Outcomes of jejunostomy-tube placement in surgical patients with esophageal cancer

Hope Conrad, MD,[a] Ahmed Elkamel, MBBS,[a] Anthony Maltagliati, MD,[a] Kevin Wang, MD,[a] Chiu-Hsieh Hsu, PhD,[a] Wendy Linville, BA,[b] Michal Lada, MD,[b] Praveen Sridhar, MD,[a] and Stephanie Worrell, MD[a]

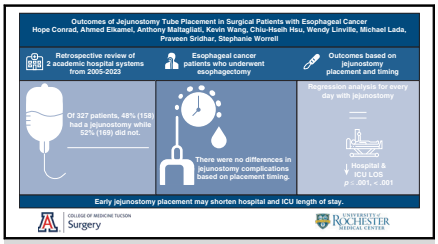
ABSTRACT

Objective: Patients with esophageal cancer who undergo esophagectomy are at high risk for malnutrition. Jejunostomy tubes are often placed to provide enteral access for nutritional support. Traditionally, jejunostomy placement occurs at the time of esophagectomy. However, benefits have been described in patients with earlier jejunostomy placement. The purpose of this study is to determine outcomes of surgical patients with esophageal cancer on the basis of jejunostomy tube placement as well as to analyze the effect of placement timing on these factors.

Methods: This is a retrospective, multi-institutional study including 2 academic hospital systems. Patients with esophageal cancer who underwent esophagectomy were included. Patients who received a jejunostomy tube were compared with patients who did not receive a jejunostomy tube. Further analysis comparing early and routine jejunostomy placement timing was then performed.

Results: Of 327 included patients, 48.32% (158) had a jejunostomy tube and 51.68% (169) did not have any form of enteral access. For every day a patient had a jejunostomy tube in place, there was a reduction in hospital length of stay (LOS) and intensive care unit LOS ($P \leq .001$ and $< .001$).

Conclusions: Jejunostomy tube placement in patients with esophageal cancer undergoing esophagectomy significantly enhances nutritional outcomes, particularly in malnourished patients, and reduces 90-day mortality and recurrence rates. Patients with esophageal cancer who underwent esophagectomy and received an early jejunostomy tube had shorter hospital and intensive care unit LOS. Early placement of jejunostomy tubes should be considered to optimize nutritional support and improve overall patient resilience before surgery. Further prospective studies are warranted to confirm these findings and refine guidelines for jejunostomy tube placement in patients with esophageal cancer. (JTCVS Open 2025;24:496-509)



Outcomes of jejunostomy-tube placement in surgical patients with esophageal cancer.

CENTRAL MESSAGE

Patients with esophageal cancer who underwent esophagectomy with early j-tubes have significantly shorter hospital and ICU lengths of stay.

PERSPECTIVE

Patients with esophageal cancer who undergo esophagectomy are at high risk for malnutrition. j-tube placement can mitigate this risk by providing enteral access for supplementation. Patients with j-tubes benefit from shorter ICU LOS and decreased overall mortality compared with patients without j-tubes. Earlier j-tube placement is associated with decreased hospital LOS and ICU LOS.

Esophageal cancer is the seventh most common malignancy worldwide, accounting for 1 of every 18 cancer deaths in 2020 alone.[1] Esophageal cancer is typically advanced at the time of diagnosis, with 50% of patients presenting with locally advanced disease. The most common presenting symptom is dysphagia, which can be attributed to motility dysfunction or obstruction caused by tumor growth within the esophageal lumen.[2] This often leads to reduced nutritional intake which, combined with increased metabolic demands associated with malignancy, places patients at high risk for malnutrition.[3]

The treatment for locally advanced disease typically involves neoadjuvant chemoradiation or chemotherapy followed by surgical resection. The relationship between nutritional status and patient outcomes has been well-described in esophageal cancer. Poor nutrition can lead to intolerance of neoadjuvant therapy and worsened perioperative outcomes.[3] To optimize nutrition, the Enhanced

From the [a]Division of Thoracic Surgery, Department of Surgery, University of Arizona, Tucson, Ariz; and [b]Division of Thoracic and Foregut Surgery, Department of Surgery, University of Rochester, Rochester, NY.

Read at the 104th Annual Meeting of The American Association for Thoracic Surgery, Toronto, Ontario, Canada, April 27-30, 2024.

Received for publication May 15, 2024; revisions received Dec 9, 2024; accepted for publication Dec 23, 2024; available ahead of print Feb 7, 2025.

Address for reprints: Stephanie Worrell, MD, Division of Thoracic Surgery, Department of Surgery, University of Arizona, 1625 N Campbell Ave, Tucson, AZ 85718 (E-mail: sworrell@arizona.edu).

2666-2736

https://doi.org/10.1016/j.xjon.2025.01.003

Abbreviations and Acronyms

BMI = body mass index
CI = confidence interval
ECOG = Eastern Cooperative Oncology Group
GI = gastrointestinal
ICU = intensive care unit
j tube = jejunostomy tube
LOS = length of stay

Recovery after Surgery guidelines for esophagectomy recommend performing a nutritional assessment upon diagnosis. If supplementation is needed, the method of nutritional support is left to the discretion of the provider.[4]

Although ensuring good nutritional status is well understood, determining the method and timing of supplementation is not well described. When possible, enteral nutrition is preferred over parenteral nutrition. Feeding jejunostomy-tube (j-tube) placement is often performed in patients with esophageal cancer, as it provides enteral access while preserving the stomach for conduit creation at time of resection. Traditionally, j-tube placement occurs at the time of esophagectomy. However, the benefits of enteral nutrition have been found to improve neoadjuvant and perioperative outcomes when initiated before treatment.[5-7] The purpose of this study is to determine outcomes of surgical patients with esophageal cancer on the basis of j-tube placement as well as analyze the effect of placement timing on these factors.

METHODS

Study Design and Setting

This is a retrospective, multi-institutional study that included patients from 2 academic hospital systems between 2005 and 2023. Patients older than the age of 18 years who were diagnosed with esophageal cancer and underwent esophagectomy were included. Patients who received total parenteral nutrition, nasoenteric nutrition, gastrostomy, or gastrojejunostomy tubes were excluded from the study. Data collected for the analysis included patient demographics, disease characteristics, and j-tube information. Clinical and pathologic staging data (T and N stages) were included to evaluate disease severity and its association with outcomes. Neoadjuvant treatment data were also collected and analyzed to account for variations in treatment patterns over time.

J-Tube Protocol

Patient weight, body mass index (BMI), and reported 3-month weight loss were noted at the initial visit before neoadjuvant therapy, if applicable. The decision to offer j-tube placement and timing of placement were surgeon dependent. The timing of j-tube placement was influenced by surgeon preference, patient-specific factors, and institutional practices. Over the long study period (2005-2023), these practices evolved alongside advancements in surgical techniques and perioperative care protocols. Because of the involvement of numerous surgeons across 2 institutions and the diversity of practices, it was not feasible to quantify the specific impact of individual surgeon preferences on j-tube placement decisions Nevertheless, in our recent practice, j-tube placement was offered to patients who were malnourished or had self-reported poor oral intake, as well as patients who intended to undergo neoadjuvant therapy. In the case of patients undergoing neoadjuvant therapy, j tubes were typically placed before neoadjuvant therapy. The technique and approach of the j-tube placement varied depending on institutional practices, surgeon preferences, and common practices at the time. The approach, whether open or laparoscopic, evolved resulting from the long course of the study period.

Postoperative Care and Data Collection

Postoperative level of care (routine intensive care unit [ICU] vs optional ICU admission postoperatively) was dependent on institution and surgeon preference. Postoperative diet advancement was also a clinical decision made on a case-by-case basis and was typically preceded by an upper gastrointestinal (GI) study in the early postoperative course with gradual advancement from liquid to solid food. Postoperative clinic visits measured relative weight, BMI, and albumin, with the decision for j-tube removal dependent on adequate oral intake and occurred no earlier than 6 weeks postoperatively.

Data Collection and Outcome Measures

A comprehensive collection of patient demographics, disease characteristics, and detailed information regarding j-tube placement was done. This included the timing of j-tube insertion (preoperative or postoperative) and any associated complications. In addition, clinical outcomes such as hospital and ICU length of stay, in-hospital and postoperative mortality, and recurrence rates were meticulously recorded to assess the impact of j-tube use on patient recovery and overall prognosis.

Statistical Analysis

Patients were first compared on the basis of j-tube placement. Outcome measures included hospital length of stay; ICU length of stay; 30-day readmission; in-hospital-, 30-, and 90- day mortality; change in BMI; recurrence; and esophagectomy complications. Wilcoxon rank sum test was performed to compare each of the continuous variables and the χ^2 test was performed to compare each of the categorical variables. Log-normal regression was performed to derive the relative risk ratio of geometric mean for changes in BMI, hospital LOS and ICU LOS. Logistic regression was performed to derive odds ratio for mortality, recurrence and esophagectomy complications. Adjustments were made for age, clinical stage (III/IV), ethnicity, Eastern Cooperative Oncology Group (ECOG) functional status, neoadjuvant chemoradiation, timing of j-tube placement, and year of surgery to account for temporal differences in care.

Next, rates of j-tube complications were compared on the basis of the timing of tube placement. The complications were collected for the entire duration of j-tube placement. Patients who received j tubes before surgery, during surgery, or after surgery were compared. The Kruskal-Wallis test was performed to compare each of the continuous variables, and the χ^2 test was performed to compare each of the categorical variables. This was then performed for tube placement relative to neoadjuvant therapy. Finally, the effect of j-tube duration on patient outcomes was analyzed per day of tube placement. Log-normal regression was employed for continuous outcomes, including hospital LOS and ICU LOS, whereas logistic regression was used for binary outcomes, such as mortality, recurrence, and esophagectomy complications. Adjustments were made for age, clinical stage, ECOG status, ethnicity, neoadjuvant chemoradiation, timing of j-tube placement, and the year of surgery. Multi-institutional institutional review board approval was obtained for this study (STUDY00001755; May 26, 2023).

RESULTS

Demographics and Clinical Characteristics

A total of 327 patients were included in the study, with a median age of approximately 62 years across all groups ($P = .629$). Among these patients, 48 (14.7%) had an early

j-tube placement, 109 (33.3%) had a concurrent j-tube placement at time of esophagectomy, and 170 (52%) did not have a j tube. The gender distribution showed that 17.4% of the total population was female, with no significant difference between the groups.

There was a significant difference in ECOG functional status among the groups ($P = .002$). Specifically, patients with early j-tube placement comprised a greater proportion of ECOG 1 (64.6%) compared with those with concurrent j-tube placement (49.5%) and lower proportion compared with those with no j-tube placed (71.8%). The concurrent j-tube group had the greatest percentage of ECOG 0 patients (49.5%), suggesting the best overall functional health, whereas the no j-tube group had the lowest percentage of ECOG 0 patients (25.9%) and a slightly greater percentage of ECOG 2 or 3 patients (2.4%), indicating poorer functional health.

Comorbidities and Weight Loss

In terms of comorbidities, there were no significant differences in the rates of coronary artery disease, congestive heart failure, peripheral vascular disease, diabetes, chronic kidney disease, or chronic obstructive pulmonary disease across the groups. However, there was a trend toward significance for coronary artery disease, with the greatest incidence in the no j-tube group (26.5%) compared with the early (12.5%) and concurrent (19.3%) j-tube groups ($P = .08$). Regarding tobacco use, the distribution of never, past, and current users was similar across the groups ($P = .74$).

Weight loss was significantly different between groups ($P < .001$). Patients with early j-tube placement had the greatest percentage of severe weight loss (>5% weight loss or BMI <20) at 70.3%, followed by those with concurrent j-tube placement at 41.3%, and the no j-tube group at 35.9%.

Cancer Characteristics and Surgical Approach

Table 1 provides clinical and pathologic staging data, highlighting the more advanced disease burden in the j-tube groups. Patients in the early j-tube group had the greatest proportion of T4 (2.9%) ($P = .008$) and N3 (64.7%) ($P = .8$) stage disease, compared with lower rates in the concurrent and no j-tube groups. In addition, neoadjuvant chemoradiation usage was significantly greater in the early (70.8%) and concurrent (78.9%) j-tube groups compared with the no j-tube group (41.2%) ($P < .001$). Tumor location differed significantly, with the lower esophagus being the most common site across all groups ($P = .006$). However, there were no significant differences in the final pathology between adenocarcinoma and squamous cell carcinoma ($P = .093$) or in the presence of positive resection margins ($P = .268$).

Patients who underwent a transhiatal or McKeown esophagectomy were more likely to be in the no j-tube group, whereas the Ivor Lewis approach was more common in the early j-tube group ($P < .001$). In addition, a minimally invasive approach was significantly more common in the early and concurrent j-tube groups compared with the no j-tube group ($P < .001$).

Timing of Surgery and J-Tube Duration

Regarding perioperative timelines, most patients without a j-tube had surgery before 2015, whereas the early and concurrent j-tube placements were more common after 2015 ($P < .001$). The mean duration of j-tube use was significantly longer in the early group (182 days; 95% confidence interval [CI], 141-224) compared with the concurrent placement group (116 days; 95% CI, 62-171) ($P < .001$). Change in BMI postsurgery did not differ significantly between the j-tube groups ($P = .145$), although there was a nonsignificant trend towards greater weight loss in the early j-tube group (Table 1).

J Tube Versus No J Tube

When comparing operative and postoperative outcomes on the basis of j-tube status, patients with a j tube had shorter hospital LOS (11 days vs 13 days, $P < .001$) and lower overall mortality (49.03% vs 68.50%, $P = .002$). No differences were found when comparing change in BMI, ICU LOS, in-hospital mortality, 30-day mortality, 90-day mortality, recurrence, and esophagectomy complications (Table 2). Regression analysis was then performed, adjusting for age, ethnicity, neoadjuvant chemoradiation, surgical approach, ECOG status, and year of surgery. No significant differences were observed in ICU and hospital LOS, in-hospital mortality, 30-day or 90-day mortality, recurrence, or esophagectomy complications (Table 3).

In malnourished patients with weight loss more than 5% from basal weight or a BMI <20 at the initial visit, j-tube placement was associated with a greater mean rank for weight gain compared with those without j-tube placement (mean rank 80.05 vs 46.64, $P < .001$), indicating a significant improvement in nutritional outcomes. Although malnourished patients with a j-tube had a shorter ICU LOS (mean rank 62.03 vs 51.06, $P = .072$), this difference did not reach statistical significance. Similarly, there were no significant differences in hospital LOS (mean rank 61.59 vs 72.21, $P = .111$), 30-day mortality (1.4% vs 1.6%, $P = .279$), 90-day mortality (2.9% vs 4.3%, $P = .500$), or recurrence rates (49.3% vs 57.4%, $P = .129$) between the j tube and no j tube in the malnourished patients (Table E1).

Early J-Tube Placement Versus Routine J-Tube Placement

Outcomes were then compared on the basis of timing of j-tube placement. Early j tubes were placed before esophagectomy, whereas routine j tubes were placed during esophagectomy. Patients who received j tubes after

TABLE 1. Demographic and clinical characteristics of patients by j-tube placement status

Variable	Early j tube	Concurrent j tube	No j tube	Total	*P* value
N	48	109	170	327	
Gender					
Female	13 (27.1)	20 (18.3)	24 (14.1)	57 (17.4)	
Age, y	63 ± 9.5	62 ± 10.1	62.5 ± 10.4		.629
ECOG					**.002**
0	13 (31.3)	54 (49.5)	44 (25.9)	113 (34.6)	
1	31 (64.6)	54 (49.5)	122 (71.8)	207 (63.3)	
2	2 (4.2)	0 (0)	3 (1.8)	5 (1.5)	
3	0 (0)	1 (0.9)	1 (0.6)	2 (0.6)	
CAD	6 (12.5)	21 (19.3)	45 (26.5)	72 (22)	.08
CHF	1 (2.1)	3 (2.8)	2 (1.2)	6	.62
PVD	2 (4.3)	6 (5.5)	10 (5.9)	18 (5.5)	.91
Diabetes	8 (17)	28 (25.7)	37 (21.8)	73 (22.4)	.47
CKD	2 (4.3)	5 (4.6)	7 (4.1)	14 (4.3)	.98
COPD	10 (21.3)	13 (11.9)	35 (20.6)	58 (17.8)	.14
Tobacco use					.74
Never	5 (13.2)	23 (21.1)	31 (18.2)	59 (18.6%)	
Past	25 (65.8)	71 (65.1)	113 (66.5)	209 (65.9)	
Current	8 (21.1)	15 (13.8)	26 (15.3)	49 (15.5)	
Clinical T stage					.045
T1	0 (0)	14 (13.9)	9 (6.3)	23 (8.3)	
T2	6 (17.6)	27 (26.7)	36 (25.2)	69 (24.8)	
T3	27 (79.4)	60 (59.4)	97 (67.8)	184 (66.2)	
T4	1 (2.9)	0 (0)	1 (0.7)	2 (0.7)	
Clinical N stage					.2
N0	9 (26.5)	18 (22.8)	11 (9.1)	38 (16.2)	
N1	0 (0)	0 (0)	7 (5.8)	7 (3)	
N2	3 (8.8)	16 (20.3)	27 (22.3)	46 (19.7)	
N3	22 (64.7)	45 (57)	76 (62)	143 (61)	
Pathologic T stage					.008
T0	20 (55)	65 (60)	92 (55)	177	
T1	9 (25)	27 (25)	44 (26.3)	80 (25.7)	
T2	5 (13.9)	13 (12)	19 (11.4)	37 (11.9)	
T3	2 (5.6)	3 (2.8)	12 (7.2)	17 (5.5)	
Pathologic N stage					.83
N0	20 (55.6)	65 (60.2)	92 (55)	177 (56)	
N1	9 (25)	27 (25)	44 (26.3)	80 (25.7)	
N2	5 (13.9)	13 (12)	19 (11.4)	37 (11.9)	
N3	2 (5.6)	3 (2.8)	12 (7.2)	17 (5.5)	
Weight loss					**<.001**
No weight loss	6 (16.2)	34 (31.2)	93 (54.7)	133 (42.1)	
<5% weight loss	5 (13.5)	30 (27.5)	16 (9.4)	51 (16.1)	
>5% weight loss or BMI <20	26 (70.3)	45 (41.3)	61 (35.9)	132 (41.8)	
nCT	1 (2.1)	2 (1.8)	40 (23.5)	43 (13.1)	**<.001**
nCR	34 (70.8)	86 (78.9)	70 (41.2)	190 (58.1)	**<.001**
Final pathology					.093
Adenocarcinoma	31 (81.6)	99 (90.8)	155 (91.2)	285 (89.9)	
Squamous cell carcinoma	7 (18.4)	8 (7.3)	15 (8.8)	30 (9.5)	

(Continued)

TABLE 1. Continued

Variable	Early j tube	Concurrent j tube	No j tube	Total	*P* value
Tumor location					.006
GEJ	9 (19.1)	26 (23.9)	38 (22.4)	73 (22.4)	
Lower esophagus	25 (53.2)	78 (71.6)	103 (60.6)	206 (63.2)	
Middle esophagus	2 (4.3)	4 (3.7)	5 (2.9)	11 (3.4)	
Upper esophagus	0 (0.0)	0 (0.0)	2 (1.2)	2 (0.6)	
Cervical esophagus	1 (2.1)	0 (0.0)	1 (0.6)	2 (0.6)	
Positive resection margin					.268
Negative	33 (89.2)	102 (93.6)	125 (87.4)	260 (90.0)	
Positive	4 (10.8)	7 (6.4)	18 (12.6)	29 (10.0)	
Esophagectomy procedure					**<.001**
Transhiatal	12 (25.0)	50 (45.9)	80 (47.1)	142 (43.4)	
McKeown	9 (18.8)	20 (18.3)	79 (46.5)	108 (33.0)	
Ivor Lewis	26 (54.2)	38 (34.9)	11 (6.5)	75 (22.9)	
Minimally invasive approach	23 (57.5)	31 (35.6)	16 (15.5)	70 (30.4)	**<.001**
Date of surgery					**<.001**
Before 2015	15 (6.8)	37 (16.7)	170 (76.6)	222	
After 2015	33 (31.4)	72 (68.6)	0 (0.0)	105	
Days j-tube in place, mean (CI)	182 (141-224)	116 (62-171)	–	–	**<.001**
Change in BMI, mean (CI)	−1.4 (−0.7 to −2.1)	0.8 (−0.2 to −1.5)	–	–	.145
Days feeding before surgery, mean (CI)	104 (±34.1)				

Bold value indicates statistically significant. *j-tube*, Jejunostomy tube; *ECOG*, Eastern Cooperative Oncology Group; *CAD*, coronary artery disease; *CHF*, congestive heart failure; *PVD*, peripheral vascular disease; *CKD*, chronic kidney disease; *COPD*, chronic obstructive pulmonary disease; *BMI*, body mass index; *nCT*, neoadjuvant chemotherapy; *nCR*, neoadjuvant chemo radiation; *GEJ*, gastroesophageal junction; *CI*, confidence interval.

esophagectomy were excluded. This analysis included a total of 156 patients, of whom 47 patients underwent early j-tube placement and 109 patients underwent routine j-tube placement. We initially found that patients who underwent early j-tube placement had lower hospital LOS compared with those who received routine j-tube placement (12 days vs 9 days, $P = .017$) (Table 4). However, after we adjusted for age, ethnicity, neoadjuvant chemoradiation, ECOG status, clinical staging, and neoadjuvant chemoradiation, this was no longer statistically significant.

J-Tube Complications

In our study, complications associated with j tubes were carefully monitored from the time of insertion until removal, including both during the initial hospitalization and postdischarge. Complication rates between routine and early j-tube placement were similar (53.19% vs 55.05%), with the majority of complications being minor, such as superficial soft-tissue infections, nausea/vomiting, and dislodgement of the j tube from a mature tract. These complications were categorized into mild (eg, skin irritation, mild infection), moderate (eg, tube obstruction, localized infection), and severe (eg, peritonitis, dislodgement requiring surgery). Among the 157 patients reviewed, 73 (46.5%) experienced no complications, 21 (13.4%) had mild complications, and 63 (40.1%) experienced moderate complications, with no severe complications reported. Readmissions related to j-tube complications occurred in 45 patients, with a greater frequency observed in those with early j-tube placement (62.2%), although this was not statistically significant ($P = .252$). The readmissions were predominantly due to nonsevere causes such as tube dislodgment not requiring reoperation and localized infections requiring intravenous antibiotic therapy (Table 5).

Postoperative Complications and Mortality

The analysis of postoperative complications revealed notable differences between early concomitant j-tube and no j-tube groups. Esophagectomy complications were further categorized by severity using the Clavien-Dindo classification and by type of complication. This included cardiopulmonary complications (acute coronary syndrome, atrial fibrillation), infectious complications (sepsis, pneumonia, wound dehiscence), renal and genitourinary complications (acute kidney injury, urinary retention), and GI complications (ileus, anastomotic leaks) with anastomotic leaks in a subcategory (Table 5).

GI complications were significantly more frequent in the concomitant j-tube group (30.3%) compared with the early j-tube (8.7%) and no j-tube groups (25.9%, $P = .016$). The no j-tube group had the greatest rate of overall postoperative

TABLE 2. Outcomes on the basis of j-tube placement

Outcomes	No j-tube n = 169	j-tube n = 158	*P* value
Change in BMI	NA	−0.80 (−2.38, 0.10)	
Hospital LOS	13.00 (11.00, 21.00)	11.00 (8.00, 16.00)	**<.001**
ICU LOS	3.00 (1.00, 8.00)	3.00 (1.00, 5.00)	.39
In-hospital mortality	7 (4.14%)	4 (2.53%)	.62
30-d mortality	3 (1.79%)	2 (1.27%)	>.99
90-d mortality	9 (7.20%)	10 (6.85%)	>.99
Overall mortality	87 (68.50%)	76 (49.03%)	**.002**
Recurrence	64 (46.72%)	68 (44.74%)	.83
Esophagectomy complications	98 (57.99%)	82 (51.90%)	.32

Bold value indicates statistically significant. *j-tube*, Jejunostomy tube; *BMI*, body mass index; *NA*, not available; *LOS*, length of stay; *ICU*, intensive care unit.

complications, particularly Clavien-Dindo class IIIb complications (18.2%, $P < .001$). When considering the severity of complications, class II complications were the most prevalent, occurring in 47.7% of the concomitant j-tube group, 32.4% of the early j-tube group, and 31.8% of the no j-tube group ($P \leq .001$). Notably, class IV complications, which are life-threatening and necessitate intensive care, were more frequent in the early j-tube group (27.0%) compared with the concomitant group (15.6%) and no j-tube (17.1%) groups. This is primarily driven by cardiopulmonary events such as pulmonary embolism and myocardial infarction.

No statistically significant differences were found between the groups regarding cardiopulmonary complications ($P = .28$), infectious complications ($P = .43$), or renal/genitourinary complications ($P = .67$). In addition, the overall severity of j-tube−related complications did not significantly differ between the groups ($P = .770$).

Regarding mortality outcomes, the timing of j-tube placement (early vs concomitant) did not significantly impact short-term mortality. The 30-day mortality rate was 1% overall, with a slightly greater rate in the concomitant group (4.2%) compared with the early placement group (0.9%), although this difference was not statistically significant ($P = .164$).

In patients with Clavien-Dindo class III and IV postoperative complications such as anastomotic leaks or pneumonia, j-tube placement was associated with shorter ICU stay. Specifically, patients with a j-tube had a mean ICU length of stay rank of 32.9 compared with 44.3 in those without a j-tube ($P = .027$) (Table E2).

However, the hospital LOS and incidence of sepsis did not significantly differ between the groups ($P = .264$, $P = .327$, respectively). Data on mechanical ventilation were incomplete, preventing a thorough analysis of this outcome, although the absence of data in the no j-tube group suggests potential differences in ventilator use between the groups.

TABLE 3. Adjusted outcomes on the basis of j-tube placement

Outcomes	adj. RR/OR	Lower 95% CI	Upper 95% CI	adj *P*
Hospital LOS, d	0.033	0.001	3.5	.227
ICU LOS, d	0.177	0.0037	3.26	.338
In-hospital mortality	2.187	.324	14.754	.422
30-d mortality	.499	.097	2.584	.408
90-d mortality	.857	.376	1.956	.715
Overall mortality	1.068	.683	1.669	.066
Recurrence	inf	inf	−1.6	.055
Esophagectomy complications	1.517	.709	3.247	.28

j-tube, Jejunostomy tube; *RR*, relative risk; *OR*, odds ratio; *CI*, confidence interval; *LOS*, length of stay; *ICU*, intensive care unit.

Outcomes and Survival on the Basis of J-Tube Duration

Outcomes on the basis of j-tube duration were analyzed, after controlling for age, clinical stage, Hispanic ethnicity, ECOG status, date of surgery, surgical approach and timing of j-tube placement, and neoadjuvant chemoradiation (Table 6). For each day a j tube was in place, there was a reduction in hospital LOS and ICU LOS ($P \leq .001$ and $< .001$). However, no significant associations were found between j-tube duration and in-hospital mortality ($P > .999$), 30-day mortality ($P = .983$), 90-day mortality ($P = .997$), or recurrence ($P > .999$).

Finally, to assess long-term survival outcomes, we performed a Kaplan-Meier analysis on patients who underwent neoadjuvant therapy, focusing on the timing of j-tube placement (Figure 1). The analysis revealed no statistically significant differences in survival times across the groups (before surgery vs concomitant placement: $P = .706$; before surgery vs no j-tube placement: $P = .944$; concomitant placement vs no j-tube placement: $P = .666$). Patients who had a j tube placed on the day of surgery had a mean survival time of 90.31 months (95% CI, 65.65-114.98 months) and a median survival time of 68.30 months (95% CI, 26.36-110.24 months). Those who received a j tube before surgery had a mean survival time of 73.87 months (95% CI, 61.66-86.07 months) and a median survival time of 56.90 months (95% CI, 2.14-111.66 months). In comparison, patients without a j tube had numerically longer survival times, with a mean of 113.74 months (95% CI, 99.53-127.96 months) and a median of 151.00 months (95% CI, 132.45-169.55 months); however, these differences were not statistically significant (Table E3). The results showed no statistically significant differences in survival times across the groups (before surgery vs concomitant placement: $P = .706$; before surgery vs

TABLE 4. Outcomes on the basis of timing of j-tube placement

Outcomes	Early placement n = 47	Routine placement n = 109	*P* value
Change in BMI	−1.09 (−2.39, −0.27)	−0.46 (−2.30, 0.28)	.15
Hospital LOS	9.00 (7.00, 15.50)	12.00 (9.00, 17.00)	.017
ICU LOS	2.00 (0.00, 5.00)	3.00 (1.00, 5.00)	.31
In-hospital mortality	3 (6.38%)	1 (0.92%)	.15
30-d mortality	2 (4.26%)	0 (0.00%)	.17
90-d mortality	5 (10.87%)	5 (5.05%)	.35
Overall mortality	21 (45.65%)	54 (50.47%)	.71
Recurrence	17 (39.53%)	50 (46.73%)	.54
Esophagectomy complications	22 (46.81%)	60 (55.05%)	.44
j-tube complications	25 (53.19%)	60 (55.05%)	.97
j tube duration	144.50 (89.50, 189.75)	61.00 (38.00, 92.00)	<.001

j-tube, Jejunostomy tube; *BMI*, body mass index; *LOS*, length of stay; *ICU*, intensive care unit.

no j-tube placement: $P = .944$; concomitant placement vs no j-tube placement: $P = .666$).

DISCUSSION

Measures of Nutritional Status

Nutritional status can be evaluated using anthropomorphic measures, laboratory analysis, and risk stratification scales. Anthropomorphic measures like weight and BMI are frequently used options because of their noninvasive and convenient nature. Patients with esophageal cancer are more susceptible to weight loss compared with other patients with cancer, and 70% of patients present with 10% or more loss in body weight.[3] Decreased overall survival, increased mortality, and increased perioperative complications have been associated with weight loss in this patient population.[8-10] In our study, changes in BMI were compared among patients with early and routine j-tube placement, with no significant difference noted ($P = .15$).

J-Tube Placement

The impact of nutritional status on surgical outcomes in patients with esophageal cancer is well described. Most

TABLE 5. Postoperative complications, j-tube complication severity, and mortality outcomes by j-tube placement timing (early vs concomitant)

Complication type	Early j tube (n = 48)	Concomitant j tube (n = 109)	No j tube (n = 170)	Total (n = 327)	*P* value
j-tube complication severity					.770
No complications	23 (47.9%)	56 (50.9%)		73 (46.5%)	
Mild	5 (10.4%)	16 (14.7%)		21 (13.4%)	
Moderate	20 (41.7%)	43 (39.4%)		63 (40.1%)	
j-tube−related readmission	28 (62.2%)	17 (37.8%)		45 (28.7%)	.252
Postoperative complications					<.001
No complications	6 (16.2%)	20 (18.3%)	46 (27.1)	72 (22%)	
Class I Clavien-Dindo	2 (5.4%)	8 (7.3%)	10 (5.9)	20 (6.3%)	
Class II Clavien-Dindo	12 (32.4%)	52 (47.7%)	54 (31.8)	118 (37.3)	
Class IIIa Clavien-Dindo	3 (8.1%)	6 (5.5%)	0 (0)	9 (2.8)	
Class IIIb Clavien-Dindo	4 (10.8%)	6 (5.5%)	31 (18.2)	41 (13)	
Class IV Clavien-Dindo	10 (27.0%)	17 (15.6%)	29 (17.1)	56 (17.7)	
Anastomotic leak requiring medical Tx only	4 (8.7%)	23 (21.1%)	31 (18.2)	58 (17.8)	.18
Anastomotic leak—stent placement	0 (0.0%)	1 (0.9%)	0 (0)	1 (0.3)	.37
Cardiopulmonary complications	20 (43.5%)	52 (47.7%)	65 (38.2)	137 (42%)	.29
Infectious complications	17 (37.0%)	49 (45.0%)	64 (37.6)	130 (40)	.43
GI complications	4 (8.7%)	33 (30.3%)	44 (25.9)	81 (24.9)	.016
Renal/GU complications	2 (4.3%)	2 (1.8%)	5 (2.9)	9 (2.8)	.67

j-tube, Jejunostomy tube; *Tx*, treatment; *GI*, gastrointestinal; *GU*, genitourinary.

TABLE 6. Outcomes determined on the basis of j-tube duration

Outcomes	adj. RR/OR	Lower 95% CI	Upper 95% CI	adj *P*
Change in BMI	inf	0	inf	.953
Hospital LOS, d	1.051	1.026	1.007	<.001
ICU LOS, d	1.033	1.014	1.05	<.001
In-hospital mortality	0	0	inf	>.999
30-d mortality	0.557	0.927	1.042	.983
90-d mortality	0.759	0.981	1.014	.997
Overall mortality	0.668	0.998	1.004	1.001
Recurrence	0	0	inf	>.999
Esophagectomy complications	1.003	.997	1.009	.301

j-tube, Jejunostomy tube; *RR*, relative risk; *OR*, odds ratio; *CI*, confidence interval; *BMI*, body mass index; *LOS*, length of stay; *ICU*, intensive care unit.

patients have trouble meeting their nutritional needs throughout treatment.[11] Local tumor invasion and obstruction can result in dysphagia, whereas systemic changes can lead to cancer-related cachexia. This ultimately leads to decreased nutritional intake and increased metabolic demand.[2,3] Treatment of esophageal cancer can further exacerbate these problems. Radiation may cause mucosal inflammation and odynophagia, chemotherapy often leads to nausea and vomiting, and surgery can result in reduced stomach volume, early satiety, and reflux.[12] Patients who cannot maintain their caloric needs warrant intervention in the form of nutritional support.

Although oral supplementation is ideal, the nature of esophageal cancer often precludes this option. Parenteral and enteral supplementation have been demonstrated to be effective methods of nutritional support.[13] Parenteral nutrition is typically reserved for patients with complete obstruction or fistulas, as it carries increased risk of metabolic disturbances, sepsis, and gut atrophy.[4,14] Studies have found that enteral nutrition is associated with shorter hospital LOS, lower health care costs, and faster return of bowel function compared with parenteral nutrition.[15,16]

Methods of enteral access include nasoenteric, gastrostomy, and j tubes. Nasoenteric tubes are the least-invasive option but are not often used because of the risk of migration and postoperative pneumonia.[17] Gastrostomy tubes are avoided in patients who undergo esophagectomy to ensure intact vasculature in the stomach for conduit creation. j-tube placement is often the enteral access of choice in patients with esophageal cancer. Although some physicians prefer routine placement in all patients with

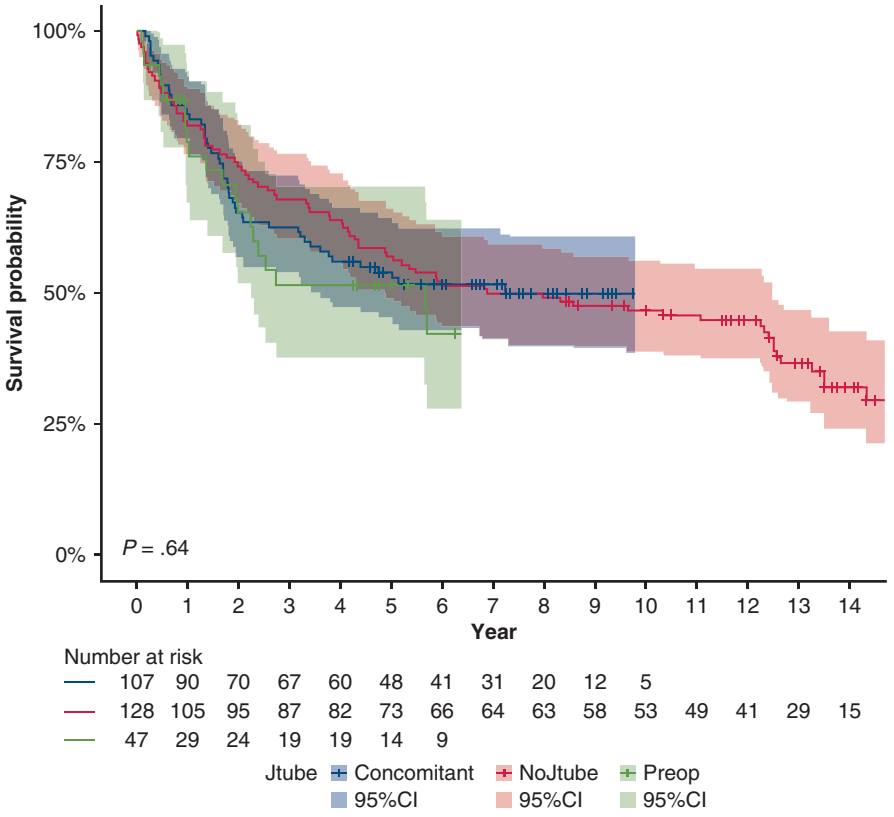


FIGURE 1. Kaplan-Meier overall survival estimates of patients with no jejunostomy tube, jejunostomy tube placed before, or concomitantly at the time of esophagectomy (95% confidence interval [CI], $P = .64$).

esophageal cancer, most determine the need for a j tube on the basis of individual patient and disease characteristics. Low BMI, severe dysphagia, and chemotherapy have been identified as risk factors for feeding tube placement.[18,19]

In our study, a subgroup analysis of malnourished patients—defined by a weight loss of more than 5% from basal weight or a BMI <20 at the initial visit—revealed that j-tube placement significantly improved nutritional outcomes. Specifically, patients who received a j tube exhibited a statistically significant increase in weight gain compared with those without j-tube placement ($P < .001$). This finding underscores the role of elective j-tube placement in enhancing nutritional support for malnourished patients, potentially aiding in better recovery during the perioperative period. However, despite the improved nutritional status, j-tube placement did not have a significant impact on other clinical outcomes, such as short-term mortality, recurrence rates, or hospital LOS. Although there was a trend toward shorter ICU stays in the j-tube group, this difference was not statistically significant ($P = .072$). The low 30- and 90-day mortality rates observed in our cohort may have limited the ability to detect statistically significant differences in mortality outcomes. These findings suggest that although j-tube placement is beneficial for nutritional support, it may not directly translate into reductions in mortality or recurrence, highlighting the complexity of factors influencing these outcomes in patients with esophageal cancer.

Traditionally, j tubes have been placed at the time of esophagectomy. In a meta-analysis including 36,384 patients with esophageal cancer, patients with a j tube placed at the time of surgical resection were found to have lower 30-day mortality compared with those who did not receive a j tube, with no significant differences in postoperative complication rates.[20] In another study, the Nationwide Readmissions Database was used to identify 22,429 patients with esophageal cancer who underwent esophagectomy and compared patients who received concurrent jejunostomy with those who did not. No differences were noted regarding hospital readmission or complications. In addition, patients who received a jejunostomy had decreased 180-day mortality.[7] Further support for j-tube placement at the time of esophagectomy comes from a National Surgical Quality Improvement Program database study spanning 2005-2016. This study included 8632 patients with esophageal cancer, of whom 45% received a jejunostomy at the time of esophagectomy. These patients demonstrated significantly decreased rates of hospital stay, in-hospital mortality, and 30-day mortality.[21]

Consistent with the literature, our study found that patients with j tubes had lower overall mortality compared with their counterparts. This remained significant after adjusting for possible confounding variables, including ECOG status and neoadjuvant chemotherapy and radiation.

Although we initially found that patients with j tubes had shorter hospital LOS, this was no longer significant after adjusting for confounders. However, in the adjusted analysis, ICU LOS was found to be significantly shorter in patients with j tubes. Shorter LOS associated with enteral nutrition has been attributed to faster return of bowel function.[7]

Timing of J-Tube Placement

The timing of j-tube placement—whether early (preoperative) or concomitant (during surgery)—did not significantly influence 30-day and 90-day mortality outcomes in our study. Although there was a trend toward greater 90-day mortality in patients who had their j tube placed concomitantly (18.8%) compared with those with early placement (5.3%), this difference did not reach statistical significance. The absence of significant differences in short-term mortality between early and concomitant j-tube placement, coupled with the observed benefits related to the duration of j-tube use, supports the notion that the timing of placement may be less critical than the overall duration of nutritional support. Nonetheless, these findings emphasize the importance of early nutritional intervention, particularly in malnourished patients, to optimize surgical outcomes and reduce the risk of recurrence. Further investigation with larger cohorts is warranted to confirm these trends and to explore the long-term implications of j-tube timing and duration on patient outcomes.

Waiting until resection to perform j-tube placement may not optimize the benefits that can be gained from this intervention. Enhanced nutrition in earlier stages of treatment can result in improved neoadjuvant and surgical outcomes. Patients with poor nutrition may have lower tolerance of neoadjuvant therapy, leading to chemotoxic effects or inability to complete treatment.[3] One Society of Thoracic Surgeons database study found that enteral access can improve odds of stable or improved nutrition during neoadjuvant therapy.[5] All patients who undergo esophagectomy will experience weight loss and most experience symptoms that exacerbate poor intake.[22,23] Initiation of preoperative nutritional support has been shown to reduce weight loss, with benefits extending 1 year postoperatively.[24] Lower rates of infectious complications and accelerated recovery after surgery have been associated with preoperative enteral nutrition.[16,25]

Our data indicate that patients with j tubes had statistically significant difference in hospital LOS (Table 2). Moreover, those with early j-tube placement had an associated decrease in ICU LOS and hospital LOS (Table 6). This suggests that providing nutritional support through early j-tube placement may help ensure patients are better nourished and more resilient before surgery. By addressing malnutrition preoperatively, especially in patients undergoing neoadjuvant therapy, patients are likely to have improved tolerance to the stress of surgery, leading to quicker

recovery and less intensive postoperative care, including reduced ICU stays.

Ben-David and colleagues[26] studied patients with esophageal cancer who received a laparoscopic feeding jejunostomy 10 weeks before resection. All patients completed neoadjuvant chemoradiation and no intraoperative complications occurred. In other studies, earlier j-tube placement has been shown to prevent morbidity and mortality in selected high-risk patients when compared with routine placement.[27] Although earlier placement of j tubes requires additional surgery, the study by Ben-David and colleagues[26] demonstrates that earlier placement can be performed safely. Use of minimally invasive techniques and performance at high-volume centers can also reduce risk.[28,29] Our study found no differences in esophagectomy complications when comparing patients with and without j tubes. However, there was a significant difference in complication patterns between early and concomitant j-tube placement groups. This highlights the impact of patient characteristics and classification criteria. The greater rate of GI complications in the concomitant group was primarily driven by anastomotic leaks requiring observation without stent placement, classified as Clavien-Dindo class II. Conversely, the greater rate of class III/IV complications in the early j-tube group was largely attributable to cardiopulmonary complications, including myocardial infarction, pulmonary embolism, and respiratory events necessitating interventions under anesthesia. These findings suggest that patients selected for early j-tube placement may have had poorer baseline health, which predisposed them to more severe non-GI complications. This underscores the need for careful preoperative optimization and risk stratification in patients undergoing early j-tube placement. In addition, j-tube–related complication rates did not differ on the basis of early or routine placement.

In our study, we did observe complications related to the j tube itself, with overall complication rates being similar between routine and early j-tube placement groups (53.19% vs 55.05%). The majority of these complications were minor, including superficial soft-tissue infections, nausea/vomiting, and dislodgement of a mature tract. Importantly, no severe complications were reported, and the readmissions related to j-tube complications were predominantly due to nonsevere issues such as tube dislodgment or localized infections that required only conservative management.

Regarding the argument that early feeding protocols might negate the need for j tubes and avoid the associated wound complications, it is crucial to recognize that while early feeding protocols are indeed beneficial, j tubes provide a reliable method of nutritional support, particularly in patients with poor oral intake. In esophageal cancer, this is a significant concern, given that the mass can be obstructing, or patients may not want to eat with significant dysphagia. Our findings suggest that although minor and moderate complications do occur, the benefit of j-tube placement outweighs the risk as patients can be ensured adequate nutrition to tolerate treatment. However, the 30% readmission rate for j-tube–related complications underscores the importance of careful patient selection, close monitoring, and proactive management of complications to minimize the burden on patients and healthcare systems. Although early feeding protocols represent a significant advancement in postoperative care, j tubes remain an essential option in the nutritional management of specific patient populations, ensuring that their nutritional needs are consistently met throughout the perioperative period.

Limitations and Future Research

This study was limited by its retrospective nature and moderate sample size. The relative dependence on the j tube for nutrition, ie, percent of nutrition via j tube versus oral intake, was also not collected in this retrospective cohort. Standard of care practice for neoadjuvant chemoradiotherapy changed over the course of this retrospective study in response to landmark papers such as the Neoadjuvant chemoradiotherapy plus surgery versus surgery alone for oesophageal or junctional cancer (CROSS) trial and as a result, the relative number of patients in this cohort who received neoadjuvant therapy and the selection criteria was not reflective of current practice.[30] Furthermore, we observed that patients who received j tubes were more likely to have undergone neoadjuvant therapy, typically associated with more advanced tumors. Stratification by the date of surgery revealed that all cases post-2015 involved j-tube placement, with a substantial portion (68%) of these patients receiving their j tubes before surgery. This shift aligns with advancements in esophageal cancer treatment, leading to improved survival rates and better overall outcomes. However, this discrepancy highlights a limitation in our study, suggesting that the observed difference in overall mortality may be influenced more by evolving treatment protocols than by the presence of a j tube itself.

The inclusion of more recent patients in the j-tube group may bias comparisons of overall mortality. Adjusting for the year of surgery in the regression model mitigated this bias, and the findings suggest that differences in mortality may be influenced by advancements in care rather than the presence of a j tube. The absence of propensity score matching, which could further account for differences in patient characteristics, remains a limitation. Also, the differences in ECOG distributions across groups highlight potential selection bias, with patients in the concurrent j-tube group being the healthiest overall (greatest percentage of ECOG 0 and lowest percentage of ECOG 2/3).

This may contribute to the observed outcomes. Although there were no significant differences in comorbidities between the groups, a significant portion of the patients identified as malnourished (ie, those with >5% weight loss from baseline or a BMI <20 at the initial encounter) were more likely to have received a j tube, with more than 50% of them having one. This difference in patient characteristics would have been better addressed through propensity score matching, a limitation that is acknowledged in this study.

Although we adjusted for year of surgery, minimally invasive versus open surgery, type of esophagectomy, tumor location, and weight loss in our multivariable models, the absence of propensity score matching remains a limitation. Propensity matching would have provided an additional layer of bias reduction, but it was not feasible in this study due to the smaller sample size. Future prospective studies with larger cohorts should consider propensity matching to further elucidate the impact of j-tube placement.

CONCLUSIONS

Early j-tube placement provides significant advantages, particularly in malnourished patients or those with low BMI, who tend to have better outcomes with adequate nutritional support. However, the high cardiopulmonary complications and readmission rate for j-tube–related complications (30%) highlights the importance of preoperative optimization, careful selection of candidates for early j tube, and judicious use and robust follow-up strategies. These findings underscore the importance of liberal but selective j tube use in esophageal cancer patients to optimize perioperative outcomes while mitigating potential risks. J-tube placement in patients with esophageal cancer undergoing esophagectomy was associated with shorter ICU LOS and improved nutritional outcomes. Adjusted analyses, which accounted for year of surgery, surgical approach, disease stage, and patient functional status, indicate that these benefits likely reflect advancements in perioperative care alongside effective nutritional support. Although early j-tube placement appears to offer additional benefits, including reduced hospital LOS and 90-day mortality in selected patients, these findings are primarily correlational. Future prospective studies using propensity matching or standardized cohorts are warranted to establish causation and guide practice guidelines.

Conflict of Interest Statement

Dr Worrell is a speaker for Intuitive Surgical. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

References

1. Sung H, Ferlay J, Siegel RL, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2021;71(3):209-249. https://doi.org/10.3322/caac.21660
2. Álvarez-Sarrado E, Mingol Navarro F, J Rosellón R, et al. Feeding jejunostomy after esophagectomy cannot be routinely recommended. Analysis of nutritional benefits and catheter-related complications. *Am J Surg*. 2019;217(1):114-120. https://doi.org/10.1016/j.amjsurg.2018.08.027
3. Steenhagen E, van Vulpen JK, van Hillegersberg R, May AM, Siersema PD. Nutrition in peri-operative esophageal cancer management. *Expert Rev Gastroenterol Hepatol*. 2017;11(7):663-672. https://doi.org/10.1080/17474124.2017.1325320
4. Ashok A, Niyogi D, Ranganathan P, et al. The enhanced recovery after surgery (ERAS) protocol to promote recovery following esophageal cancer resection. *Surg Today*. 2020;50(4):323-334. https://doi.org/10.1007/s00595-020-01956-1
5. Huerter ME, Charles EJ, Downs EA, et al. Enteral access is not required for esophageal cancer patients undergoing neoadjuvant therapy. *Ann Thorac Surg*. 2016;102(3):948-954. https://doi.org/10.1016/j.athoracsur.2016.03.041
6. Peng J, Cai J, Niu ZX, Chen LQ. Early enteral nutrition compared with parenteral nutrition for esophageal cancer patients after esophagectomy: a meta-analysis. *Dis Esophagus*. 2016;29(4):333-341. https://doi.org/10.1111/dote.12337
7. Zheng R, Devin CL, Pucci MJ, Berger AC, Rosato EL, Palazzo F. Optimal timing and route of nutritional support after esophagectomy: a review of the literature. *World J Gastroenterol*. 2019;25(31):4427-4436. https://doi.org/10.3748/wjg.v25.i31.4427
8. Lidoriki I, Mylonas KS, Syllaios A, et al. The impact of nutritional and functional status on postoperative outcomes following esophageal cancer surgery. *Nutr Cancer*. 2022;74(8):2846-2858. https://doi.org/10.1080/01635581.2022.2036769
9. Koterazawa Y, Oshikiri T, Takiguchi G, et al. Severe weight loss after minimally invasive oesophagectomy is associated with poor survival in patients with oesophageal cancer at 5 years. *BMC Gastroenterol*. 2020;20(1):407. https://doi.org/10.1186/s12876-020-01543-1
10. Yin V, Kim AT, Wightman SC, Harano T, Atay SM, Kim AW. Association between underweight status and chylothorax after esophagectomy for esophageal cancer: a propensity score–matched analysis. *J Thorac Cardiovasc Surg Open*. 2024;17:322-335. https://doi.org/10.1016/j.xjon.2023.10.030
11. Wang X, Liu X, Gu Z, Li X, Shu Y. Experiences and requirements in nutritional management of patients with esophageal cancer: a systematic review and qualitative meta-synthesis. *Support Care Cancer*. 2023;31(12):633. https://doi.org/10.1007/s00520-023-08100-y
12. Jordan T, Mastnak DM, Palamar N, Kozjek NR. Nutritional therapy for patients with esophageal cancer. *Nutr Cancer*. 2018;70(1):23-29. https://doi.org/10.1080/01635581.2017.1374417
13. Lakananurak N, Gramlich L. The role of preoperative parenteral nutrition. *Nutrients*. 2020;12(5):1320. https://doi.org/10.3390/nu12051320
14. Koterazawa Y, Oshikiri T, Hasegawa H, et al. Routine placement of feeding jejunostomy tube during esophagectomy increases postoperative complications and does not improve postoperative malnutrition. *Dis Esophagus*. 2020;33(1):doz021. https://doi.org/10.1093/dote/doz021
15. Han H, Pan M, Tao Y, et al. Early enteral nutrition is associated with faster post-esophagectomy recovery in Chinese esophageal cancer patients: a retrospective cohort study. *Nutr Cancer*. 2018;70(2):221-228. https://doi.org/10.1080/01635581.2018.1412477
16. Shen Y, Zhou Y, He T, Zhuang X. Effect of preoperative nutritional risk screening and enteral nutrition support in accelerated recovery after resection for esophageal cancer. *Nutr Cancer*. 2021;73(4):596-601. https://doi.org/10.1080/01635581.2020.1764981
17. Li HN, Chen Y, Dai L, Wang YY, Chen MW, Mei LX. A meta-analysis of jejunostomy versus nasoenteral tube for enteral nutrition following esophagectomy. *J Surg Res*. 2021;264:553-561. https://doi.org/10.1016/j.jss.2021.02.027
18. Li Y, Pond G, Van Osch A, et al. Enhancing nutrition support for esophageal cancer patients: understanding factors influencing feeding tube utilization. *Nutr Cancer*. 2024;76(3):271-278. https://doi.org/10.1080/01635581.2024.2301796
19. Bonner SN, Rebernick R, Wakeam E. Ongoing controversies in esophageal cancer I: feeding tubes, pyloroplasty, thoracic duct clipping. *Thorac Surg Clin*. 2022;32(4):541-551. https://doi.org/10.1016/j.thorsurg.2022.07.003
20. Lee Y, Lu JY, Malhan R, et al. Effect of routine jejunostomy tube insertion in esophagectomy: a systematic review and meta-analysis. *J Thorac Cardiovasc Surg*. 2022;164(2):422-432.e17. https://doi.org/10.1016/j.jtcvs.2021.12.050
21. Watson M, Trufan S, Benbow JH, Gower NL, Hill J, Salo JC. Jejunostomy at the time of esophagectomy is associated with improved short-term perioperative

outcomes: analysis of the NSQIP database. *J Gastrointest Oncol*. 2020;11(2): 421-430. https://doi.org/10.21037/jgo.2020.02.06
22. Berkelmans GHK, Fransen L, Weijs TJ, et al. The long-term effects of early oral feeding following minimal invasive esophagectomy. *Dis Esophagus*. 2018;31(1): 1-8. https://doi.org/10.1093/dote/dox114
23. Wang SA, Dai WS, Zhu JY, Gao B, Ren W, Chen X. Nasogastric tube feeding improves nutritional status and physical state in esophageal cancer patients during chemoradiotherapy: a retrospective study. *Support Care Cancer*. 2023;31(6): 341. https://doi.org/10.1007/s00520-023-07780-w
24. Davies SJ, West MA, Rahman SA, Underwood TJ, Marino LV. Oesophageal cancer: the effect of early nutrition support on clinical outcomes. *Clin Nutr ESPEN*. 2021;42:117-123. https://doi.org/10.1016/j.clnesp.2021.02.006
25. Cao Y, Han D, Zhou X, Han Y, Zhang Y, Li H. Effects of preoperative nutrition on postoperative outcomes in esophageal cancer: a systematic review and meta-analysis. *Dis Esophagus*. 2022;35(3).:1-13. https://doi.org/10.1093/dote/doab028
26. Ben-David K, Kim T, Caban AM, Rossidis G, Rodriguez SS, Hochwald SN. Pretherapy laparoscopic feeding jejunostomy is safe and effective in patients undergoing minimally invasive esophagectomy for cancer. *J Gastrointest Surg*. 2013; 17(8):1352-1358. https://doi.org/10.1007/s11605-013-2231-4
27. Boshier PR, Klevebro F, Schmidt A, et al. Impact of early jejunostomy tube feeding on clinical outcome and parameters of body composition in esophageal cancer patients receiving multimodal therapy. *Ann Surg Oncol*. 2022;29(9): 5689-5697. https://doi.org/10.1245/s10434-022-11754-3
28. Kim BR, Jang EJ, Jo J, Lee H, Jang DY, Ryu HG. The association between hospital case-volume and postoperative outcomes after esophageal cancer surgery: a population-based retrospective cohort study. *Thorac Cancer*. 2021;12(18): 2487-2493. https://doi.org/10.1111/1759-7714.14096
29. Mastoridis S, Bracalente G, Hanganu CB, et al. Laparoscopic vs open feeding jejunostomy insertion in oesophagogastric cancer. *BMC Surg*. 2021;21(1):367. https://doi.org/10.1186/s12893-021-01318-9
30. van Hagen P, Hulshof MC, van Lanschot JJ, et al. CROSS group, preoperative chemoradiotherapy for esophageal or junctional cancer. *N Engl J Med*. 2012; 366(22):2074-2084.

Key Words: esophageal cancer treatment, esophagectomy outcomes, jejunostomy tube

TABLE E1. Outcomes in malnourished patients

Outcome	j-tube	no j-tube	*P* value
ICU LOS, mean rank	62.03	51.06	.072
Hospital LOS, mean rank	61.59	72.21	.111
Weight gain, kg, mean rank	80.05	46.64	<**.001**
30-d mortality, n (%)	1/72 (1.4)	1/61 (1.6)	.279
90-d mortality, n (%)	2/69 (2.9)	2/46 (4.3)	.500
Recurrence, n (%)	36/71 (49.3)	26/61 (57.4)	.129

Bold value indicates statistically significant. *j-tube*, Jejunostomy tube; *ICU*, intensive care unit; *LOS*, length of stay.

TABLE E2. Outcomes in patients with Clavien-Dindo class III and IV

Outcome	j tube	No j tube	*P* value
ICU LOS (mean rank)	32.89	44.34	.027
Hospital LOS (mean rank)	41.38	47.58	.264
Sepsis	30 (81%)	37 (72%)	.327

j-tube, Jejunostomy tube; *ICU*, intensive care unit; *LOS*, length of stay.

TABLE E3. Survival time estimates for patients receiving neoadjuvant treatment, stratified by j-tube placement

j-tube placement	Mean survival time, mo	Std. error	95% confidence interval	Median survival time, mo	Std. error	95% confidence interval
At the d of surgery	90.31	12.58	65.65-114.98	68.30	21.40	26.36-110.24
Before surgery	73.87	6.23	61.66-86.07	56.90	27.94	2.14-111.66
No j tube	113.74	7.25	99.53-127.96	151.00	9.46	132.45-169.55
Overall	102.11	5.13	92.06-112.17	147.00	27.45	93.21-200.79

j-tube, Jejunostomy tube.