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Original Research Article

Integrated surgical and nutritional strategy with gastrostomy for semisolid enteral formula improves postoperative functional recovery after total pharyngolaryngectomy

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ABSTRACT

Background: Enteral nutrition (EN) is commonly administered after total pharyngolaryngectomy. However, it is frequently accompanied by gastrointestinal symptoms, which makes postoperative nutritional management difficult. To address this problem, we developed a surgical strategy using intraoperative gastrostomy for semisolid EN to improve postoperative recovery.
Methods: We retrospectively reviewed 41 patients who underwent total pharyngolaryngectomy with free jejunal reconstruction between 2017 and 2022. Twenty-one patients received liquid EN via a nasogastric tube (Group L), and 20 patients received semisolid EN via gastrostomy (Group SS). Postoperative energy intake, weight loss, and changes in prognostic nutritional index (PNI) and psoas muscle index (PMI) were compared between the groups.
Results: Group SS achieved significantly higher total energy intake (11,355 vs. 9,800 kcal, p=0.011) and showed lower postoperative weight loss at 1 month (-3.2% vs. -6.5%, p=0.038). At 12 months, Group SS demonstrated superior weight maintenance and better preservation of PNI (46 vs. 41, p=0.04) and PMI (p<0.001 at 6 months). Gastrointestinal symptoms were reduced, and the shortened administration time of semisolid EN enabled earlier mobilization.
Conclusions: A surgical approach combining intraoperative gastrostomy with semisolid EN reduced gastrointestinal complications, improved nutritional intake, and preserved muscle mass compared with conventional liquid EN. This integrated perioperative strategy may enhance postoperative recovery and long-term nutritional maintenance in patients undergoing total pharyngolaryngectomy.

Keywords: Enteral nutrition, Gastrostomy, Liquid enteral formula, Semisolid enteral formula, Total pharyngolaryngectomy

INTRODUCTION

Postoperative weight loss is an independent prognostic factor of various malignant diseases.[1-3] Some reports on laryngeal and pharyngeal cancer have shown that a reduced postoperative weight loss may contribute not only to maintaining performance status but also prolonging overall survival.[4] Total pharyngolaryngectomy often results in prolonged restrictions on oral intake, necessitating postoperative enteral nutrition (EN). Conventionally, EN is administered via a nasogastric tube using liquid enteral

formula.[5,6] However, this approach is frequently associated with gastrointestinal symptoms such as diarrhea, frequent defecation, and abdominal discomfort, which can lead to suboptimal energy intake and complicate nutritional management. Furthermore, the prolonged infusion time required for liquid EN often limits early mobilization, potentially contributing to postoperative muscle loss.

In contrast to esophageal or gastric surgeries, total pharyngolaryngectomy preserves gastric function. This preserved gastric anatomy allows for the creation of a gastrostomy intraoperatively without the need for additional incisions. Gastrostomy offers a more stable and longer-term route for EN and can serve as a foundation for alternative nutritional strategies.

In 2020, based on this rationale, we introduced a new surgical strategy that included intraoperative gastrostomy and the use of semisolid enteral formula. This intervention was implemented as part of a comprehensive perioperative nutritional support program involving a multidisciplinary care team, which provided individualized guidance before and after discharge. Semisolid formulas, characterized by higher viscosity than liquid ones, are expected to reduce gastrointestinal symptoms, shorten administration time, and potentially promote early postoperative rehabilitation. In addition, continuous support from a multidisciplinary care team is expected to contribute to the maintenance and improvement of postoperative functional recovery by providing tailored nutritional guidance and promoting patient adherence. We retrospectively evaluated its clinical impact.

Therefore, this study aimed to assess the effectiveness of this surgical strategy by comparing postoperative gastrointestinal symptoms, nutritional outcomes, and changes in body composition between patients receiving traditional nasogastric liquid enteral formula and those treated with semisolid enteral formula via gastrostomy.

METHODS

Setting and patients

This retrospective observational study included patients who underwent total pharyngolaryngectomy with free jejunal reconstruction at Nagoya City University Hospital between January 2017 and December 2022. Patients were excluded if they had a history of gastrectomy, did not receive enteral nutrition (EN) due to gastrointestinal dysfunction, experienced delayed oral intake due to anastomotic failure, or had no follow-up visits after discharge.

Patients who underwent surgery before August 2020 and received postoperative EN with liquid enteral formula via a nasogastric tube were classified as the liquid enteral formula group (Group L, n=21). Patients who underwent surgery after September 2020 and received semisolid enteral formula via gastrostomy were classified as the semisolid enteral formula group (Group SS, n=20) (Figure 1).

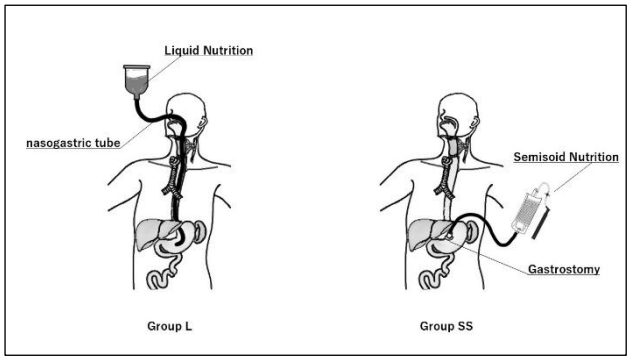

Figure 1: Schematic representation of the enroutes in each group.

This study was conducted in accordance with institutional ethical guidelines. Informed consent was obtained via an opt-out method through the hospital's official website.

Outcome measurement

The primary endpoints were frequency of defecation during EN and total volume of EN administered. The secondary endpoints included postoperative weight change, prognostic nutritional index (PNI), a postoperative nutritional index, and change in the psoas muscle area, an index of postoperative muscle mass change. PNI was examined using the Onodera's PNI (10 × serum albumin levels + 0.005 × total lymphocyte count), which is widely used in Japan.[7] The psoas muscle area was assessed using the psoas muscle index (PMI; the area of the psoas major muscle in the L3 lower border region measured on computed tomography scan images, corrected by the square of the height), which has been widely reported in previous reports.[8]

Intensive nutritional intervention strategy (Group SS)

Patients in Group SS received an intensive perioperative nutritional intervention strategy introduced in 2020. This strategy consisted of the following three components:

Perioperative and postdischarge perioperative care team support

The patients were interviewed upon admission and during outpatient visits. The patients' nutritional status was evaluated, and their nutritional supplements and diet were adjusted.

Intraoperative gastrostomy

Gastrostomy can be performed in total pharyngolaryngectomy, unlike in esophageal or stomach

surgery, because the stomach is preserved. It can be created during otorhinolaryngological anastomosis without a new skin incision, which extends the surgical time. Considering the risk of esophageal cancer, which has a relatively similar background, the tube was placed on the lesser curvature side of the stomach to prevent interfering with the creation of a gastric tube in the future.[9,10]

Use of semisolid enteral formula

Semisolid enteral formula was used to preserve gastric retention, reduce physiologic digestion and absorption, and shorten the administration time.

Postoperative nutritional management

EN was provided to group L by Meibalance® (Meiji Dairies Corp., Tokyo, Japan) at 1 kcal/mL and to group SS by RACOL®-NF SemiSolid (Otsuka Pharmaceutical Corp., Ltd., Tokushima, Japan) at 1 kcal/mL. GFO® (Otsuka Pharmaceutical Corp., Ltd., Tokushima, Japan) was administered on postoperative days 1 and 2 in the two groups. On postoperative day 3, the dosage was started at 100 mL/day × 3 times a day and increased by 100 mL/day every day in the two groups. On postoperative days 6-13, the dosage was 400 mL/day × 3 times a day. On the 14th postoperative day, fluoroscopy was performed to validate the absence of suture insufficiency or dysphagia, and oral intake was started. If the patient could not tolerate complications such as EN-related diarrhea, the dosage and rate of administration were adjusted based on the discretion of the physician in charge.

Statistical analyses

Data were presented as the numbers (%) or medians (interquartile range). The demographic characteristics of the patients were compared using the Fisher's exact test, the Mann-Whitney U test, or the Wilcoxon signed-rank test. Statistical analyses were performed using STATA MP v.17.1 (Stata Corp., College Station, TX). P-values <0.05 indicated statistically significant differences.

RESULTS

Demographic characteristics of the patients

During the study period, 46 patients underwent total pharyngolaryngectomy with free jejunal reconstruction at Nagoya City University Hospital. After applying the exclusion criteria, data from 41 patients were available for analysis. In total, 21 patients underwent surgery before August 2020 and received postoperative EN with liquid enteral formula via a nasogastric tube (group L). Meanwhile, 20 patients underwent surgery after September 2020 and received postoperative enhanced intervention including EN with semisolid enteral formula via gastrostomy (group SS). Group L and group SS did not significantly differ in terms of demographic characteristics (Table 1).

Table 1: Demographic characteristics of the patients.

	Group L (n=21)	Group SS (n=20)	P value
Age in years	72.6 (62.9-76.5)	67.9 (63.2-73.1)	0.28
Male sex	21 (100)	19 (95.0)	0.49
Height (cm)	165.0 (162.5-172.4)	162.6 (159.6-169.1)	0.10
Weight (kg)	53.4 (48.6-63.8)	55.1 (47.9-64.2)	0.89
PNI	44.5 (36.3-49.3)	41.0 (37.5-48.0)	0.52
PMI	4.26 (3.67-5.04)	4.12 (2.88-5.72)	0.83
T (1/2/3/4)	3/2/7/9	0 /1/5/14	0.20
N (0/1/2/3)	7/1/9/4	4/3/8/5	0.63
M (0/1)	21/0	20/0	N.A.
CCI (0/1/2/3/4)	8/6/4/2/1	13/6/0/1/0	0.14

Treatment efficacy based on the primary outcome

Figure 2 shows the details on postoperative days and frequency of defecation. Group L had a significantly higher frequency of defecation during enteral feeding compared with group SS (Figure 2).

Group SS had a significantly higher total energy dose during EN than group L (median [95% confidence interval]: 11355 [9681-11744] kcal and 9800 [8635-10764] kcal, respectively) (Figure 3).

Based on the scatter plots, compared with group L, group SS was more likely to have a higher energy intake administered during EN and a lower frequency of defecation. Group L was divided into two subgroups with a cutoff defecation frequency of ≥5 per day, and the total energy intake administered was examined. Group SS and the subgroup of patients with a lower frequency of defecation did not significantly differ in terms of total energy intake administered. However, patients with a higher frequency of defecation had a significantly lower energy intake administered than those with a lower frequency of defecation (Figure 4).

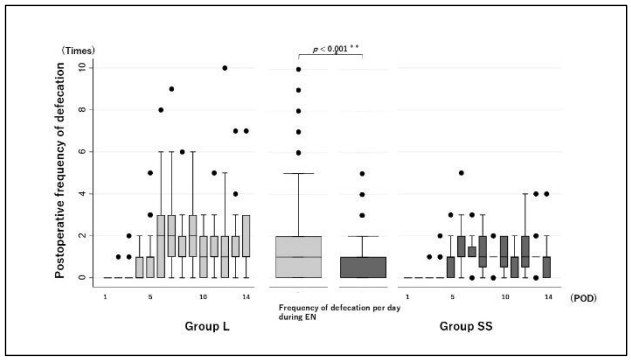

Figure 2: Postoperative frequency of defecation during EN.

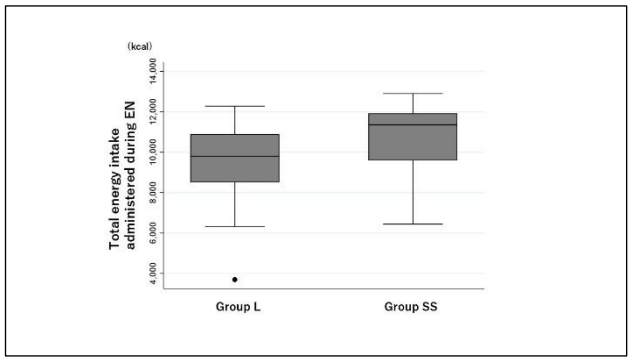

Figure 3: Total amount of energy intake during EN.

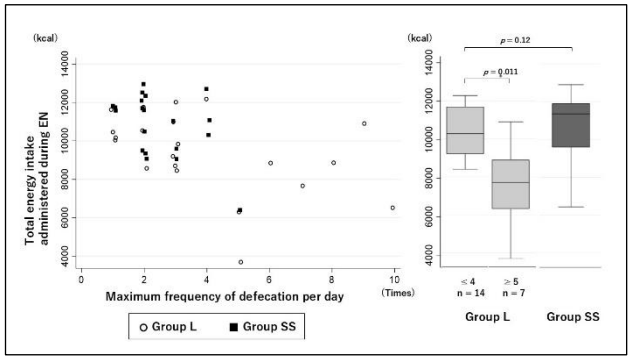

Figure 4: Scatterplot of the total amount of energy intake and frequency of defecation during EN.

Treatment efficacy according to the secondary outcome

Group SS had a significantly lower weight loss at 1 month postoperatively than group L. Further, group SS exhibited significantly higher changes in the body weight ratio at 1 year postoperatively than group L (Figure 5).

Changes in PNI preoperatively and at 6 months and 1 year postoperatively did not differ significantly between the two groups. However, compared with group L, group SS presented with a better nutritional status, from a median of 41 preoperatively to 46 at 1 year postoperatively, without a decrease in PNI after surgery (Figure 6).

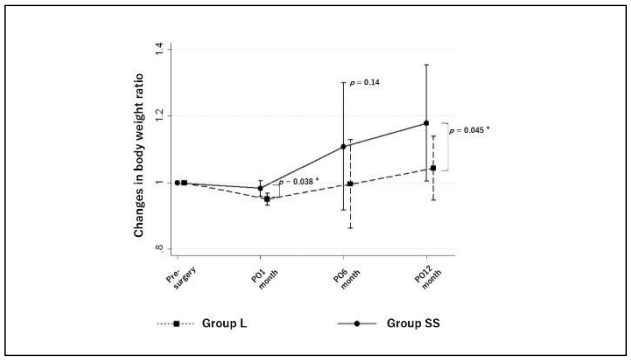

Figure 5: Postoperative changes in body weight ratio.

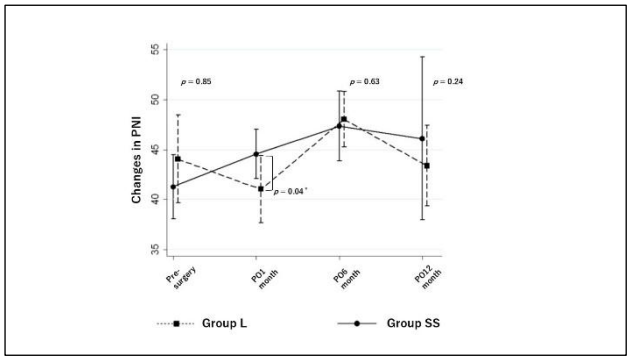

Figure 6: Postoperative changes in PNI.

The SS group did not exhibit a decrease in PMI changes after surgery. Further, compared with group L, group SS had a significantly greater reduction in muscle mass 6 months postoperatively (Figure 7).

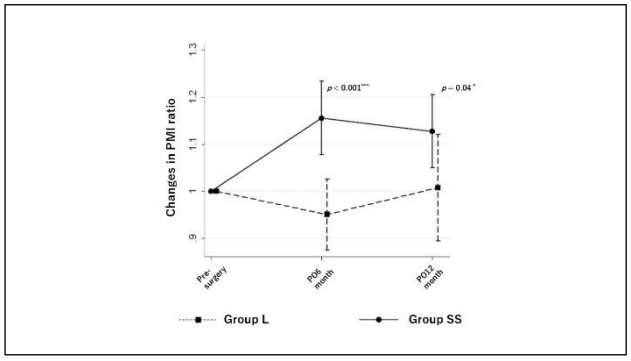

Figure 7: Postoperative changes in the PMI ratio.

DISCUSSION

This study demonstrated that a surgical strategy combining intraoperative gastrostomy and semisolid enteral formula, implemented as part of a comprehensive perioperative nutritional intervention, effectively improved postoperative functional recovery in patients undergoing total pharyngolaryngectomy with free jejunal reconstruction. Patients who received this strategy had significantly higher total energy intake, lower frequency of defecation, reduced postoperative weight loss, and

better preservation of muscle mass compared to those treated with conventional nasogastric liquid enteral formula.

Semisolid enteral formula, due to their higher viscosity compared to liquid formulas, are thought to improve physiological retention in the stomach, reduce gastrointestinal symptoms, and shorten administration time. Gastrointestinal complications are well-recognized adverse events associated with enteral nutrition (EN), including diarrhea (12-68%), abdominal distention (12.2%), vomiting (13.2%), nausea (10-20%), and reflux (0.4-6.0%).[11-15] In some cases, these complications necessitate discontinuation of EN altogether, reported in up to 15.2% of patients.[16] Preventing these complications is crucial to maintaining the required nutritional intake, especially in the early postoperative period. Although semisolid EN has been proposed as a strategy to reduce these adverse effects by improving gastrointestinal motility and absorption, few studies have provided concrete evidence of its clinical benefits.[17-19] Our findings suggest that semisolid EN may be beneficial in reducing the frequency of defecation and minimizing early postoperative weight loss.

The intraoperative creation of a gastrostomy, made possible by the preserved gastric anatomy in total pharyngolaryngectomy, offers a safe and stable route for EN administration. This approach avoids the limitations of nasogastric tubes, such as discomfort, dislodgement, and inadequate long-term use. Furthermore, liquid EN is typically administered at ≤200 mL/h, often requiring patients to remain in bed for 2-3 hours per session to ensure safety. In contrast, semisolid EN can be delivered in approximately 15 minutes, allowing for earlier ambulation.[11] This shorter administration time may help prevent muscle loss by facilitating early mobilization-a key factor in postoperative recovery.[20-22]

Multidisciplinary care team support also played a critical role in improving nutritional outcomes. Previous studies have shown that structured nutritional interventions by professionals in oncology settings can help mitigate postoperative weight loss and improve patient recovery.[23-27] In our cohort, regular follow-up, nutritional counselling, and individualized dietary adjustments likely enhanced adherence and enabled early detection of nutritional decline. These factors may have contributed to the sustained maintenance of body weight and muscle mass observed in Group SS, particularly within the first six months after surgery.

It is important to note that this intervention was multifactorial, and the observed benefits likely resulted from the synergistic effects of surgical, nutritional, and supportive care components. Therefore, while the integrated strategy as a whole appears beneficial, the individual contributions of each element (e.g., semisolid enteral formula alone or gastrostomy alone) cannot be definitively separated within the design of this retrospective study.

Despite the limitations of being a single-centre, retrospective analysis with a relatively small sample size, our findings indicate that a combined surgical and nutritional approach may offer a practical and effective alternative to conventional EN methods in patients undergoing total pharyngolaryngectomy. Future prospective and multicentre studies are warranted to validate these findings and to further delineate the independent effects of each intervention component on postoperative outcomes.

CONCLUSION

Total pharyngolaryngectomy reconstruction preserves gastric retention capacity. Thus, A surgical strategy combining intraoperative gastrostomy and semisolid enteral formula, supported by Intensive nutritional intervention, holds promise for enhancing postoperative nutritional management in patients undergoing total pharyngolaryngectomy. This integrated approach offers a practical and effective alternative to conventional nasogastric feeding.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Review Board of Nagoya City University Hospital approved the study protocol (no. 60-18-0008)

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