Early enteral feeding in newborn surgical patients

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Abstract

Objective: We report the results of a multicenter prospective trial of early enteral trophic feeding in a group of 56 neonates who required abdominal surgery for a variety of congenital anomalies.

Methods: In this clinical study, 33 neonates were fed in the early postoperative period (early enteral nutrition [EEN] group), and the remaining 23 (control [C] group) were fasted until resolution of postoperative ileus. Patients in the EEN group (Kocaeli feeding protocol) received 3 to 5 mL of breast milk every hour through a nasogastric feeding tube, starting a mean of 12 h (8 to 20 h) after surgery. The nasogastric tube was clamped for 40 min after each infusion and then opened for drainage. Groups were further divided into two subgroups according to whether an intestinal anastomosis or laparotomy was performed. The change in daily gastric drainage, time to first stool, day of toleration to full oral feeding, and length of hospital stay were compared. Blood bilirubin levels, white blood cell count, and C-reactive protein levels were monitored.

Results: The time to first stool and day of toleration to full oral feeding occurred significantly sooner, whereas nasogastric tube drainage duration and hospital stay were significantly shorter in the EEN-anastomosis group than in the C-anastomosis group. Time to first stool occurred significantly sooner in the EEN-laparotomy group than in the C-laparotomy group, although other parameters did not differ. Neither anastomotic leakage nor dehiscence was observed in any group. There were two cases of wound infection and two of exitus among patients in the C group.

Conclusion: Postoperative, early intragastric, small-volume breast milk feeding is well tolerated by newborns. It is a reliable and feasible approach in neonates even in the presence of an intestinal anastomosis after abdominal surgery.   © 2005 Elsevier Inc. All rights reserved.

Keywords: Neonate; Early enteral nutrition; Trophic nutrition; Abdominal surgery

Introduction

Early enteral nutrition (EEN) after abdominal surgery has been the subject of several studies in adults, but there are limited data in pediatric surgical patients especially in newborns [1–5]. Cessation of enteral feeding in the neonatal period may delay enteric maturation, diminish enzymatic activation, thin enteric mucosa, and atrophy enteric villae [6–9]. It has also been proposed that prolonged starvation may cause bacterial translocation and predispose serious infections in conjunction with starvation-related immune deficiency [3,10,11]. The adverse effect of prolonged starvation on tissue regeneration also has been reported [12,13]. Postoperative convalescence of newborn infants with surgically corrected obstruction of the small intestine is frequently prolonged because of delayed motility in the intestine proximal to the obstruction. Due to those deleterious effects of fasting, EEN is preferred to parenteral nutrition.

This study evaluated and compared clinical outcomes and possible benefits of small-volume EEN on prolonged fasting after abdominal surgery in newborns.

Materials and methods

A prospective, multicenter study was carried out in newborn pediatric surgical patients from January 2000 to April

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Table 1
Demographic data of patients

	EEN-L	EEN-A	C-L	C-A
Male/female	14/4	10/5	7/5	7/4
Age (d)*	7 (1, 38)	10 (2, 40)	5 (1, 18)	10 (1, 33)
Weight (g)*	2800 (1500, 4300)	2700 (1900, 3100)	2700 (2400, 3740)	2800 (1700, 3550)
Patients (n)	18	15	12	11

C-A, patients who underwent fasting and anastomosis; C-L, patients who underwent fasting and laparotomy; EEN-A, patients who received early enteral nutrition and anastomosis; EEN-L, patients who received early enteral nutrition and laparotomy

* Values are mean (minimum, maximum).

2003. Fifty-six newborns who underwent upper abdominal operations for various reasons were randomized consecutively to an EEN group or a control (C) group. These groups were further divided into subgroups according to whether an intestinal anastomosis (EEN-A and C-A groups) or a laparotomy (EEN-L and C-L groups) was performed (Table 1).

The EEN-L and C-L groups included patients who presented with gastroschisis, omphalocele, or diaphragmatic hernia and required creation of an enterostomy because of aganglionosis or anorectal malformation. The EEN-A and C-A groups included patients who had duodenal, jejunal, or ileal atresia and other disorders such as intestinal lymphangioma. These patients underwent a series of operative procedures such as intestinal anastomosis with or without segmental resection and ileostomy closures. Patients who presented with intestinal perforations were excluded from the study.

EEN (according to Kocaeli feeding protocol) was performed under informed consent from parents. Patients in the EEN group were given 3 to 5 mL of breast milk every hour through a simple nasogastric (NG) feeding tube, starting at a mean of 12 h (8 to 20 h) after surgery irrespective of bowel movement and defecation. The NG tube occluded for 40 min after each feeding and was left open for free drainage for the next 20 min. Daily gastric drainage was collected for evaluation. The feeding amount was increased in 5-mL increments when the total amount of daily gastric fluid drainage decreased to less than 30% of the given volume of breast milk. In case of abdominal distention, the regimen was reverted to the previous dose but never interrupted. The difference between daily gastric fluid drainage and the given volume of breast milk was assessed to measure the possible amount of daily absorption.

Patients in the C group received the traditional protocol of postoperative feeding. All patients were fasted until resolution of postoperative ileus. Daily gastric drainage from NG tubes was collected for evaluation. Documentation of return of normal bowel functions such as normal bowel sounds and passage of gas or stool was considered sufficient for removal of the NG tube. These patients were initially started on clear fluids only and progressed to breast feeding in accordance with their clinical outcome. In case of abdominal distention or vomiting, feeding was interrupted until resolution of symptoms.

Age and weight at presentation, sex, amount of daily NG tube drainage, duration of drainage, time to first stool, time needed for total enteric nutrition, duration of hospitalization, clinical signs and symptoms such as vomiting, abdominal distention, and wound infection were assessed, and white blood cells counts, blood bilirubin, and albumin levels were compared. Statistical analysis was performed with SPSS 10.0 (SPSS, Inc., Chicago, IL, USA). To compare specific variables, an extended chi-square test was used. Mann-Whitney U test was used for non-parametric analysis of continuous distributed variables. $P < 0.05$ was considered statistically significant with a power of 76%.

Results

Fifty-six neonates (39 male and 17 female) with a mean age of 8.3 d (1 to 40 d) and mean weight of 2800 g (1500 to 4000 g) were enrolled in the study. Demographic data of the groups are listed in Table 1. There were 33 patients in the EEN groups and 23 in the C groups. There was no statistically significant difference across groups with regard to age, sex, and weight distribution.

Different aspects of clinical outcome were compared across groups (Tables 2 and 3). An initial overall comparison was evaluated between the EEN and C groups. A more detailed study was also performed, in which results were compared between groups EEN-L and C-L and between groups EEN-A and C-A.

Passage of first stool was observed significantly sooner in the EEN-L group (Table 2; $P = 0.002$). There was no statistically significant difference regarding duration of NG feeding, time needed for full oral feeding, and hospital stay between groups EEN-L and C-L. White blood cell counts and blood levels of bilirubin and albumin did not differ statistically between groups EEN-L and C-L.

Passage of first stool was observed significantly sooner, whereas duration of NG feeding, time needed for full oral feeding, and hospital stay were significantly shorter in group EEN-A than in group C-A (Table 2; $P < 0.05$). White blood cell counts and blood levels of bilirubin and albumin were not significantly different between groups EEN and C (Table 2).

During postoperative follow-up, abdominal distention was a common observation. In contrast with this finding, a higher frequency of vomiting was observed in the C groups (Table 3).

Table 2
Comparison of clinical and laboratory data

	EEN-L	C-L	P	EEN-A	C-A	P
First defecation (h)	25.3 ± 12.8	52.2 ± 32.9	0.002*	35.8 ± 18.1	59.8 ± 31.7	0.02*
Duration of NG feeding (d)	4.7 ± 3.0	7.9 ± 8.9	0.96	6.9 ± 2.5	13.6 ± 9.3	0.01*
Full oral feeding (d)	6.3 ± 3.4	9.5 ± 9.3	0.61	8.4 ± 2.6	15.4 ± 10.2	0.01*
Hospital stay (d)	9.6 ± 6.1	14.1 ± 11.2	0.36	12.3 ± 6.1	21.4 ± 10.4	0.001*
WBC (after feeding)	$12\,400 \pm 5378.8$	$11\,533 \pm 3910.6$	0.44	$17\,113 \pm 2438.4$	$13\,363 \pm 6365.4$	0.44
Total bilirubin	12.2 ± 2.1	11.7 ± 4.1	0.07	12.8 ± 24.2	13.1 ± 18.5	0.07
Blood albumin	5.6 ± 3.1	5.8 ± 2.4	0.07	5.32 ± 3.7	5.11 ± 4.2	0.07

C-A, patients who underwent fasting and anastomosis; C-L, patients who underwent fasting and laparotomy; EEN-A, patients who received early enteral nutrition and anastomosis; EEN-L, patients who received early enteral nutrition and laparotomy; NG, nasogastric; WBC, white blood cells

* Significant at $P < 0.05$.

We did not encounter any anastomotic problems in groups EEN-A and C-A. Four patients (12.1%) from the EEN groups and three of five (21.7%) patients from the C groups showed signs of temporary clinical deterioration during the postoperative period. Wound infections and death were not observed in the EEN groups. Two wound infections were detected, and two patients in the C groups died (8.7%; Table 3).

Discussion

Postoperative ileus, nausea, and vomiting are part of a pathophysiologic reaction to abdominal surgery and traditionally have been considered obligatory responses. It has long been believed that cessation of oral intake is necessary for prevention of aspiration due to vomiting and possible anastomotic leakage after abdominal surgery. Enteral feeding has long been delayed, classically and traditionally, after abdominal operations until the occurrence of bowel movements or defecation [4,14,15].

Experimental and clinical studies have shown that traditional restriction of oral intake after abdominal surgery has no basis on scientific evidence [16], although the benefits of enteral feeding such as enhancement of immunocompe-

Table 3
Evaluation of clinical parameters between groups EEN and C*

	EEN ($n = 33$)	C ($n = 23$)
First defecation (h)[†]	31.9 ± 18.8	55.3 ± 32.0
Duration of NG feeding (d)	5.7 ± 2.9	10.6 ± 9.3
Normal oral feeding (d)	7.3 ± 3.2	12.3 ± 10.0
Vomiting	5 (15.5%)	5 (21.7%)
Abdominal distention	14 (42.4%)	7 (30.43%)
Wound infection	0	2 (8.6%)
Clinical deterioration	4 (12.1%)	5 (21.7%)
Mortality rate	0	2 (8.6%)
Hospital stay time (d)[†]	10.8 ± 6.1	17.6 ± 11.2

C, patients who underwent fasting and anastomosis or laparotomy; EEN, patients who received early enteral nutrition and underwent anastomosis or laparotomy; NG, nasogastric;

* Values are mean $\pm$ standard deviation or numbers (%) of patients.

[†] Significant at $P < 0.05$.

tence, decreased rates of clinical infection, and maintenance of gut structure with functional and potential attenuation of catabolic stress response in surgical patients are widely accepted [6,17–19]. Our current knowledge dictates that peristalsis of the small intestine recovers 6 to 8 h after surgical trauma, and that moderate absorptive function is preserved even in the absence of peristalsis, making infusion of nutrients possible soon after operation. Moreover, the direct passage of food stuff in the gut lumen increases splanchnic blood flow and stimulates the gut immune system [3,20]. The feasibility of immediate postoperative feeding through an NG tube or jejunostomy recently has been shown in extensive clinical reports [14,17,18].

A newborn patient undergoing major surgery represents more complex therapeutic problems than its adult counterpart because of the smaller body, high variability in fluid requirements, rapid growth rate, and continuation of maturation in addition to increased caloric needs and low caloric reserves. Caloric needs can be matched by total parenteral nutrition, but this has its own metabolic and technical complications. Total parenteral nutrition also leads to an increase of free radicals, further suppressing the immune response of patients [12]. Enteral nutrition has gained increased interest of pediatric and/or neonatal intensive care units [7–9,21], but there are only limited data in the literature regarding postoperative EEN in the pediatric population, especially in newborns [14,22].

Proximal hypomotility after surgery in neonates with intestinal obstruction delays the return of normal intestinal motility and prolongs the starving period. Prolonged starvation before completion of enteric mucosal development has been shown to lead to mucosal atrophy and villous flattening [1,6,14]. Increased intestinal permeability due to this mucosal injury further facilitates infections through enteric bacterial translocation [1,10,17]. Prolonged starvation produces thinning of the intestinal mucosa accompanied by villous shortening and decreased enzymatic activity. Small-volume EEN is not intended to meet the full caloric needs of a newborn undergoing abdominal surgery. It is mainly intended to improve enterocyte maturation (trophic effect) and thus prevent further intestinal atrophy. Berseth and Nordyke

[8] and Williams [9] reported significant improvements in intestinal function when using such trophic nutrition. Moore et al. [17] carried out the first clinical studies that demonstrated a clear benefit with early enteral feeding.

Many published reports have advocated continuous infusion of nutrients through a transanastomotic catheter or an enterostoma after abdominal surgery [3,14,18,23]. The optimal volume for initiation and gradual advancement in early enteral feeding is still under investigation [21]. Another topic of interest is the choice of the appropriate type of nutrients according to age and disease. In neonatal intensive care units, breast milk at 5 to 20 mL $\cdot$ k^{-1} $\cdot$ h^{-1} is used frequently for continuous enteral infusion [7,21,24]. In our trial, we preferred to use the more physiologic gastric route through simple NG tubing. We hoped to avoid further complications due to enterostomas. The daily amount of nutrient given (3 to 5 mL/h of breast milk) was in accordance with the routine practice reported from a neonatal intensive care unit.

In several series, early enteral feeding has been reported to have no beneficial effects due to side effects such as distention, nausea, and vomiting after major gastrointestinal surgery [2,5]. To prevent distention and vomiting, we used 20 min of free drainage intervals before each feeding. Fourteen patients from the EEN groups (42.40%) and seven from the C groups (30.43%) in our study developed abdominal distention, but vomiting was observed less frequently in the EEN groups than in the C groups (Table 3). We regard an hourly intermittent cycling enteral feed followed by concomitant drainage as a physiologic approach compared with continuous enteral infusion in neonates, especially after abdominal surgery.

Beneficial effects of intraluminal content on intestinal motility have been reported in different studies [3,14,15,23]. One prominent feature of our study was the beneficial effect of EEN on duration of postoperative ileus. Postoperative passage of first stool was observed significantly sooner in the EEN groups than in C groups (Table 2; $P < 0,05$). Return of normal intestinal motility may be delayed up to 3 wk after repair of gastroschisis or duodenal atresia due to prolonged intestinal adaptation. Sharp et al. [22] reported that EEN decreases hospital stay and may improve outcome in patients who have gastroschisis. Early introduction of enteral feeding has been reported to accelerate the transit time from initiation of oral feeds to full oral feeding [2,13,23]. The transit time from initiation to full oral feeding was significantly decreased in the EEN-A group compared with the C-A group (8.4 $\pm$ 2.6 versus 15.4 $\pm$ 10.2 respectively; $P < 0.05$).

Beier-Holgersen et al. [11] established that EEN after abdominal surgery importantly decreases infectious complications. Because the gastrointestinal tract is one of the largest immune organs within the body, strategies to maximize its immune function may improve outcomes in infants and help prevent or minimize the risk of infection. No wound infections were observed in the EEN groups in our study. In addition, the absence of mortality in the EEN groups may be a clue to an improved immune resistance, thus diminishing the risk of infection even in such a small study group.

It has long been believed that postoperative fasting aids in preventing an intestinal anastomosis from dehiscence. This argument has not been proved by any means of scientific data. In contrast, increased wound healing and anastomotic strength have been demonstrated with EEN in experimental and clinical studies [19,25–27]. It is also clear that a normal physiologic amount of intraluminal fluid passing through an anastomosis in a fasting patient would be no less than a few liters per day. Thus, an additional 100 to 150 mL of nutrients would likely cause no harm to the anastomotic site. Despite the transanastomotic passage of nutrients in our patients under the EEN protocol, we did not confront any complications related to the anastomosis site. Sangkhathat et al. [28] reported that EEN stimulates early bowel movement and decreases hospital stay without increasing adverse effects after colostomy closure in pediatric patients.

A meta-analysis showed that duration of hospitalization was shorter in 8 of 11 studies on EEN [25]. The present study also showed that hospital stay was significantly shorter in the EEN groups.

In conclusion, early, intragastric, small-volume breast feeding is well tolerated by newborns in the postoperative period, and its benefits are valuable regardless of the type of abdominal operation performed. We also advocate the use of small-volume nutritional support according to our feeding protocol. The steady increase of nutritional elements in gradient within bowel fluids seems to provide a trophic effect on gut mucosa and prevent adverse effects of prolonged fasting in a neonate.

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