Original Article

Home enteral nutrition after minimally invasive esophagectomy can improve quality of life and reduce the risk of malnutrition

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Background and Objectives: The potential benefits of home enteral nutrition (HEN) and the effects of HEN on quality of life (QOL) after esophagectomy remain unclear. The aim was to investigate the effect of 3 months HEN on health related QOL and nutritional status of esophageal cancer patients who were preoperatively malnourished. **Methods and Study Design:** 142 malnourished (PG-SGA stage B or C) patients with esophageal cancer were assigned to receive Ivor Lewis minimally invasive esophagectomy (MIE group) with laparoscopic jejunal feeding tube placement or open esophagectomy (OE group) with nasojejunal feeding tube placement. After discharge, patients in the MIE group received HEN with 500-1000 kcal/d for 3 months, while the OE group patients did not receive HEN, as nasojejunal feeding tubes had been removed. QLQ-C30 and PG-SGA questionnaires were used to evaluate the QOL and the risk of malnutrition. **Results:** 67 patients were enrolled in the MIE group and 75 patients were enrolled in the OE group. Symptoms related to fatigue, nausea, vomiting, pain, and appetite loss were significantly decreased in the patients treated with 3 months HEN. Similarly, patients treated with 3 months HEN had a lower risk of malnutrition than patients did not receive HEN (PG-SGA score, 5.7 vs 7.9, $p<0.01$). More patients in the MIE group (received 3 months HEN) were able to complete postoperative chemoradiotherapy than patients in the OE group ($p<0.01$). **Conclusions:** MIE and subsequent treatment with 3 months HEN can improve the QOL and reduce the risk of malnutrition in preoperatively malnourished patients.

Key Words: home enteral nutrition, quality of life, esophagectomy, nutrition support, cancer

INTRODUCTION

Patients with cancer occasionally need nutrition support. Essential elements of a nutrition support program comprise early identification of patients at greatest risk, nutrition assessment to determine the level of deficit, and appropriate nutrition intervention.[1] Nutrition support is extremely important for patients suffering from esophageal carcinoma, as the incidence of cachexia and preoperative malnutrition is reported to be up to 60 to 85% in this cohort of patients.[2] No matter what surgery approach, most esophageal surgeons seem to have an intuitive grasp of the fact that their patients experience marked deterioration in nutritional status and quality of life in the first few months after esophagectomy.[3] After undergoing esophagectomy, patients' normal intake patterns are often interfered with by complications such as asthenia, pain, anorexia, and disorders in digestion processes. It has been reported that patients require 3 to 9 months to regain a defined eating pattern after esophagectomy.[4] Most patients lose more than 10-15% of their body mass index (BMI) within 6 months after esophagectomy, and are therefore at severe nutritional risk, which negatively affects quality of life.[5] Moreover, about 20% patients need 'rescue' enteral nutrition (EN) feeds after being discharged due to failing nutrition.[6] Early EN has been demonstrated to induce lower rates of surgical complications, such as pneumonia, and has been shown to result in shorter postoperative hospital stays than with parenteral nutrition.[7,8] However, the potential benefits of HEN and the effects of HEN on quality of life after esophagectomy remain unclear.

METHODS

This was a single-center, prospective, and non-randomized study conducted to evaluate postoperative outcomes, health related QOL, and nutritional status in malnourished patients receiving 3 months of HEN after MIE. The experimental protocol and the consent form of this study were approved by the Ethics Committee of the Second Affiliated Hospital of Zhejiang University (registration number: ISRCTN63015230). Written informed consent was obtained from all patients. Initially, patients were randomly allocated to receive MIE or OE. Nevertheless, for ethics reasons, the allocation was permitted to be

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changed either by patients or by surgeons, for safety concerns or for personal preference; the trial was therefore non-randomized. Between January 2014 and August 2015, 198 consecutive patients diagnosed in our department with esophageal and esophagogastric junction cancer were deemed suitable for potentially curative resection with intrathoracic anastomosis. All of the patients had been staged preoperatively by endoscopy with biopsy, radiograph of the digestive tract with barium ingestion, computed tomography (CT) scanning of the chest and abdomen, ultrasound of the neck, and single photon emission CT bone scan. In addition, all of the patients completed respiratory function tests and a cardiologic assessment to determine surgical risk. Patients deemed medically unfit, as well as those with unresectable tumours, those who were older than 80-years-old, and the patients that needed cervical incision and anastomosis, were excluded from this study.

The nutritional status of the patients was assessed by the Patient Generated Subjective Global Assessment (PG-SGA) standard questionnaire.[9,10] The first section of the PG-SGA is completed by the patient and assesses weight change, dietary intake, nutritional impact symptoms, and functional capacity. The second section is completed by an experienced dietitian within the initial 72 h of hospitalization and involves accounting for metabolic stress, as well as a physical examination. After completion of the assessment, the patient is subjectively categorized as A (well nourished), B (moderately malnourished), or C (severely malnourished). We excluded patients with PG-SGA stage A (well nourished). QOL was assessed with the European Organization for Research and Treatment of Cancer (EORCT) general quality of life questionnaire (QLQ-C30).[11,12] All questionnaire responses were transformed linearly to scores from 0 to 100. For functional scores and global QOL, higher scores represent better function and QOL, whereas a higher score for the symptom scales and PG-SGA represents more severe symptoms and malnutrition.

Minimally invasive Ivor Lewis esophagectomy has been described in detail elsewhere.[13,14] Briefly, this minimally invasive Ivor Lewis technique consists of laparoscopic gastric mobilization, formation of a gastric conduit and lymph node dissection, followed by thoracoscopic esophageal mobilization, intrathoracic lymphadenectomy, and intrathoracic anastomosis. Open surgery was performed with intrathoracic anastomosis and two field lymphadenectomy. A jejunal feeding tube was placed in all MIE patients by laparoscopic jejunostomy, while OE patients were placed with a nasojejunal feeding tube. All resected tissues were sent for pathological examination. Tumor, node, and metastasis descriptors, and the staging classification used for this analysis were those defined in the seventh edition of the American Joint Committee on Cancer (AJCC) staging manual.[15,16]

All patients received antibiotics and prophylaxis for deep vein thrombosis. Postoperative analgesia was provided by patient controlled analgesia. Total energy demand, enteral plus parenteral methods, was set as 25-30 kcal•kg-1day-1in both groups. Enteral nutrition was initiated by using 500 mL 5% glucose fluid via the feeding tubes in the first day after surgery. From the second day on, infusion of EN emulsion was gradually increased until it provided the total energy demand at the 3rd or 4th post-operative day. Some patients, for various reasons, who could not receive enough enteral nutrition, were fed with extra parenteral nutrition to meet the energy demand. Usually, patients in both groups began their oral food intake at the 7th post-operative day, after anastomosis was checked by a barium swallow exam. Patients were discharged when they could eat semi-liquid food, were mobile, and were comfortable with oral analgesia.[17]

After discharge, both groups were provided with dietary advice to maximize oral intake. The patients in the MIE group continued to undergo HEN with 500-1000 kcal/d for 3 months. The detailed EN dose was decided according to the HEN guidelines of our department (Table 1). For example, if the oral intake was less than a third compared with the usual situation, and there were no serious adverse reactions, patients could supplement 1000 kcal/d. Prescribed EN emulsion, which afford convenience of calorie accumulation, was usually used by the patients to replenish the energy deficiency. Patients were also encouraged to supplement their diet with alible liquids, such as milk, porridge, broth, through enteric feeding tube injection made by themselves. The patients were suggested to complete the EN fluid via 5 or 6 infusions per day. Remarkably, we recommend that every patient should develop their own HEN pattern that induced slightest digestive tract discomfort. As nasojejunal feeding was removed before discharge, no HEN was made for the OE patients. Patients were arranged to follow-up at two weeks and 3 months after discharge, then every 3 months for a year and half-yearly thereafter.

Baseline PG-SGA and QLQ-C30 scores were evaluated and recorded within 3 days prior to surgery. Clinical and demographic information, including age, sex, BMI, nutritional status, preoperative albumin, hemoglobin, and the site of the esophageal neoplasm was also collected.

After surgery, the information including total hospital stay, time in the intensive care unit (ICU), morbidity, and mortality within 30 days was recorded. Major complica-

Table 1. HEN guideline of our department for MIE patients

	Daily postoperative oral intake volume/ daily usual oral intake volume[†‡]		
	<1/3	<2/3	>2/3
No serious adverse reaction	1000 kcal/d or more	500-1000 kcal/d	500 kcal/d
Had serious adverse reaction	<1000 kcal/d and consult the surgeon or dietitian	<500 kcal/d and consult the surgeon or dietitian	<500 kcal/d and consult the surgeon or dietitian

[†]Ratio of daily postoperative oral intake volume / daily usual oral intake volume are decided by patients themselves.
[‡]Patients were informed the calorie amount of each kind of prescribed emulsion and how to convert the calorie demand to emulsion volume.

tions were also evaluated: these included complications relating to pneumonia (defined as abnormal chest radiograph with fever (>38°C) and WBC >12,000 cells/L and positive sputum or bronchoalveolar lavage), chylothorax, vocal-cord paralysis confirmed by laryngoscopy, wound infection needing reoperation, anastomotic leakages (defined as any dehiscence with clinical and radiological evidence), cardiac insufficiency (defined as unstable blood pressure requiring use of extra fluids and/or cardiac stimulants), the visual analogue scale (VAS) pain score (measured until day 3 after surgery), ileus requiring stopping EN, and jejunostomy site enterocutaneous fistula. Pathological results including pathological tumor-node-metastasis classification, resection and circumferential margins (R0 defined as >1 mm from a resection margin), and the number of lymph nodes retrieved for different stations were recorded. Patients met with the surgeon and a dietitian at 2 weeks postoperative and 3 months after discharge for follow-up; BMI, albumin, hemoglobin, and PG-SGA and QLQ-C30 scores were collected at these times. The number of patients receiving and completing postoperative chemoradiotherapy was recorded.

All of these data were compared. Proportions and percentages were used to summarize the category variables, whereas, descriptive statistics with mean values (±SD), medians, and ranges were used for numerical variables. When appropriate, we compared groups with an independent samples Student's t-test; otherwise, a Mann-Whitney U test, or a χ^2 test was used. Significant differences were defined at the $p<0.05$ level. Data analysis was performed using SPSS (version 20.0).

RESULTS

Between January 2014 and August 2015, 198 patients were registered (Figure 1). 56 patients were excluded (42 patients were PG-SGA stage A; 4 patients were older than 80-years; 3 patients had other malignancies; 2 patients declined participation; 5 patients had unresectable tumors). Therefore, 142 patients were judged eligible and enrolled in the study. For each patient, a randomized allocation was made initially; therefore, an even number of patients was allocated to the MIE group (treated with HEN) and the OE group (without HEN). During the practice, given that changes were allowed by the research protocol, 18 patients in the MIE group switched and received OE, while 14 patients in the OE group switched and received MIE. Therefore, finally, 67 patients were assigned to the MIE group and 75 patients were assigned to the OE group. Demographic parameters were comparable between the two groups (Table 2). The postoperative pathological variables including TNM stage, tumor differentiation, location, and surgical margin status were insignificantly different between the two groups. Remarkably, more lymph nodes were harvested from the MIE group ($p<0.01$). A comparison of postoperative outcomes between the two groups is shown in Table 3. The time spent in the ICU and hospital were comparable between the two groups, with no significant differences, even though a better trend was clear for the MIE group. According to the VAS pain score, patients in the MIE group had significantly less pain in the first 3 days after surgery than those in the OE group.

With regard to postoperative complications, the frequencies of pneumonia (26.9% vs 53.3%, $p<0.01$) and reoperation (4.5% vs 13.3%, $p<0.05$) were significantly

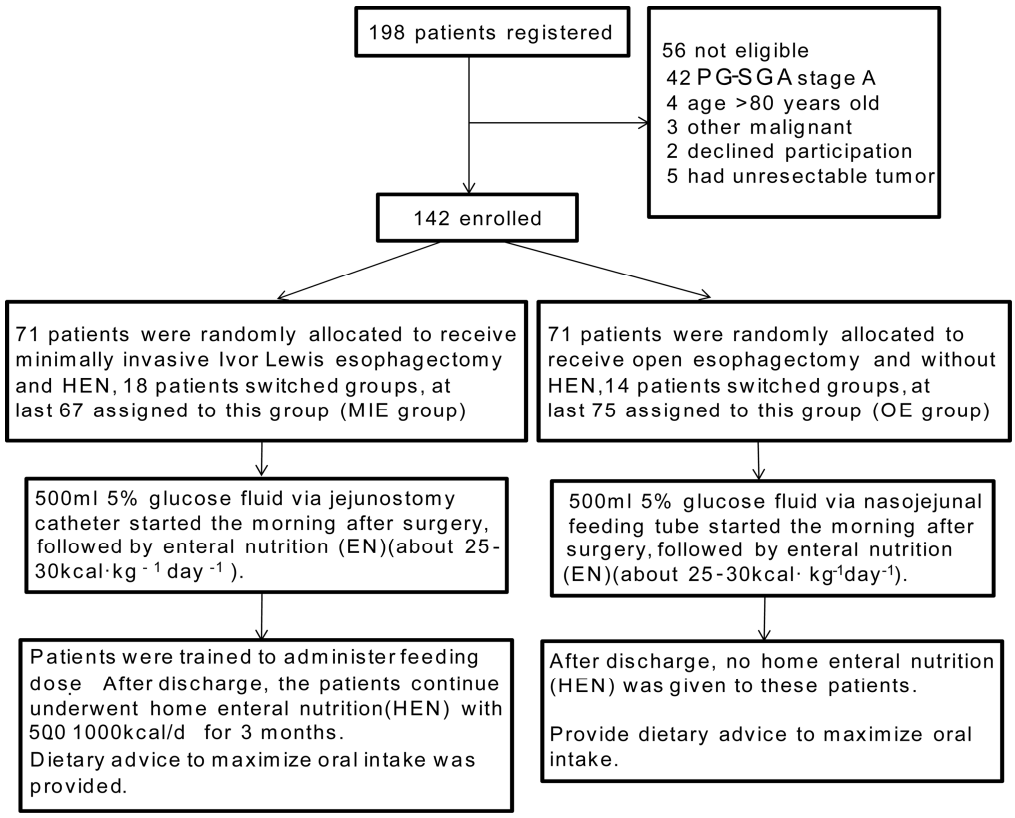

Figure 1. Trial profile.

Table 2. Baseline demographics and characteristics of patients for both groups

	MIE (N=67)	OE (N=75)	*p* value
Age(years)	62 (45-80)	61 (43-80)	0.148
Sex			0.224
Men	55 (82.1%)	67 (89.3%)	
Women	12 (17.9%)	8 (10.7%)	
Type of carcinoma			0.403
Adenocarcinoma	6 (9.0%)	4 (5.3%)	
Squamous cell carcinoma	61 (91.0%)	71 (94.7%)	
Location of tumor			0.115
Upper third	1 (1.5%)	2 (2.7%)	
Middle third	22 (32.8%)	37 (49.3%)	
Lower third	44 (65.7%)	36 (48.0%)	
Total LN harvested	31 (2-84)	19 (3-52)	0.001*
Stage			0.712
Stage 0/ I	13 (19.4%)	10 (13.3%)	
Stage Ⅱ	27 (40.3%)	36 (48.0%)	
Stage Ⅲ	27 (40.3%)	29 (38.6%)	
Differentiation			0.989
Well	12 (17.9%)	18 (24.0%)	
Moderate	42 (62.7%)	38 (50.7%)	
Poor	13 (19.4%)	19 (25.3%)	
Resection margins			0.204
R0	65 (97.0%)	71 (94.7%)	
R1	2 (3.0%)	4 (5.3%)	

MIE: minimally invasive esophagectomy; OE: open esophagectomy; LN: lymph node.
Data are presented as n (%) or median (range).
*$p<0.05$ between the two groups.

Table 3. Postoperative outcomes of patients for both groups

	MIE (N=67)	OE (N=75)	*p* value
Postoperative complication			
Pneumonia	18 (26.9%)	40 (53.3%)	0.001*
Chylothorax	1 (1.5%)	1 (1.3%)	0.937
Anastomotic leakage	1 (1.5%)	2 (2.7%)	0.632
Vocal-cord paralysis	2 (3.0%)	2 (2.7%)	0.910
Cardiac insufficiency	20 (29.9%)	7 (9.3%)	0.002*
Ileus need stop EN	2 (3.0%)	2 (2.7%)	0.910
JSEF	0 (0.0%)	NA	
Reoperation	3 (4.5%)	10 (13.3%)	0.037*
Mortality	1 (1.5%)	1 (1.3%)	0.937
VAS pain score (within 72 h)	2.0 (1.0-5.0)	4.0 (1.0-7.0)	0.001*
ICU stay (days)	3 (1-34)	4 (1-61)	0.075
Hospital stay (days)	15 (10-79)	16 (13-49)	0.095
3 months HEN†	67 (100%)	0	
Decreased EN dose	3 (4.6%)	NA	
Ileus need stop EN	0 (0.0%)	NA	
Postoperative chemoradiotherapy†			
Need chemoradiotherapy	54 (81.8%)	62 (83.8%)	0.760
Choose chemoradiotherapy	43 (65.2%)	37 (50.0%)	0.071
Complete chemoradiotherapy	41 (62.1%)	25 (33.8%)	0.001*

MIE: minimally invasive esophagectomy; OE: open esophagectomy; JSEF: jejunostomy site enterocutaneous fistula; NA: not available; VAS: visual analogue scale; ICU: intensive care unit.
Data are presented as n (%) or median (range).
†N=66 in the MIE group and N=74 in the OE group.
*$p<0.05$ between the two groups.

lower in the MIE group. The frequencies of cardiac insufficiency were significantly higher (29.9% vs 9.3%, $p<0.01$) in the MIE group. One of the MIE group patients died from a myocardial infarction, and one patient in the OE group died from anastomotic leakage induced MOSF. There were two ileus that required stopping EN in the MIE group and two such cases in the OE group; these patients were cured without surgery. No jejunostomy site

enterocutaneous fistula occurred during this study. No severe HEN-related complications occurred in the patients treated with 3 months HEN. Of these patients, only 3 cases decreased their HEN dose in order to relieve discomfort. Mild ileus might have occurred, but no patients needed to stop EN. Therefore, the 3-month HEN component of this study was performed safely.

The majority of patients, 81.8% in the MIE group and 83.8% in the OE group, needed to undergo postoperative chemoradiotherapy. Among the patients who chose to receive postoperative chemoradiotherapy, more patients were able to complete postoperative chemoradiotherapy in the MIE group than in the OE group (62.1% vs 33.8%, $p<0.01$).

There was no significant difference between the two groups in mean PG-SGA score, global health status (GHS), or functional and symptom scales at diagnosis (Table 4). The mean PG-SGA scores for the MIE and OE groups increased from 7.8 and 8.0 preoperatively to 10.6 and 10.4 postoperatively, respectively. Compared with baseline values, the postoperative PG-SGA score was significantly increased, implying that the status worsened following esophagectomy in both groups ($p<0.05$). Additionally, at the 3 month follow-up, the PG-SGA score for the MIE was reduced to a level lower than the baseline score, and the mean PG-SGA score was significantly higher in the OE group than in the MIE group (7.9 vs 5.7, $p<0.01$). At the 3-month follow-up, BMI, albumin, and hemoglobin values were significantly higher in the MIE group than in the OE group. Considering that there was no significant difference between the two groups in PG-SGA score, BMI, albumin, or hemoglobin at the preoperative stage and at two weeks post operation, we believe that surgery approach have no great influence in patients' nutritional status and 3 months HEN supplementation can reduce the risk of malnutrition.

At 2 weeks following esophagectomy, patients in both the MIE and the OE groups were given a QOL assessment. The QOL indicators shared similar trends in both groups, namely, that the GHS and the functional scores were significantly reduced and symptom scores were generally increased as compared to the values assessed prior to esophagectomy. At 3 months after surgery, most aspects of QOL started to improve for both groups. This was particularly apparent for physical, emotional, and cognitive functioning. The mean scores of the global quality of life (55.7 vs 41.8, $p<0.01$), physical function (80.7 vs 71.2, $p<0.01$), role function (48.7 vs 36.8, $p<0.01$), and social function (59.2 vs 53.7, $p<0.05$) were significantly higher in the MIE group than in the OE group. Symptom scores related to fatigue (15.4 vs 29.9, $p<0.01$), nausea and vomiting (14.4 vs 20.4, $p<0.01$), pain (9.0 vs 21.3, $p<0.01$), and appetite loss (25.6 vs 34.4, $p<0.05$) were more significantly decreased in the MIE patients (after 3 months HEN) than in the OE patients. Therefore, we conclude that, after 3 months HEN, patients in the MIE group had fewer symptoms and had superior improvements in functioning as compared to patients of the OE group.

DISCUSSION

No matter what surgery approach, most esophageal surgeons experience is of marked deterioration in nutritional status and quality of life in the first few months after esophagectomy.[3] Patients usually have some gastrointestinal symptoms, including dysphagia, early satiety, postprandial dumping syndrome, and reflux; these can cause nutritional intake problems.[18] Even in patients without problematic symptoms, resection of part of the stomach, gastric mobilization, and formation of a gastric conduit and intrathoracic anastomosis can reduce reservoir function and cause early fullness and consumption of a less adequate diet. Therefore, most post-esophagectomy patients experience significant postoperative malnutrition resulting from long-term suboptimal intake. As for the preoperatively malnourished esophageal cancer patients, their nutritional situation would most likely get even worse following surgery; therefore, we assumed that effective short-term nutritional support would be even more critical for this patient cohort. In this study, we sought to investigate the feasibility of using HEN to make up for the deficiency caused by limited oral food intake after esophagectomy.

There is unequivocal agreement that the QOL of patients who undergo esophagectomy is significantly impaired compared to preoperative levels.[19] During the first postoperative year, patients are observed to have problems with fatigue, dyspnea and pain, as well as decreased physical and role functioning.[11] The return of QOL toward baseline levels seems to occur within 6 to 12 months after experiencing the major deficits observed immediately following surgery and during the first phase of recovery. Reduced QOL in patients appears to be multifactorial, and both deleterious nutritional status and gastrointestinal symptoms are believed to be strong influences.[20] In the present study, patients that received MIE and 3 months of HEN had faster recovery rates than those who did not received HEN (after OE). This supports the hypothesis that effective short-term home nutritional support after surgery is beneficial for esophageal cancer patients.

In this study, we recommended that every patient develop their own HEN pattern; the daily EN dose was decided by the patients themselves based on advice provided by a HEN guideline used by our department. Briefly, patients were encouraged to reach a comfortable maximal oral intake and then they were asked to compare postoperative oral intake with their usual intake and decide on a suitable daily EN dose. Our HEN guidelines were designed to enable the patients to meet a daily energy demand at 25-30 kcal/kg. The prescribed enteral emulsions were nutritionally pre-balanced. We consider that the HEN methods used in this study helped patients to reach their energy demand and nutritional adequacy. With the self-decision pattern of EN administration, patients are asked to administer a daily volume of enteral emulsion of their own selected dosage and frequency. Compared with the ordered pattern of dosage, this self-decision pattern resulted in less digestive tract discomfort as assessed by ventosity (flatulence) and diarrhea. In this study, as the PG-SGA scores between the two groups were similar at the preoperative stage and at two weeks post operation, we could conclude that the surgical approach had no great influence on the patients' nutritional status. The PG-SGA

Table 4. Health related quality of life (QOL) and nutritional status of patients for both groups

	Preoperative		*p* value	2 weeks after operation		*p* value	3 months after operation		*p* value
	MIE (N=67)	OE (N=75)		MIE (N=66)	OE (N=74)		MIE (N=66)	OE (N=74)	
Global health status	69.9 (9.1)	70.1 (10.3)	0.546	19.6 (7.5)	18.4 (7.0)	0.821	55.7 (7.4)	41.8 (7.0)	0.001*
Functional scales									
Physical	92.1 (6.3)	92.0 (6.5)	0.963	41.3 (12.6)	39.1 (10.9)	0.438	80.7 (9.4)	71.2 (6.9)	0.001*
Role	71.4 (15.8)	70.0 (14.5)	0.585	13.6 (11.3)	11.9 (10.6)	0.343	48.7 (12.3)	36.8 (10.8)	0.001*
Social	73.4 (10.1)	75.1 (11.4)	0.343	29.3 (11.0)	28.5 (10.2)	0.675	59.2 (13.5)	53.7 (12.6)	0.014*
Emotional	60.0 (9.0)	61.4 (9.2)	0.626	42.3 (15.2)	32.5 (9.8)	0.001*	81.7 (10.7)	80.1 (9.9)	0.375
Cognitive	79.9 (11.1)	79.0 (10.6)	0.686	70.7 (14.6)	64.6 (17.3)	0.028*	79.2 (16.4)	77.1 (17.8)	0.466
Symptom scale									
Fatigue	9.8 (8.5)	9.8 (7.5)	0.996	48.6 (18.0)	56.0 (13.4)	0.097	15.4 (9.1)	29.9 (13.1)	0.001*
Pain	5.3 (10.2)	5.0 (10.0)	0.896	18.9 (14.9)	44.5 (14.4)	0.001*	9.0 (12.9)	21.3 (10.2)	0.001*
Dyspnea	2.0 (7.9)	4.9 (11.9)	0.087	39.4 (24.7)	40.4 (24.2)	0.604	17.9 (21.3)	23.6 (21.2)	0.122
Insomnia	7.0 (13.7)	6.2 (13.0)	0.741	29.8 (24.9)	47.0 (28.8)	0.001*	19.5 (16.6)	28.2 (41.3)	0.116
Nausea & vomiting	10.4 (15.6)	12.9 (16.3)	0.365	25.7 (8.4)	27.9 (7.9)	0.447	14.4 (10.6)	20.4 (14.0)	0.005*
Appetite	19.4 (18.5)	17.3 (20.0)	0.525	44.4 (21.4)	45.2 (23.8)	0.844	25.6 (20.2)	34.3 (21.6)	0.018*
Constipation	10.4 (15.6)	12.9 (16.3)	0.365	24.2 (29.0)	21.9 (28.4)	0.634	18.7 (21.3)	17.6 (18.5)	0.869
Diarrhea	10.9 (21.9)	8.0 (15.3)	0.066	19.2 (19.5)	18.9 (17.1)	0.564	8.2 (16.7)	10.8 (20.1)	0.414
Finance	30.8 (23.4)	28.4 (23.0)	0.540	62.1 (21.8)	55.7 (26.1)	0.120	38.9 (23.2)	30.1 (29.7)	0.055
PG-SGA	7.8 (1.9)	8.0 (2.5)	0.532	10.6 (2.0)	10.4 (2.2)	0.673	5.7 (1.5)	7.9 (1.6)	0.001*
BMI (kg/m^2)	21.5 (2.6)	22.3 (2.5)	0.071	20.0 (2.2)	18.9 (2.6)	0.215	22.1 (1.3)	20.1 (1.6)	0.001*
Albumin (mg/dL)	4.2 (0.4)	4.2 (0.4)	0.884	3.2 (0.3)	3.2 (0.4)	0.822	4.0 (0.4)	3.6 (0.5)	0.001*
Hemoglobin (mg/dL)	13.3 (1.7)	13.7 (1.7)	0.187	10.8 (1.3)	10.6 (1.5)	0.253	13.2 (1.6)	12.0 (2.1)	0.001*

MIE: minimally invasive esophagectomy; OE: open esophagectomy; BMI: body mass index; PG-SGA: Patient Generated Subjective Global Assessment.
Data are presented as mean (SD). For functional scores and global QOL, higher scores represent better function and QOL, whereas a higher score for symptom scales and PG-SGA represents more severe symptoms and malnutrition.
*$p<0.05$ between the two groups.

score was reduced to a level below the baseline score in the MIE group, indicating that 3 months of HEN supplementation can reduce the risk of malnutrition.

Considering the high degree of recurrence or metastasis in esophageal cancer patients, a large proportion of this population needs postoperative chemoradiotherapy, for which they need to be in good physical condition. Studies have shown that HEN helps to maintain good physical and nutritional status, which can result in better tolerance to further treatment.[20,21] Similarly, our study demonstrated that HEN for 3 months helped to improve postoperative chemoradiotherapy endurance. In our study, 81.8% in the MIE group and 83.8% in the OE group needed postoperative chemoradiotherapy and among the patients who chose postoperative chemoradiotherapy, the completion rates were 95.3% (41/43) in the patients treated with HEN and 67.6% (25/37) in the patients treated without HEN. The disease free survival and overall survival for the patients of this study will be assessed in the future to detect possible effects of complementation with adjunctive therapies on survival rates.

This study showed benefits in short-term HEN for patients who have undergone the MIE Ivor Lewis procedure. This may be the first report in which surgeons advocate HEN by jejunal feeding tube after MIE. MIE Ivor Lewis is admittedly complex and technically challenging, so that the advantages of this operation may not be evident before a surgeon, even one highly skilled at performing OE, progresses through a learning curve. In this study, patient enrollment was not started until we had operated on over 80 cases, using the MIE Ivor Lewis approach, when we could perform a laparoscopic jejunostomy effectively (in about 10 min) and safely. We hope that any deviation in patient postoperative outcome caused by difference in surgical proficiency with MIE or OE was minimised.

Patients in this study were able to perform jejunal tube feeding safely for their HEN regimen. Every patient was educated about how to manage a feeding tube and how to adjust the feeding volume. For further security, they were also given a guideline booklet and an inquiry phone number at the time of discharge. This enabled the HEN in this study to be performed safely with only minor complications. When considering that the QOL level improved more quickly in patients with HEN (underwent MIE) than in those patients without HEN (underwent OE), we have to, acknowledge the advantages of minimally invasive technique over conventional open technique. Nevertheless, we consider that 3 months HEN and the fact that every patient developed their own HEN pattern were likely contributors to the improved outcomes. In addition, the prospective and longitudinal design, the relatively large sample size, and the use of validated, multidimensional questionnaires in this study will have decreased both selection and information biases. A randomized study of patients undergoing MIE followed by 3 months HEN or lacking HEN will now be conducted in our department.

In summary, we suggest that 3 months HEN after MIE can enhance the quality of life and reduce the risk of malnutrition in preoperatively malnourished esophageal cancer patients. HEN can be performed safely and a self-decision pattern of HEN dosage is both possible and recommended.

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AUTHOR DISCLOSURES

The authors declare no conflict of interest.

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