Original Article

Early enteral nutrition in neonates with partial gastrectomy: a multi-center study

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Background and Objectives: Compared with total parenteral nutrition (TPN), enteral nutrition is more suitable for patients post-operatively. Our aim was to determine the safety and feasibility of early enteral nutrition (EEN) using a jejunum feeding tube in neonates after undergoing a partial gastrectomy. **Methods and Study Design:** This was a retrospective review of 46 patients who underwent partial gastrectomies for gastric perforation in our hospital. These patients were categorized into two groups (EEN group [n=24 patients], a jejunal feeding tube was inserted during surgery; and a control group [n=22 patients], a jejunal feeding tube was not placed). Differences in operative time, time to first defecation post-operatively, time to first oral feeding post-operatively, length of hospital stay post-operatively, nutrition indices, and post-operative complications (died due to septic shock, cholestasis, pneumonia, abdominal distension, and diarrhea) were reviewed. **Results:** There were no significant differences in the operative time and the time to first oral feeding post-operatively between the two groups; however, the time to first defecation post-operatively in the EEN group and the hospital length of stay post-operatively for the EEN group were significantly shorter than the control group. The levels of albumin, retinol binding protein, and prealbumin were not significantly different between the two groups pre-operatively and 14 days post-operatively. The incidence of cholestasis and abdominal distention in the EEN group was significantly lower than the control group. **Conclusion:** EEN using a jejunal feeding tube in neonates who have undergone a partial gastrectomy for gastric perforation is safe, easy, and has fewer complications than TPN.

Key Words: early enteral nutrition, partial gastrectomy, neonate, total parenteral nutrition, gastric perforation

INTRODUCTION

Gastric perforation is a serious problem for neonates and is associated with a high mortality rate.[1,2] Gastric perforation may occur due to a number of reasons, including congenital agenesis of gastric muscle, asphyxia, vigorous respiratory effort, stress at birth, and increased intragastric pressure caused by distal obstruction.[3-6]

Anastomosis leakage of the stomach is a serious complication following partial gastrectomy. Anastomosis leakage is often lethal, thus to protect the stomach sutures, and the edema and paralysis of the intestinal for the chemical peritonitis and septic bacterial peritonitis results from gastric perforation, a long period of gastric rest after partial gastrectomy is recommended. However, a long period of fasting leads to longer hospital stays, additional costs, and is associated with increased morbidity and mortality.[7,8] Moreover, hospitalized patients are at risk for malnutrition. Malnutrition contributes to impaired muscle function, organ function, and impaired immune function, which also lead to an increased incidence of infection, extended hospitalization, and increased morbidity.[9-11]

Compared with total parenteral nutrition (TPN), enteral nutrition (EN) is less expensive, requires a shorter hospital stay, improves nitrogen balance, and has fewer septic complications.[12-15] Early enteral nutrition (EEN) can prevent gut mucosal atrophy, maintain the gut absorptive capacity and peristaltic activity, and preserve the gut mucosal barrier and immunocompetence post-operatively. Moreover, EEN after subtotal gastrectomy has been successfully administered to adults,[16] but whether or not EEN after subtotal gastrectomy in newborns is also feasible and safe is unknown.

Our aim was to investigate if EEN using a jejunum feeding tube in neonates after undergoing a partial gastrectomy is safe and feasible.

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MATERIALS AND METHODS

Subjects

This was a retrospective review of 46 patients with gastric perforations, including 28 patients who were treated in the Department of Paediatric Surgery at Nanjing Children's Hospital affiliated with Nanjing Medical University, 12 patients who were treated in the Department of Paediatric Surgery of Beijing Children's Hospital Affiliated to Capital Medical University, and six patients who were treated in the Department of Paediatric Surgery of Anhui Provincial Children's Hospital, between 1 January 2008 and 31 July 2014.

The study was approved by the Ethics Committees of Nanjing Children's Hospital, Beijing Children's Hospital Affiliated to Capital Medical University, and Anhui Provincial Children's Hospital. All of the guardians of the study subjects consented to this study. The patients were categorized into two groups: the EEN group (n=24 patients; 14 males and ten females 2-12 days of age; median age=4.5 days), and the TPN group (control group; n=22 patients; 14 males and eight females 2-11 days of age; median age=4.8 days). In the EEN group, EEN was initiated 48 h post-operatively. A micro-pump was used for continuous infusion EN. Nutrients were derived from 5% dextrose with a gradual transition to a low osmolality, extensively-hydrolyzed formula (Pepti-Junior Nutricia the Netherlands), in which 100 mL contains 67 kcal. Oral feeding was started after 7±2 days of EN and when no biliary drainage occurred in the nasogastric tube aspirate. Then, the quantity of formula was gradually increased to complete oral nutritional feeding. Inadequate calorie intake was supplemented by parenteral nutrition (PN). All of the patients received a total of 70 kcal/kg/d. For PN, the paediatric compound amino acid began at 1.5 g/kg/d and gradually increased to 3 g/kg/d; fat accounted for 40%-50% of the calories, and the remaining calories were supplemented by glucose.

The jejunal feeding tube was a silicone catheter, 150 cm in length and 2 mm in diameter (6-Fr). When the partial gastrectomy was completed, the EN catheter was inserted through a nostril, advanced through the pylorus, and placed in the jejunum under direct visual assistance. The tip of the feeding tube was placed advanced approximately 10 cm distal to the ligament of Treitz (Figure 1).

A jejunal feeding tube was not placed in the TPN group (control group); a nasogastric aspirate tube was routine placed post-operatively, and the patients were administered TPN. Oral feeding was started when no biliary drainage existed in the nasogastric aspirate tube, then the quantity of feeding was gradually increased to complete oral nutritional feeding.

Differences in operative time, time to first defecation post-operatively, time to first oral feeding post-operatively, length of hospital stay post-operatively, nutrition indices (levels of albumin, retinol binding protein, and prealbumin), and post-operative complications (died due to septic shock, cholestasis [serum direct bilirubin >34 μmol/L], pneumonia, abdominal distension, and diarrhea) were reviewed.

Statistical analysis

Statistical analysis was carried out using SPSS software (version 14.0; SPSS, Inc., Chicago, IL, USA). A Pearson chi-square test was used to compare the complications in the two groups. The operative time, time to first defecation post-operatively, time to first oral feeding post-operatively, and length of hospital stay post-operatively are expressed as the mean±SD. Parameters were analyzed using Student's t-tests. For the above parameters, $p<0.05$ was considered statistically significant.

RESULTS

Operative time

The operative times of the EEN and control groups were 103.3±15.5 min and 98.5±11.7 min, respectively. There was no statistically significant difference between the two groups (Figure 2A).

Time to first defecation post-operatively

The time to first defecation post-operatively in the EEN and control groups was 50.1±5.1 h and 69.4±6.8 h, respectively. The time to first defecation in the EEN group was significantly shorter than the control group (Figure 2B).

Time to first oral feeding post-operatively

The time to first oral feeding post-operatively in the EEN and control groups was 7.3±0.5 days and 7.5±0.6 days, respectively. There was no statistically significant difference between the two groups (Figure 2C)

Length of hospital stay post-operatively

The length of hospital stay post-operatively in the EEN and control groups was 12.2±2.7 days and 17.3±3.2 days, respectively; the hospital length of stay post-operatively in the EEN group was significantly shorter than the control group (Figure 2D).

Nutrition indices and increases in body weight

The levels of albumin, retinol binding protein, and prealbumin were not significantly different between the two groups pre-operatively and 14 days post-operatively. (Figure 3A–C). The weekly increase in body weight in the EEN and control groups was 10.9±0.7 g and 10.4±1.2 g, respectively (two weeks post-operatively). There was no statistically significant difference between the two groups with respect to the weekly increase in body weight.

Post-operative complications

In the EEN group, no tube plugging occurred; however, one patient died due to septic shock, one patient developed cholestasis, pneumonia occurred in two patients, no patient developed abdominal distention, and diarrhea occurred in three patients.

In the control group, two patients died due to septic shock, cholestasis occurred in six patients, pneumonia occurred in three patients, abdominal distention occurred in four patients, and diarrhea occurred in two patients.

The incidence of cholestasis and abdominal distention in the EEN group was significantly lower than the control group. The incidence of mortality, and pneumonia was lower than the control group, and the incidence of diarrhea was higher than the control group, but the differences were not significant (Figure 3D). Four cases under-

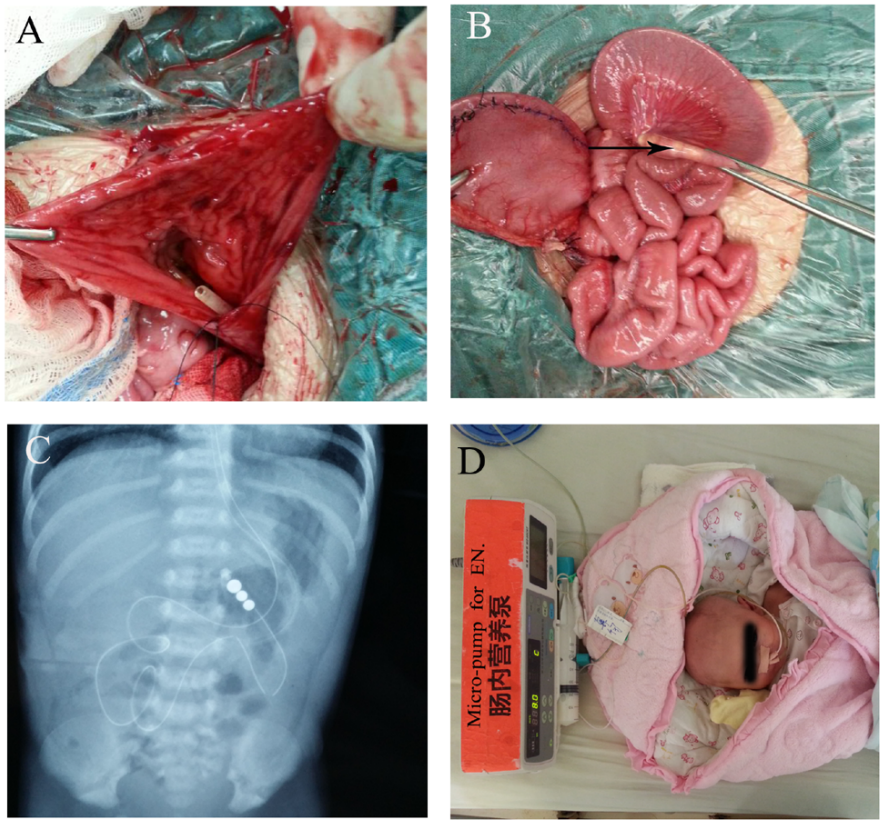

Figure 1. Jejunal feeding tube placement. (A) Gastric perforation in a neonate. (B) The end of the catheter (arrow). (C) Observation of the position of the tip (three consecutive spherical bright spots) of the feeding tube post-operatively by X-ray. (D) Nutrition tube is directly connected to the nipple of the injector to pump milk.

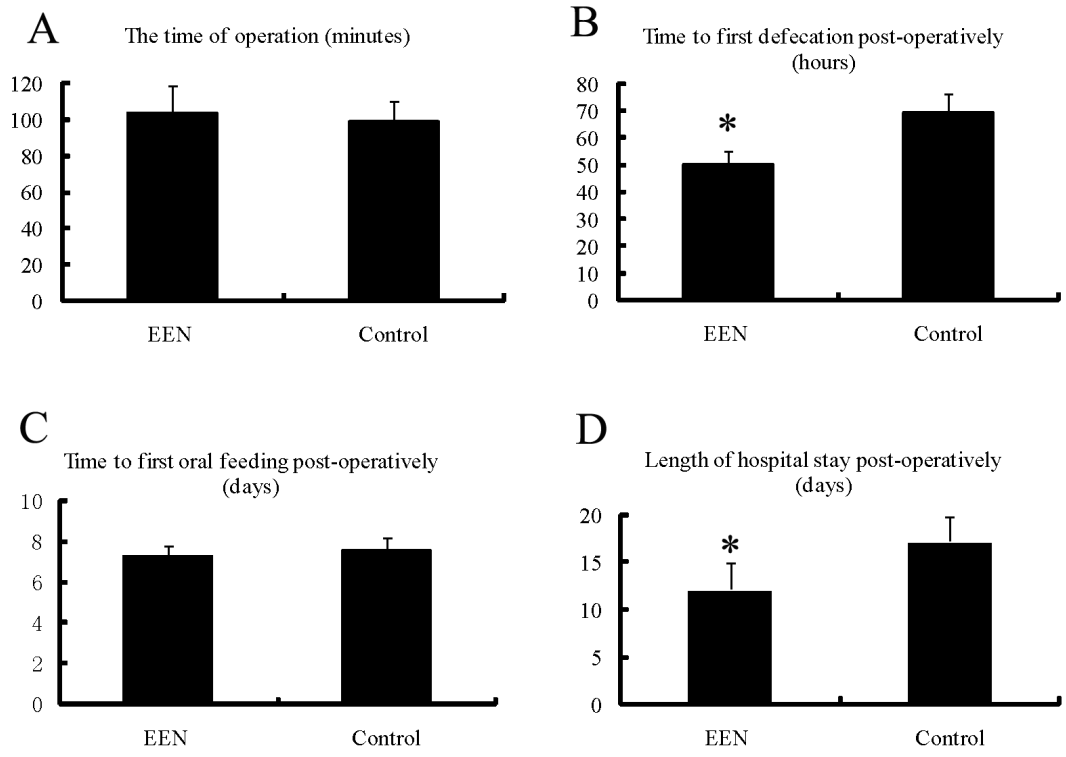

Figure 2. (A)The operative time was not significantly different between the two groups. (B) The time to first defecation in the EEN group was significantly shorter than the control group. (C) Time to first oral feeding post-operatively was not significantly different between the two groups. (D) The hospital length of stay post-operatively in the EEN group was significantly shorter than the control group ($^{*}p<0.05$).

went repeat surgery in the TPN group for adhesive intestinal obstruction.

DISCUSSION

We have presented our experience with a 6-Fr jejunal feeding tube in neonates who have undergone a partial gastrectomy. No patients had tube plugging in the EEN group, and the incidence of cholestasis in the EEN group was lower than the control group.

There are multiple etiologies for neonatal gastric perforation, including congenital agenesis of the gastric muscle,[17] ischemia of the stomach wall resulting from asphyxia,[18] and C-KIT mast cell deficiency.[19] Gastric perforation in neonates usually occurs between 2 and 7 days of age.[20] All of these patients presented with gastric perforation in this study at 2-12 days of age, and most of the patients in the current study between 2 and 7 days of age.

In a study involving jejunal feeding in adults which commenced approximately 24 h post-operatively, tolerance of the feed and a shorter length of hospital stay were reported.[21,22] Considering the edema and paralysis of the intestines and tolerance of the neonates however, in our study jejunal feeding commenced approximately 48 h post-operatively. Patients with peritonitis resulting from gastric perforation (chemical peritonitis and septic bacterial peritonitis) differ from most other gastrointestinal procedures because of the edema and paralysis of the intestines. Many other studies have demonstrated that EEN is feasible in patients with perforation peritonitis. EEN reduces septic morbidity and is feasible in patients with perforation peritonitis.[23] Moreover, EEN is well-tolerated in patients with perforation peritonitis, helps to reduce the duration of ileus post-operatively, and reduces the incidence of complications.[24]

Pneumonia is one of the potential complications in neonates who receive EEN.[25] In the current study, a micropump was used for continuous infusion EN. There were only two patients who developed pneumonia in the EEN group.

A high-osmotic EN liquid infused directly into the jejunum will cause diarrhea. As a result, diarrhea is the most frequently reported complication in the EEN group in many other studies.[12-15] Pepti-Junior is a depth-hydrolyzed protein formula powder (80% short peptides + 20% amino acids). The osmotic pressure of Pepti-Junior is 210 mOsm/kg. Pepti-Junior contains glutamine, which helps to restore intestinal function, so we chose Pepti-Junior as the EN liquid. The low osmolality of Pepti-Junior may reduce the incidence of diarrhea in neonates who receive EEN; indeed, in the current study, the incidence of diarrhea was very low. Moreover, for the low osmotic pressure of Pepti-Junior, neonatal necrotizing enterocolitis was not observed.

With EEN, the liver serves as the first site for processing nutritional components and can increase bile excretion, which can facilitate the treatment of cholestasis caused by infections or fat emulsion in PN. Indeed, in the current study a significant reduction in cholestasis was

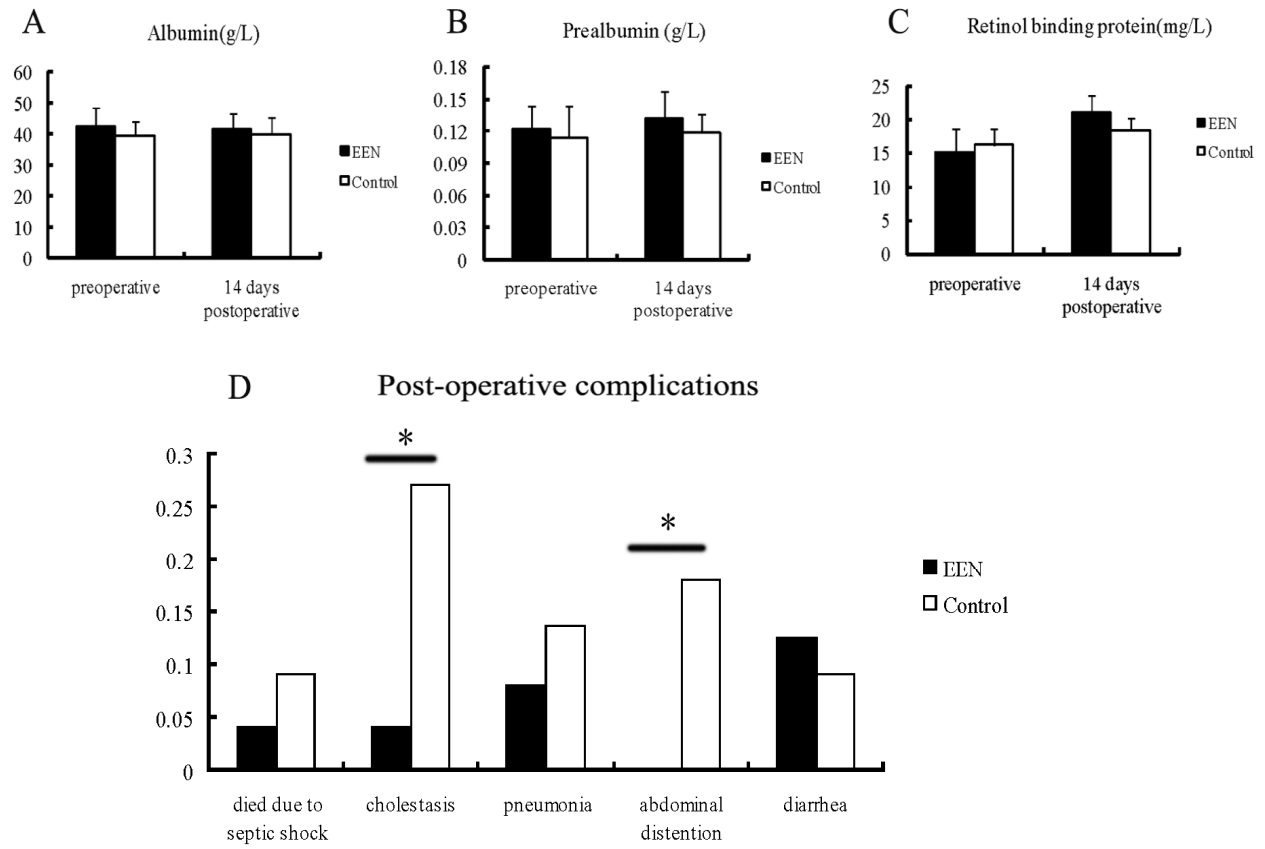

Figure 3. Levels of albumin. (A) prealbumin. (B) and retinol binding protein. (C) were not significantly different between the two groups pre-operatively and 14 days post-operatively. (D) The incidence of cholestasis and abdominal distension in the EEN group was significantly lower than the control group. The incidences of mortality and pneumonia were lower than the control group, but the differences were not significant ($^{*}p<0.05$).

observed in the EEN group compared to the control group.

EEN after gastrointestinal tumor resection has been shown to have a lower incidence of infections.[26-29] Indeed, in the current study a reduction in septic complications, albeit not statistically significant, was observed in the EEN group compared to the control group.

Our intent in the group in which micro-feeding of EEN was implemented was to improve the intestinal blood circulation, protect the intestinal mucosal barrier, promote the recovery of intestinal peristalsis and function, and reduce adhesion formation. Indeed, in the current study a significant reduction in abdominal distention was noted in the EEN group compared to the control group.

In addition to reducing the complication rate, there are other advantages of administering EEN via a jejunal feeding tube and micro-feeding. A shorter length of hospital stay in the EEN group was observed in this study because EN was started early, so the amount of oral feeding increased faster and a similar outcome has been observed in other studies.[30,31]

Previous studies have demonstrated that EEN has many benefits for malnourished patients. EEN improves nutritional status by increasing nutrient intake in the intestine[32-34] and altering the hypermetabolic response after surgery.[35] The half-life of serum albumin is 20 days, thus the suitability of an albumin level for assessment of nutritional support is controversial. Retinal binding protein and prealbumin have a short half-life and are more sensitive parameters for assessment of supplementation on the nutritional status. However, in the present study the nutritional status based on the levels of albumin, prealbumin, and retinol binding protein was not significantly different in EEN group compared to the control group 2 weeks post-operatively. When we provide nutrition for these patients, the calories between the two groups is considerable, so there is no significant difference in the nutrition indices in the two groups.

EEN support is an important part of the care of critically ill neonates post-operatively. The current study showed that a jejunal feeding tube following a partial gastrectomy is safe, feasible, well-tolerated, and associated with fewer complications and better clinical outcomes. Clearly, further research is needed to collect additional data.

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AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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Original Article

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新生儿胃部分切除术中的早期肠内营养：一个多中心研究

背景与目的：研究表明肠内营养比完全肠外营养更适合在术后运用。本文主要目的是研究新生儿胃部分切除术后运用空肠营养管的安全性和可行性。**方法与研究设计：**回顾性研究 46 例胃穿孔行胃部分切除术的病人。这些病人被分为两组，早期肠内营养组（24 例），空肠营养管在术中放置；完全肠外营养组即对照组（22 例），未放置空肠营养管。比较两组的手术时间、术后首次排便时间、术后首次经口喂养时间，术后住院时间，营养指标、术后并发症如脓毒症导致的死亡率，胆汁淤积、肺炎、肠粘连、腹泻等。**结果：**手术时间和术后首次经口喂养时间两组间差异无统计学意义。术后首次排便时间和术后住院时间肠内营养组均明显短于完全肠外营养组。总蛋白、视黄醇结合蛋白及前白蛋白肠内两组间术前和术后 14 天差异均无统计学意义。胆汁淤积和肠梗阻的发生率肠内营养组明显低于完全肠外营养组。**结论：**采用空肠营养管的早期肠内营养方法在新生儿胃穿孔行胃部分切除术后使用是安全和可行的，且并发症较少。

关键词：早期肠内营养、胃部分切除术、新生儿、完全肠外营养、胃穿孔