RESEARCH ARTICLE

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Preoperative Nutritional Status Influences Enteral Nutrition Weaning 6 Months Post-Surgery in Patients with Esophageal Cancer

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Abstract

Objective: This study aimed to clarify whether nutritional status at admission affects enteral nutrition weaning 6 months after surgery in patients with esophageal cancer. **Methods:** This was a retrospective study of 81 patients who underwent subtotal esophageal cancer resection between April 2014 and February 2016. The survey items were as follows: 1) sex, 2) age, 3) presence or absence of family members living together, 4) clinical stage, 5) surgical procedure, 6) reconstructed organs, 7) nutritional status at admission, 8) presence or absence of postoperative complications (anastomotic leakage, chylothorax, and recurrent laryngeal nerve paralysis), and 9) presence or absence of treatment other than surgery (chemo- or radiotherapy). **Results:** The enteral nutrition withdrawal rate after 6 months was 15.5% in the malnutrition group and 84.5% in the normal nutrition group ($p = 0.007$). In a comparison between groups with and without enteral nutrition after 6 months, a significant association was observed with surgical procedure, nutritional status at admission, and postoperative complications ($p < 0.05$). Logistic regression analysis showed that the odds of discontinuing enteral nutrition 6 months later were 5.692 (hazard ratio: 1.545–20.962) for malnutrition on admission and 11.921 (hazard ratio: 3.449–41.207) for complications. **Conclusion:** Regardless of the presence or absence of treatment other than surgery, preoperative nutritional improvement is beneficial for increasing postoperative oral intake.

Keywords: Enteral nutrition- gastric cancer- geriatric nutritional risk index- preoperative management

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Introduction

Patients with esophageal cancer are prone to malnutrition due to reduced oral intake caused by tumors in the digestive tract [1]. Malnutrition is a significant problem in patients with cancer and is associated with decreased treatment tolerance and increased morbidity. It is recognized as an independent prognostic factor in patients with cancer [2]. Nutritional screening and assessment are the first steps in nutritional management and form the foundation for subsequent nutritional therapies. Currently, there is no single nutritional assessment index used for cancer patients. The indexes generally used for nutritional assessment include: 1) physical measurements, 2) body composition analysis, 3) medical history and treatment history, 4) nutritional intake history, 5) physical examination, 6) laboratory tests, and 7) functional tests. Nutritional assessment indexes that combine these in a simple manner to predict complications and prognosis include the Prognostic Nutritional Index (PNI) [3] and the Geriatric Nutritional Risk Index (GNRI) [4]

In addition, preventing postoperative malnutrition is important. Esophagectomy for squamous cell carcinoma of the esophagus is performed with stomach or jejunum reconstruction, leading to several inconveniences due to organ loss. For example, patients may experience a wide range of symptoms, such as reduced digestive capacity, dumping syndrome, and difficulty swallowing. Enteral nutrition is used to prevent malnutrition caused by these symptoms [5]. Short-term use of enteral nutrition (up to 3 months after surgery) has been shown to improve nutritional status, physical function, and role function. It also reduces nausea/vomiting, fatigue, loss of appetite, diarrhea, and sleep disorders compared with oral intake alone [6].

Based on the aforementioned perspective, providing

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enteral nutrition is beneficial for a short period after surgery. However, following esophageal cancer surgery, the use of enteral nutrition often requires an intestinal fistula rather than a gastrostomy, leading to prolonged physical restraint during administration. Consequently, extended use of enteral nutrition can result in a potential decrease in the patient's quality of life. Therefore, for patients whose postoperative condition is stable and who are expected to tolerate some oral intake, managing nutrition exclusively through oral intake supplemented with oral nutritional supplements is preferable [7]. Identifying the barriers to increased oral intake after the initial postoperative decline is crucial for improving the patient's quality of life. However, no studies have yet been published on this topic.

This study aimed to determine factors affecting enteral nutrition weaning 6 months after surgery in patients with esophageal cancer. In particular, it investigated whether preoperative nutritional status influences the ability to wean off enteral nutrition 6 months post-surgery.

Materials and Methods

Study design

This single-center retrospective cohort study was conducted at Okayama University Hospital and included patients who underwent radical esophagectomy for esophageal cancer at Okayama University Hospital between April 2014 and February 2016. The eligibility criteria were as follows: 1) underwent radical esophagectomy for esophageal cancer at age 60 or older, 2) visited Okayama University Hospital regularly for 6 months after surgery, and 3) performed activities of daily living independently. The use of enteral nutrition was assessed during an outpatient visit 6 months post-surgery. Data were collected between September 2016 and February 2017. Patients who died within 6 months after surgery or did not attend follow-up outpatient visits were excluded. This study was designed and conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Okayama University Hospital (approval number: 1612-510). Information about the study was provided during the opt-out period, and all patients were given an opportunity to decline participation.

Evaluation criteria for main outcomes

The main outcome was the use of enteral nutrition 6 months after surgery. Patients were considered to have no enteral nutrition if they could manage their nutritional needs by oral intake alone and the fistula had been removed at the outpatient clinic 6 months post-surgery. Conversely, patients were considered to have received enteral nutrition if they were using it in addition to oral intake or were managing their nutrition solely with enteral nutrition. Patients were followed up at the outpatient clinic 2 weeks after discharge and 2, 3, and 6 months post-surgery. During each outpatient visit, blood tests and physical condition assessments were performed. If necessary, the enteral nutrition technique was reconfirmed, and nutritional counseling was provided. The decision to discontinue enteral nutrition was made by the attending physician based on the patient's physical condition and the opinions of the registered dietitian, the patient, and the patient's family. Survey items, in addition to the use of enteral nutrition, were as follows: 1) sex, 2) age, 3) presence or absence of family members living together, 4) clinical stage, 5) surgical procedure, 6) reconstructed organs, 7) nutritional status at admission, 8) presence or absence of postoperative complications (such as suture leakage, chylothorax, and recurrent laryngeal nerve paralysis), and 9) presence or absence of treatment other than surgery (chemotherapy or radiation therapy). All data were collected from the electronic medical records. Data on age and the presence of family members living with the patients were recorded at admission for surgery, and the information on whether patients had family members was based on patient reports. The geriatric nutritional risk index (GNRI) was used to evaluate nutritional status at admission, classifying patients into those with malnutrition (GNRI <92) and those without malnutrition (GNRI ≥92). Ideal body weight was calculated using body mass index by height (m) x height (m) x 22. Data on weight and albumin levels used for the GNRI calculation were collected at admission for surgery, with serum albumin obtained from peripheral blood. Data on clinical stage, operative procedures, and reconstructed organs were obtained from operative records, and postoperative complications were classified as grade 2 or higher using the Clavien–Dindo classification.

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences Statistics 29.0 package for Windows (IBM Japan, Tokyo, Japan). Values were expressed as the mean ± standard deviation. Epidemiological analyses were performed using the chi-square test. We used binomial logistic regression models to estimate the odds ratios (ORs) with 95% confidence intervals (CIs) of enteral nutrition weaning. A p-value < 0.05 was considered statistically significant.

Results

Baseline patient characteristics

The flowchart of this study is shown in Figure 1. In total, 81 patients with esophageal cancer met the eligibility criteria and were selected for this study. Three patients who died within 6 months after surgery and nine patients who did not visit our hospital 6 months post-surgery were excluded.

At admission for surgery, 19 patients (23.5%) were observed to have malnutrition, while 62 patients (76.5%) did not. The patient background information is shown in Table 1. A comparison between the two groups based on the presence or absence of malnutrition revealed significant differences in clinical stage ($p = 0.008$), surgical procedure ($p = 0.037$), reconstructed organs ($p = 0.017$), and the presence or absence of treatment other than surgery ($p = 0.015$).

Main outcomes

The enteral nutrition withdrawal rate after 6 months

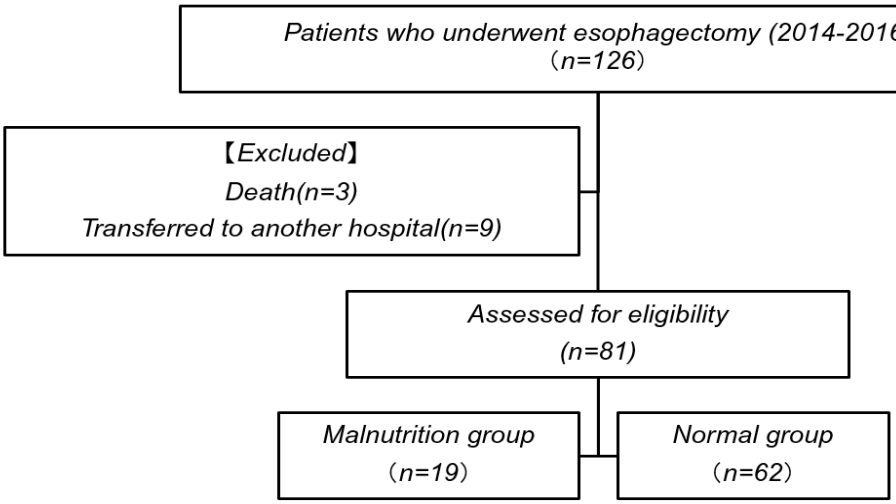

Figure 1. Participant Flowchart

Table 1. Patients' Characteristics

	Total (n=81)	Malnutrition group (n=19)	Normal group (n=62)	p Value
Sex (Male: Female)	69:12	15:4	54:8	0.446
Age (Mean ± SD)	68.5 ± 5.3	68.5 ± 5.1	68.7 ± 6.1	0.870
Family living together	67 (82.7%)	15 (78.9%)	52 (83.9%)	0.649
Clinical Stage 0: I: II: III: IV	3: 23: 26: 24: 5	1: 1: 5: 9: 3	2: 22: 21: 15: 2	0.008
Route of substitution (Retrosternal route) Posterior mediastinal (Antethoracic route)	52:07:22	9:01:09	43:06:13	0.037
Organ for substitution(Stomach: Jejunum: Colon)	71:09:01	14:04:01	57:05:00	0.017
Leak or Chylothorax	13 (16.0%)	5 (26.3%)	8 (12.9%)	0.168
Recurrent laryngeal nerve palsy	11 (13.6%)	2 (10.5%)	9 (14.5%)	0.643
Treatment other than surgery	49 (60.5%)	16 (84.2%)	33 (53.2%)	0.015

was 15.5% in the malnutrition group and 84.5% in the normal nutrition group (p = 0.007) (Figure 2). In a comparison between groups with and without enteral nutrition after 6 months, a significant association was

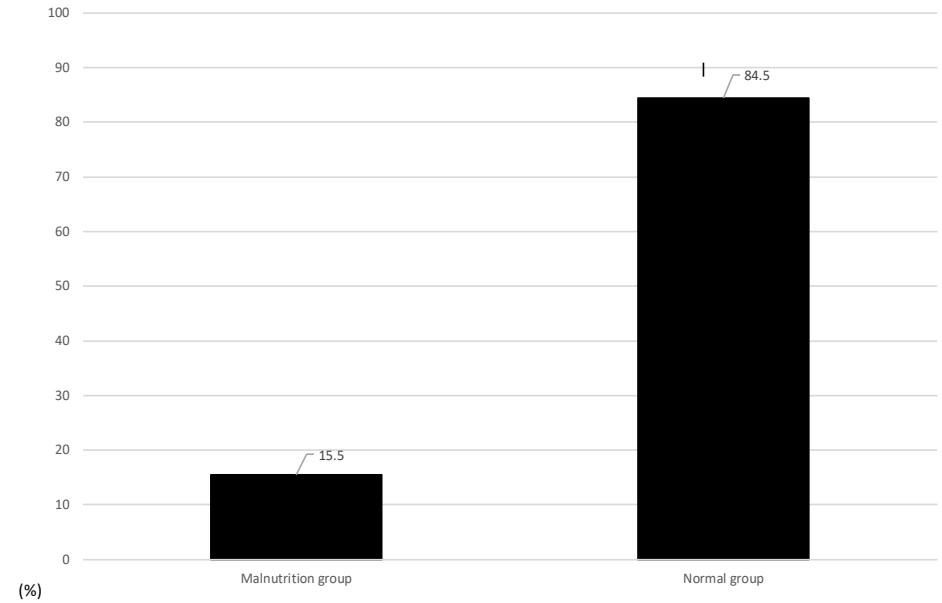

Figure 2. Main Outcome

Table 2. Univariate Analysis Results Using or Not Using Enteral Nutrition as an Explanatory Variable

	Using enteral nutrition (n= 23)	No enteral nutrition (n= 58)	p Value
Sex (Male:Female)	21:2	48:10	0.335
Age (Mean ± SD)	70.4±6.6	67.8 ± 4.6	0.055
Family living together	21 (91.2%)	46 (79.3%)	0.203
Clinical Stage 0: I: II: III: IV	1:6:7:7:2	2:17:19:17:3	0.709
Route of substitution (Retrosternal route)Posterior mediastinal(Antethoracic route)	11:02:10	41:05:12	0.036
Organ for substitution (Stomach: Jejunum: Colon)	19:04:00	52:05:01	0.578
Leak or Chylothorax	8 (34.8%)	5 (8.6%)	0.003
Recurrent laryngeal nerve palsy	7 (30.4%)	4 (6.9%)	0.005
Treatment other than surgery	13 (56.5%)	36 (62.1%)	0.656
Malnutrition at admission	10 (43%)	9 (15.5%)	0.007

Table 3. Multivariate Logistic Regression Analysis for Using Enteral Nutrition 6 Months Later

Factors	Adjusted odd ratio	95% Cl	p-value
Malnutirition	5.692	1.545-20.962	0.009
Complication	11.921	3.449-41.207	<0.001

observed with surgical procedure (p=0.036), nutritional status at admission (p=0.007), and postoperative complications of anastomotic leakage, chylothorax (p=0.003), and recurrent laryngeal nerve paralysis (p =0.005). No significant association was noted between enteral nutrition withdrawal and sex, presence or absence of family members living together, clinical stage, reconstructed organs, or presence or absence of treatment other than surgery (Table 2).

Relationship between nutritional status at admission and nutritional management method 6 months after surgery

The results of the binomial logistic regression analysis are shown in Table 3. Malnutrition on admission and postoperative complications were included in the logistic regression analysis. Logistic regression analysis showed that the odds of discontinuing enteral nutrition 6 months later were 5.692 (hazard ratio: 1.545–20.962) for malnutrition on admission and 11.921 (hazard ratio: 3.449–41.207) for complications.

Discussion

This study shows that preoperative nutritional status influences the ability to wean off enteral nutrition 6 months post-surgery.

Enteral nutrition after esophageal cancer surgery has been considered more useful than parenteral nutrition for maintaining nutritional status and immune function [8]. However, there are few studies comparing oral intake (including oral intake of oral nutritional supplements) with enteral nutrition. Some studies have shown that oral intake immediately after surgery results in a higher quality of life, fewer digestive symptoms, and a lower patient burden compared to enteral nutrition [9, 10]. It is easy to imagine that long-term enteral nutrition after surgery is a burden for patients, but there has been no research into the reasons why patients cannot be weaned from enteral nutrition. This study clearly demonstrated that malnutrition during hospitalization is a predictive factor that prevents weaning from enteral nutrition.

Chen et al. reported that elderly patients who underwent esophageal cancer surgery and consumed enteral nutritional supplements orally for 8 weeks or more in addition to their regular diet had higher immune function than those who only consumed a regular diet [11]. Even for patients who were malnourished preoperatively, it is expected that they will be able to be weaned from long-term enteral nutrition early by taking enteral nutritional supplements orally in addition to taking oral food after surgery. Furthermore, in this study, there was a tendency for patients with postoperative complications to have difficulty weaning from enteral nutrition. The risk of postoperative complications increases in malnourished patients, and the period until the start of postoperative oral intake is extended, reducing the amount of oral intake. Nutritional management from the preoperative stage onwards is important.

In this study, the GNRI was used as a nutritional assessment tool for preoperative evaluation. It is a non-invasive, easy-to-use tool with significant clinical relevance, particularly for older people. Preoperative GNRI has been shown to be a powerful predictor of survival outcomes in patients with esophageal cancer [12]. Therefore, the active use of such evaluation tools and performing nutritional assessments at various times are important.

This study had two limitations. First, because the study was limited to patients aged 60 or older, it was not possible to study patients under 60 years of age. Second, it exclusively enrolled patients from a university hospital, excluding stable patients who could be followed up at other hospitals or those residing far away, potentially introducing bias.

In this study on esophageal cancer, factors influencing the presence or absence of enteral nutrition 6 months after surgery were surgical procedure, postoperative complications, and malnutrition at admission. A comparison of these factors using logistic regression analysis showed that preoperative nutritional status

was associated with increased oral intake after surgery. Since surgical procedure is a difficult factor to change, actively implementing preoperative nutritional therapy and education may enhance patient independence in oral intake after surgery and alleviate healthcare costs. A more intensive approach for patients with poor nutritional status before surgery could yield clinical benefits. Increasing the sample size in future studies to investigate barriers to improving preoperative nutritional status would be valuable. The obtained results suggest that nutritional status at admission affects weaning from enteral nutrition 6 months after surgery. Regardless of whether the patients received treatment other than surgery, preoperative nutritional improvement seems beneficial for increasing postoperative oral intake. Future research should focus on effective preoperative nutritional enhancement strategies.

Author Contribution Statement

S.M. and M.H. contributed substantially to the conceptualization of the study. S.M. and T.S. contributed significantly to the data curation and formal analysis. S.M., S.Y., and S.N. contributed substantially to this methodology. M.H. contributed substantially to the project administration and supervision. S.M., S.Y., and S.N. wrote the manuscript. All authors critically reviewed and revised the manuscript and approved the final version for submission.

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General

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Ethical Declaration

This study was designed and conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Okayama University Hospital (approval number: 1612-510). Information about the study was provided during the opt-out period, and all patients were given an opportunity to decline participation.

Conflict of Interest

The authors declare no conflicts of interest.

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