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Enteral refeeding is useful for promoting growth in neonates with enterostomy before stoma closure☆

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ABSTRACT

Background: Enterostomy may lead to fluid and electrolyte imbalance, or impaired absorption of nutrition followed by impairment of growth. This study aimed to clarify the effectiveness of enteral refeeding (ER) in premature and full-term neonates.
Methods: A retrospective database of all consecutive neonates who had enterostomy during 2000–2014 in a regional center was analyzed. Thirteen patients with ER (ER group) and 14 patients without ER (control group) were included. Detailed clinical data were evaluated with reference to the increment in body weight during ER.
Results: The ER group had a significantly higher rate in weight gain compared with the control group ($P = 0.0012$), despite the gestational age (<37 weeks: $P = 0.0012$, ≥37 weeks: $P = 0.029$). ER starting at a lower body weight was also associated with a higher weight gain ($P = 0.0002$). Moreover, univariate and multivariate analyses showed that only the ER procedure ($P < 0.0001$) and birth weight ($P = 0.049$) were significantly independent predictors of good weight gain.
Conclusions: Using ER, low-birth-weight infants may have benefits, such as better acceleration of growth, than normal-birth-weight infants. We do not hesitate to perform ER, even in low-birth-weight neonates or those with low body weight, when starting ER.

During recent years, the percentage of low-birth-weight infants with congenital or acquired intestinal disorders, such as atresia, necrotizing enterocolitis, and meconium-related ileus, has increased. These infants often require creation of temporary enterostomy. Enterostomy that is located in the jejunum or proximal ileum may result in large ostomy losses, leading to fluid and electrolyte imbalance, metabolic acidosis, and impaired absorption of nutrients. This condition may lead to adverse effects on growth and development as a result of nutritional and electrolyte imbalance [1,2]. These infants also require management of total parenteral nutrition. Total parenteral nutrition is associated with a significant risk of catheter-related blood stream infection, thrombosis, and neonatal cholestasis.

Refeeding of proximal stoma effluent through a distal mucous fistula uses the absorptive surface of the distal bowel for nutrient absorption, stimulates mucosal growth and intestinal adaptation, and prevents atrophy of the distal bowel [3]. This technique was first described by Puppala et al. and has been proven as safe in a small series of neonates with postoperative short gut syndrome[1,3–8].

To date, analysis of better factors for outcome of the enteral refeeding (ER) procedure in infants has not been performed. Therefore, this study aimed to evaluate the effectiveness of ER by evaluating the rate in gain of body weight.

1. Patients and methods

A retrospective database of all consecutive infants who had enterostomy from January 2000 to December 2014 in our unit was analyzed. In the study period, many neonatal patients who had a temporary small bowel enterostomy received a stoma closure operation within 2 weeks from the first surgery. ER patients had a temporary small bowel enterostomy for longer than 2 weeks from the first surgery. To clarify the effectiveness of the ER procedure compared with patients without the ER procedure, only neonatal patients who had small bowel enterostomy for longer than 14 days were included in this study as the control group. In all of the studied patients, written consent that comprised a retrospective chart review under anonymity was obtained from the patients' parents. After 2008, we started the ER procedure. We informed the patients' parents about management of ER, including information that there might be a risk of intestinal perforation. After these explanations, we left the final decision to the patients' parents. Finally, only patients who had received the ER procedure with consent from their parents were included in this study as the ER group.

During the study period, 46 neonatal patients who had temporary small bowel enterostomies and matched the above-mentioned protocol were included in this study. The study design is shown in Fig. 1. Of the 46 patients, six died before stoma closure was performed because of

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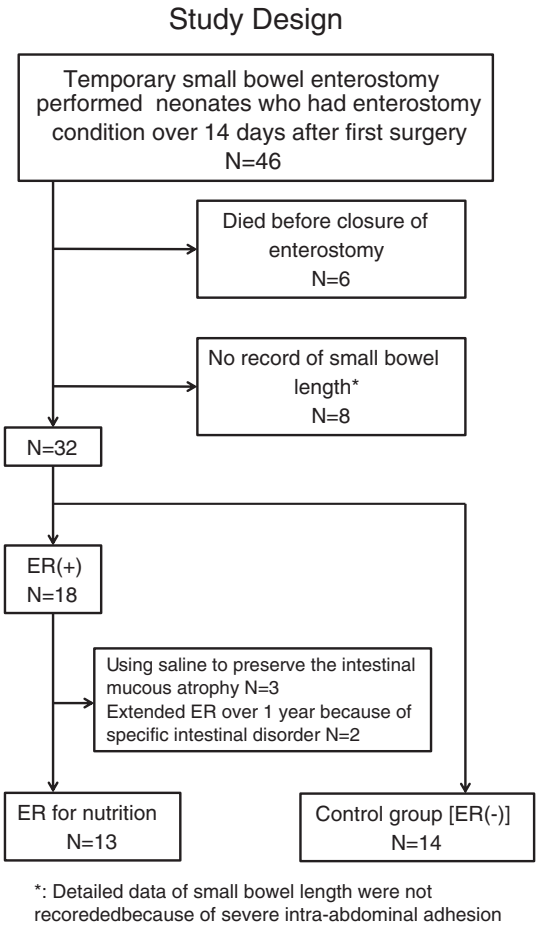

Fig. 1. Study design.

severe sepsis or pulmonary dysfunction. In eight patients, we could not record the small bowel length because of intra-abdominal adhesion, such as meconium peritonitis. In the remaining 32 patients, 14 neonates without the ER procedure were selected as the control group. The remaining 18 patients who had enterostomy performed were treated by the ER procedure. Of the 18 patients with ER, three had ER by using saline to preserve intestinal mucosal atrophy and another two had an extended ER procedure over 1 year because of specific intestinal disorders (extended aganglionosis and Hirschsprung's disease-allied disorders). Except for these five patients, 13 patients were treated by ER to improve their nutritional status before stoma closure. These patients who had ER were defined as the ER group. The 13 patients with ER and the 14 patients without ER (control group) were analyzed to evaluate the effectiveness of ER by evaluating the increment in weight gain.

Management of ER was performed using the New Enteral Feeding Tube (size 5 Fr or 6.5 Fr; Covidien, Japan). We first inserted this tube from a distal enterostomy under fluoroscopy to confirm the safety of using the distal small bowel and its patency by radiographic contrast medium. If patients who are planning to have ER have stenosis or occlusion, or stasis in the distal intestine, they are recognized as contraindications of ER. After confirmation of safety, including the insertion length (range, 3–8 cm), this tube was attached by an ostomy pouch through a small hole with waterproof film. Stool was collected every 4 h, and collected stool was filtrated by dry gauze. Only filtrated fluid was aspirated into a syringe because consisted stool could cause occlusion of the feeding tube. The syringe was placed into a syringe pump, which had been programmed to deliver the stool within 4 h to reduce bacterial overgrowth. This basic ER procedure was performed according to a previous method reported by Gardner et al. [1].

We recorded birth weight, the position of the enterostomy from the Treitz ligament (cm), the small bowel length from the distal enterostomy to the terminal ileum (cm), oral feeding or age at the start of ER, oral feeding or ER time (oral feeding time: duration from the start of oral feeding to starting ER; ER time: from the start of ER to anastomosis), and body weight at oral feeding or the starting point of ER. Patients whose clinical data were unreferenced because of severe intra-abdominal adhesion were excluded from this study. To analyze the effectiveness of ER, a control group without ER was also included to analyze the effectiveness of ER. In the control group, the oral feeding time was defined as the duration of the start of oral feeding to anastomosis.

The rate of gain in body weight in the ER and control groups was calculated by the following formulas:

ER group

$$\text{Rate of weight gain during ER} = (\text{BW at anastomosis} - \text{BW at start of ER})/\text{days of ER}$$

$$\text{Rate of weight gain during oral feeding without ER} = (\text{BW at just before the start of ER} - \text{BW at the start of oral feeding})/\text{days of oral feeding}$$

Control group

$$\text{Rate of weight gain in only oral feeding} = (\text{BW at anastomosis} - \text{BW at the start of oral feeding})/\text{days of ER}$$

BW: body weight

1.1. Statistical analysis

We used the statistical program JMP 6.0 (SAS Institute, Cary, NC, USA) to analyze the data. The Mann–Whitney U test, the chi-square test, and the Student's t test were used to analyze differences between the ER group and control group. Values of $P < 0.05$ were considered significant. After univariate analysis, predictive markers were included in a multivariate logistic regression model. Those markers with a P value of <0.1 in univariate analysis were included in multivariate analysis.

2. Results

The detailed data of 13 patients with ER are shown in Table 1. In the ER group, mean gestational age was 34.4 weeks (range, 27–41 weeks). Mean birth weight was 2.00 kg (range, 0.57–3.28 kg). The mean position of the enterostomy from the Treitz ligament was 53.8 cm (range, 10–110 cm) and the mean small bowel length used was 33.6 cm (range, 7–55 cm). The mean time span between initial surgery and the start of ER was 39.5 days (range, 8–97 days). The mean duration of ER was 26.2 ± 14.9 days (range, 8–59 days).

The characteristics of the patients in the ER and control groups are shown in Table 2. In all of the patients, there were no significant differences in sex, gestational age, birth weight, position of enterostomy, small bowel length from the distal enterostomy to the terminal ileum, ER and oral feeding times until the closure of enterostomy, and body weight at starting ER or oral feeding after the initial operation of enterostomy between the ER and control groups. The age of starting ER and oral feeding in both groups widely varied. This explained why some patients had an extended postoperative paralytic ileus or severe sepsis postoperatively in this study. In both groups, intestinal atresia and meconium-related ileus were leading etiologies. Enterostomies were performed because of intestinal perforation and discrepancy in the cross-sectional diameters of the proximal and distal bowel end after resection. All of the patients had an ileocecal valve after initial surgery. ER was successfully established after initial surgery in all of the patients, with no complications.

There was a significant positive correlation between the position of the enterostomy from the Treitz ligament and the rate of gain in body weight in all of the patients (Fig. 2A). In the ER group, there was also a