OF group in weeks 3 and 4 post-operatively (Figure 3A–B).

Post-operative complications

No patients experienced tube plugging in the TF group. Cholestasis occurred in 12 patients, intestinal obstruction occurred in 3 patients, and water-electrolyte disturbances occurred in 18 patients in the TF group. Cholestasis occurred in 28 patients, intestinal obstruction occurred in 4 patients, and water-electrolyte disturbances occurred in 44 patients in the OF group. The incidence of cholestasis and water-electrolyte disturbances in the TF group was significantly lower than the OF group, and the incidence of intestinal obstruction was lower than the control group, but the differences were not statistically significant (Figure 3C).

DISCUSSION

In this paper we have reviewed our experience in intermittent OF and continuous TF in patients with IPEs post-operatively. No patients experienced tube plugging in the TF group, and there were many advantages in the TF group compared to the OF group, including promotion of

intestinal energy absorption and limiting parenteral nutrition (PN)-associated complications.

IPE patients often experience large losses of intestinal fluid that can lead to chronic dehydration. When this occurs, ostomy patients present with a large amount of water, sodium, and magnesium loss,¹⁴ and can also experience malnutrition, which is known as HOSs. Previous studies have shown that the readmission rate of patients who have undergone enterostomies is high and readmissions of such patients are frequent and costly.^{15,16} Currently, existing methods of treating HOS in infants is not very effective, thus surgeons are in search for a solution to the problem. In this study the fistulas in the OF group often had dilute water samples, and the stool volume post-operatively was high, but in the TF group the characteristics of the stool were significantly improved, and the incidence of water-electrolyte disturbances was lower than the OF group. As a result, TF might be an effective way to treat HOSs in infants.

Compared with milk feedings given by the intermittent bolus gavage method, continuous nasogastric feedings is considered to increase the energy absorbed, decrease the energy expenditure, and improve nutrient absorption, which results in improved energy efficiency and improved growth.^{10,11} Based on previous analyses, very low birth weight infants gained weight faster in the continuous feeding method group than with the intermittent feeding method.^{11,17} Moreover, premature infants may have a problem with sucking because preterm infants commonly acquire the coordinated sucking ability between the 32nd and 34th weeks of post-menstrual age, thus they require a period of TF before developing competent sucking.¹⁸

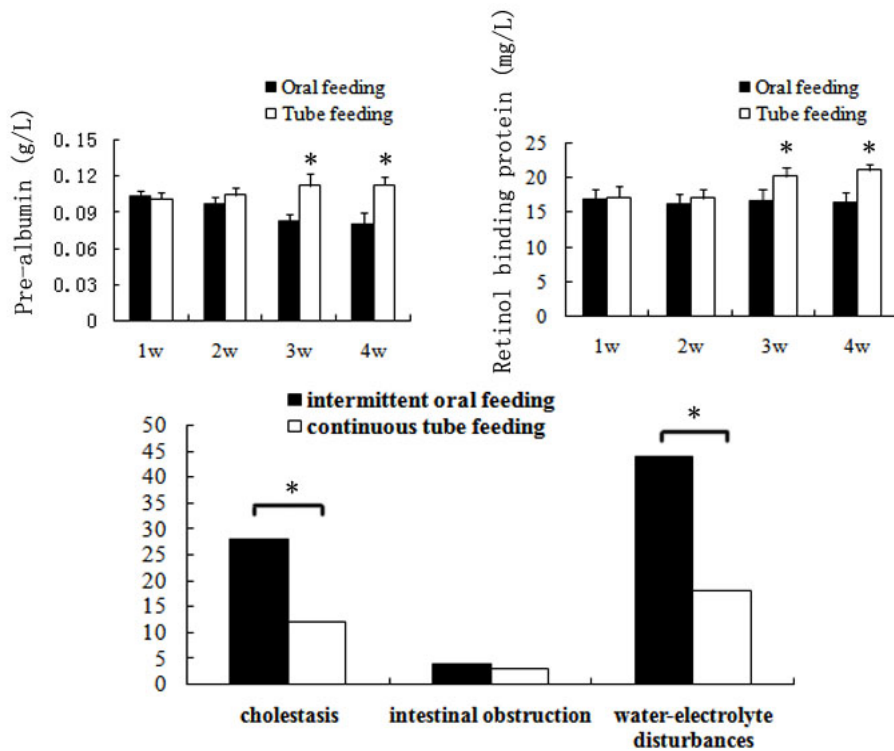


Figure 3. The pre-albumin (A), and retinol binding protein levels (B) were not significantly different between the two groups in weeks 1 and 2 post-operatively, but were significantly higher in the TF group than the OF group in weeks 3 and 4 post-operatively. The incidence of cholestasis and water-electrolyte disturbances in the TF group was significantly lower than the OF group (C). ($p < 0.05$).

For premature infants, Krishnan¹⁹ reported that continuous nasogastric TF reached enteral intakes of 90 kcal/kg/d more quickly than infants given intermittent bolus gavage feeding. Indeed, in the current study the nutritional status of the patients in the TF group improved; specifically, the weight gain in the TF group was greater than the OF from week 3 post-operatively, and the pre-albumin and retinol binding protein levels were significantly higher in the TF group than the OF group in weeks 3 and 4 post-operatively.

Enterostomy infants are at a higher risk for nutritional problems. PN must be given until enteral nutrition can maintain the nutritional needs. Prolonged PN has a relationship with hepatobiliary derangements, and cholestasis is thought to be one of the potential complications in infants receiving PN.^{20,21} In the current study, daily intravenous fluid infusion in the TF group was less than the OF group from week 2. Along with the decrease in venous nutrition, the incidence of cholestasis in the TF group was also significantly lower than the OF group.

Continuous tube feeding at our hospital for the ostomy patients has been shown to be effective and safe in addressing complications from poor nutritional status and electrolyte alterations compared with intermittent OF. Continuous tube feeding had better clinical outcomes in IPEs than intermittent OF. Therefore, continuous tube feeding is recommended for intermediate position enterostomy in infants.

AUTHOR DISCLOSURES

The authors declare no conflict of interest. This study was supported by the National Natural Science Foundation of China (81100318), Jiangsu provincial key research and development program (BE2017609), the Abbott Fund Institute of Nutrition

Science (AFINS-HOPE-201301), and the Nanjing Medical Science and Technology Development Project (ZKX11010, ZKX14014).

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