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Efficacy of semi-solidification of enteral nutrients for postoperative nutritional management with a nasogastric tube

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ABSTRACT

Postoperative nutritional management with a nasogastric tube is often used to prevent malnutrition after oral and maxillofacial surgery. However, enteral nutrients (EN) may cause various complications due to their liquid formulation. In this study, we retrospectively evaluated the efficacy of semi-solid EN with a xanthan gum thickener through a nasogastric tube and examined patients' complications, nutritional status, and quality of life. We established two groups: an L group (n=20) to which we administered liquid EN, and an SS group (n=20) to which we administered semi-solidified EN. The primary outcome was the occurrence of gastrointestinal complications. The secondary outcome was a change in nutritional status based on body weight and controlling nutritional status. The other outcome was the improvement in the patients' quality of life, assessed by the administration time. During nutritional management with a nasogastric tube, the median daily administration time in the L group was 9.0 hours, and 9 patients experienced diarrhea. In the SS group, the median daily feeding time was 2.3 hours, and only 2 patients experienced diarrhea. Both groups exhibited a decrease in body weight while controlling nutritional status scores were maintained. Semi-solidification of EN may be useful for postoperative nutritional management after oral and maxillofacial surgery by reducing complications, maintaining nutritional status, and shortening administration time.

Keywords: nutritional management, nasogastric tube, enteral nutrients, semi-solidification

Abbreviations:
EN: enteral nutrients
QOL: quality of life
ALB: serum albumin concentration
CHOL: total cholesterol concentration
CONUT: controlling nutritional status
LYM: total peripheral lymphocyte counts

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INTRODUCTION

In the field of oral and maxillofacial surgery, postoperative nutritional management with a nasogastric tube is often chosen. However, enteral nutrients (EN) may cause gastrointestinal, infectious, and metabolic complications due to their liquid formula.[1] Clinicians are empirically testing various measures, such as adjusting the dose, rate, and temperature of EN administration, to prevent such complications.[1] Semi-solidified EN have several advantages, including reduced cases of diarrhea and aspiration pneumonia, and are usually administered in rehabilitation, long-term care, and home settings via percutaneous endoscopic gastrostomy owing to the high viscosity.[2,3] In recent years, administering semi-solidified EN via a nasogastric tube was introduced in clinical practice.[4,5]

In this study, we retrospectively examined the efficacy of semi-solidification with xanthan gum thickener in terms of patients' complications, nutritional status, and quality of life (QOL). Xanthan gum is an anionic polysaccharide that can be obtained by microbial fermentation from *Xanthomonas campestris*. It is a natural polymer broadly employed in numerous food products and is also used as a thickener for patients with dysphagia.[6] There are some reports on the semi-solidification of EN with sodium alginate thickener applied to nasogastric tube feeding in the field of oral and maxillofacial surgery.[4,5] Semi-solidification of EN with sodium alginate thickener occurs under acidic conditions in the stomach. Therefore, semi-solidification does not occur under elevated gastric pH conditions, such as in the elderly patients with reduced gastric acid secretion.[7] On the other hand, semi-solidification with xanthan gum thickener does not depend on the gastric pH conditions. However, no study has investigated xanthan gum thickener for the semi-solidification of EN.

MATERIALS AND METHODS

Patients

We conducted a retrospective cohort study among 40 patients who received postoperative nutritional management with a nasogastric tube after oral and maxillofacial surgery at Toyota Kosei Hospital from April 2014 to March 2017. To evaluate gastrointestinal complications, patients taking gastric acid-suppressing drugs, anticancer drugs, and radiation therapy were excluded from the study. Patients who might have food allergies to the EN being administered were also excluded. This study complied with ethical guidelines and was approved by the Medical Research Ethical Board at Toyota Kosei Hospital (2019-ST42). Informed consent to participate was obtained in the form of patients being provided with an opportunity to opt-out on the institution's website.

Postoperative nutritional management with a nasogastric tube

We established two groups according to the period of postoperative nutritional management: the L group (n=20) to which we administered EN in a liquid formula from April 2014 to September 2015, and the SS group (n=20) to which we administered semi-solidified EN from October 2015 to March 2017. Postoperatively, a nasogastric tube (Zeon EN Catheter® 10Fr, Zeon Medical Inc., Tokyo, Japan) was inserted through the nasal cavity and the tip was placed in the stomach. On the day after the surgery (postoperative day 1), 250 mL of EN diluted twice with plain hot water was administered at approximately 100 mL/h from the administration bag to patients in a sitting or semi-sitting position. Ensure H® (Abbott Japan Co., Ltd., Tokyo, Japan) served as the EN in all cases. In the L group, the planned dose of undiluted EN was administered at 100 mL/h on and after the second postoperative day. In the SS group, EN was administered in

the same manner as the L group but on the first postoperative day. Thereafter, from the second postoperative day, 1 g of a thickener (Neo-High Toromeal III®, Foodcare Inc., Kanagawa, Japan) was added to 250 mL of EN immediately before the start of the administration. The mixture was stirred and then administered at approximately 400 mL/h. The semi-solidification of EN in this study was based on the previous literature.[8] We confirmed the state of the semi-solidified EN and checked whether or not the nasogastric tube was blocked before administering. When a patient could not tolerate the EN associated complications such as diarrhea, we adjusted the administration rate adjustment. The planned dose was calculated at 30 kcal/kg/day according to the body weight.

Measurement of outcomes

The primary outcome was the occurrence of mechanical, gastrointestinal, infectious, and metabolic complications. In our study, diarrhea was defined as watery or muddy stools more than 5 times a day.

The secondary outcome was the change in nutritional status based on body weight and the controlling nutritional status (CONUT) during nutritional management. The CONUT was calculated from the serum albumin concentration (ALB), the total peripheral lymphocyte counts (LYM), and the total cholesterol concentration (CHOL).

The other outcome was the improvement in the patients' QOL, assessed by the administration time. The daily administration dose and the achievement rate, which compared the administration of the nutrients with that of the planned dose, were measured, to assess the nutritional management.

Statistical analysis

JMP® Pro version 15.1.0 software (SAS Institute, Cary, NC, USA) was used to perform the chi-square test or Fisher's exact test for categorical variables, Mann-Whitney's U test for continuous variables, and Wilcoxon signed-rank test for the time-dependent difference. For all tests, a p-value <0.05 was considered statistically significant.

RESULTS

Patients

The characteristics of patients in the L and SS groups are described in Table 1. The distribution of the background condition for oral and maxillofacial surgery was similar in both groups. These conditions included fracture of the jaws, jaw deformity, and benign tumors. We observed no differences between the groups in terms of age, gender, height, weight, blood test, or CONUT.

Efficacy with regard to the primary outcome: occurrence of complications

Patients with multiple episodes of a complication were counted only once while evaluating the total number of complications. In this study, we observed only gastrointestinal complications and no mechanical, infectious, or metabolic complications. In the L group, 9 patients (45%) had diarrhea during nutritional management, as opposed to 2 patients (10%) in the SS group. The number of cases of diarrhea in the L group was thus significantly higher than that of the SS group (p=0.031). In the SS group, there was one patient who experienced nausea, two patients who experienced abdominal distension, and one patient who developed constipation. None of the patients in the L group developed any complication other than diarrhea (Table 2).

Table 1 Characteristics of patients

	L group	SS group	*p*-value
Patients, N (%)	20 (100)	20 (100)	
Gender			
Male, N (%)	12 (60)	14 (70)	0.507[a]
Female, N (%)	8 (40)	6 (30)	
Age (years), Median (IQR)	26 (19–42)	22.5 (19–59)	0.978[b]
Height (cm), Median (IQR)	166.5 (159.2–170.3)	166.1 (160.5–170.0)	0.989[b]
Body weight (kg), Median (IQR)	57.8 (49.7–63.7)	57.6 (50.5–66.6)	0.626[b]
Background condition			
Jawbone fracture, N (%)	13 (65)	12 (60)	0.809[c]
Jaw deformity, N (%)	5 (25)	4 (20)	
Benign tumor, N (%)	2 (10)	4 (20)	
Preoperative blood tests			
ALB (g/dL), Median (IQR)	4.5 (4.3–5.0)	4.4 (4.2–4.6)	0.157[b]
CHOL (mg/dL), Median (IQR)	150 (142–178)	156 (140–185)	0.597[b]
LYM ($\times 10^3/\mu L$), Median (IQR)	1.7 (1.2–2.1)	1.9 (1.2–2.2)	0.531[b]
CONUT (score), Median (IQR)	1(1–3)	1 (0–2)	0.492[b]

[a]Chi-square test, [b]Mann-Whitney U test, [c]Fisher's exact test.
N: number
IQR: Interquartile range

Table 2 Occurrence of complications

Complication	L group	SS group	*p*-value[†]
Patients, N (%)	20 (100)	20 (100)	
Nausea, N (%)	0 (0)	1 (5)	1.000
Abdominal fullness, N (%)	0 (0)	2 (10)	0.487
Constipation, N (%)	0 (0)	1 (5)	1.000
Diarrhea, N (%)	9 (45)	2 (10)	0.031*

Values are number (percentage).
[†]Fisher's exact test, *$p<0.05$

Efficacy with regard to the secondary outcome: change of nutritional status

For the blood tests, there was no difference in the SS group ($p=0.114$) for ALB, but this decreased significantly in the L group ($p<0.001$). In both the groups, LYM did not change (p=0.469; L group, $p=0.069$; SS group), but CHOL decreased ($p<0.001$; L group, SS group) during the nutritional management. When the CONUT score was calculated, we observed no difference between the groups ($p=0.058$; L group, $p=0.269$; SS group). The body weight was significantly reduced in both groups ($p=0.008$; L group, $p<0.001$; SS group) (Table 3).

Table 3 Change of nutritional status during nutritional management with a nasogastric tube

	L group		p-value†	SS group		p-value†
	Before	After		Before	After	
ALB (g/dL)	4.5 (4.3–5.0)	3.9 (3.8–4.1)	<0.001*	4.4 (4.2–4.6)	4.3 (4.1–4.5)	0.114
CHOL (mg/dL)	150 (142–178)	139 (128–173)	<0.001*	156 (140–185)	142 (129–169)	<0.001*
LYM ($\times 10^3/\mu L$)	1.7 (1.2–2.1)	1.6 (1.2–1.9)	0.469	1.9 (1.2–2.2)	1.5 (1.4–1.9)	0.069
CONUT (score)	1.0 (1.0–3.0)	2 .0 (1.3–3.8)	0.058	1.0 (0.0–2.0)	2.0 (1.3–3.0)	0.269
Body weight (kg)	57.8 (49.0–63.8)	57.2 (47.0–61.7)	0.008*	57.6 (50.5–66.6)	56.1 (48.8–63.9)	<0.001*

Values are Median (IQR).
†Wilcoxon signed-rank sum test, *p<0.05
Before: before nasogastric tube feeding
After: after nasogastric tube feeding

Efficacy with regard to the other outcome: measurement of the administration time, indicating the improvement in patient's QOL

The median of the management period was 11 days in the L group and 8 days in the SS group with no significant difference between the groups (p=0.145). The daily administration dose amounted to 1688 kcal in the L group and 1875 kcal in the SS group. The achievement rate for the planned dose was 98.3% in the L group and 95.6% in the SS group. There was no significant difference in the administration dose (p=0.766) and the achievement rate (p=0.675) between the two groups, but the daily administration time was significantly shortened to 2.3 hours in the SS group compared to 9.0 hours in the L group (p<0.001) (Table 4).

Table 4 Nutritional management

	L group	SS group	p-value†
Management periods (days)	11 (8–14)	8 (5–14)	0.145
Administration time (hours)	9.0 (7.8–10.3)	2.3 (2.0–2.4)	< 0.001*
Administration dose (kcal/day)	1688 (1500–1875)	1875 (1500–1875)	0.766
Achievement rate (%)	98.3 (91.5–102.8)	95.6 (89.0–103.9)	0.675

Values are Median (IQR).
†Mann-Whitney U test, *p<0.05

DISCUSSION

Patients usually have a functional gastrointestinal tract after undergoing oral and maxillofacial surgery. The administration of EN is favorable for postoperative nutritional management as it is more cost-effective than intravenous nutrition and results in fewer infections clinically.[9,10] However, EN often causes complications and may affect the patient's QOL. Patients must be confined to

bed or restrained during EN administration to ensure safety, which is time-consuming and may result in discomfort. In this study, we examined whether semi-solidification of EN was effective in improving QOL, preventing complications, and maintaining nutritional status during postoperative nutritional management with a nasogastric tube.

Diarrhea is a major gastrointestinal complication. The occurrence is high and ranges from 12% to 68% in the literature.[11,12] Clinicians, therefore, need to take appropriate precautionary measures. Although high caloric density, high osmolality, large dose, low fiber content, low temperatures, and fast administration rate are reported as direct or indirect risk factors,[13] the main cause of diarrhea due to liquid EN remains unclear. In Japan, slow administration rate of EN is important, and the administration rate is generally 100 mL/hour.[4,5] However, the caloric density of most EN is 1.0~1.5 kcal/mL, and an administration time of 100 mL/hour or slower would take up almost an entire day for a planned dose. Although we administered semi-solidified EN at a rate of 400 mL/hour in this study, the occurrence of diarrhea was statistically less compared to liquid EN at 100 mL/hour. This finding suggests that semi-solidified EN not only reduces the occurrence of diarrhea but also makes it possible to improve the QOL of patients during nutritional management with a nasogastric tube. In general, liquid EN rapidly passes through the stomach, requiring a short lag phase, whereas semisolid EN stays in the stomach for a while, has a long lag phase, and is slowly empties the stomach. Thus, the occurrence of diarrhea may be reduced by imitating the physiological peristaltic movement of the stomach.[4,5]

We assessed the nutritional status by CONUT, which is an efficient tool for continuous nutritional management.[14] The CONUT has been applied to assess the risk of postoperative complications in various cases.[15-17] Patients in both the groups lost weight but CONUT was maintained. Although the achievement rate was high in both groups, the weight loss may have occurred because the daily administration dose was insufficient for patients with less postoperative activity restriction. Increasing the administration dose may impose additional time constraints on patients in the L Group and may increase the incidence of diarrhea. On the other hand, our results suggested that the administration dose could be increased in the SS group.

This study had a few limitations. First, the effects of drugs that may cause enteric toxicity or disruption of the normal gut flora were not considered. Antibiotics, especially when two or more are prescribed together, are associated with diarrhea.[18] The guidelines published in 2017 recommend a maximum prophylactic antibiotic administration period of 48 hours for oral and maxillofacial surgery,[19] but the conventional administration period tends to be longer. In this study, conducted prior to 2017, all patients received antibiotics for 5 to 7 days. Secondly, this was a short-term, single-center study. It focused only on complications and nutritional status in acute conditions; no chronic conditions were included. In addition, due to the small number of cases included in this study, the complications of semi-solidification of EN may not have been comprehensively elucidated. Actually, nausea, abdominal fullness, and constipation were observed in this study. In addition, a previous report indicated the risk of tracheal obstruction by reflux and aspiration of semi-solidified EN via the nasogastric tube.[20] Furthermore, the time-consuming preparation must be evaluated as well as the complications. A long-term multicenter study will clarify the efficacy of semi-solidification of EN.

CONCLUSION

This study demonstrated that the semi-solidification of EN for nutritional management with a nasogastric tube is effective in reducing complications, maintaining nutritional status, and improving the QOL by shortening the administration time.

DISCLOSURE STATEMENT

The authors declare no conflict of interest for this study.

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