Original Article

Safety of omitting nasogastric decompression after esophagectomy: a propensity score-matched study

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Background: Nasogastric (NG) decompression is routinely performed after esophagectomy. However, whether it aids postoperative recovery is still controversial. This study aimed to assess the effects of NG decompression on postoperative complications after esophagectomy.

Methods: Data of 1,489 consecutive patients who underwent esophagectomy between January 2019 and December 2020 were retrospectively analyzed. All patients were assigned to two groups based on whether they had undergone NG decompression or not. We conducted a propensity score matching (PSM) analysis to minimize the effect of potential confounders.

Results: In total, 1,466 patients (including 1,235 patients with NG tubes and 231 without NG tubes) were included in the study, and 219 pairs were successfully matched. After PSM analysis, there was no difference in morbidity and mortality between the two groups. Postoperative hospital stay in the non-NG tube group was shorter than that in the NG tube group (8 *vs.* 10 days, P<0.001). The incidence of pneumonia and anastomotic leakage showed no significant differences (13.2% *vs.* 17.8%, P=0.235 for pneumonia; 13.7% *vs.* 11.0%, P=0.460 for anastomotic leakage). For patients who developed anastomotic leakage after surgery, the leakage developed earlier in the non-NG group (6 *vs.* 8 days, P=0.033) than in the NG group. However, no significant between-group differences were observed in the postoperative hospital stay and severity of leakage.

Conclusions: Routine NG decompression may not confer any discernible benefits for patients who have undergone esophagectomy. As such, the omission of this procedure could be considered in postoperative care.

Keywords: Esophagectomy; nasogastric tube (NG tube); perioperative care; postoperative complication

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Introduction

Esophagectomy is a curative treatment for esophageal cancer; however, it is associated with substantial morbidity and mortality, such as pulmonary and anastomotic complications (1-3). Insufficient postoperative gastric decompression may cause gastric distention and aspiration. Therefore, routine nasogastric (NG) decompression has been considered standard practice in abdominal surgery. The introduction of enhanced recovery after surgery (ERAS) programs has led to the abandonment of NG tubes for gastric decompression in various gastrointestinal surgeries (4). However, the routine use of NG decompression after esophagectomy remains controversial (5,6).

Proponents believe that NG decompression may reduce the risk of anastomotic leakage, as it reduces the dilation of gastric tubes (7). It is also advocated that continuous decompression may prevent the occurrence of respiratory complications, including aspiration (8). Conversely, opponents argue that routine NG tube application causes significant discomfort and extended hospital stay without reducing complications (9). However, the current evidence regarding the efficacy of routine NG tube placement remains limited due to the small sample size and the heterogeneity of the available evidence.

We aimed to investigate this controversy through a propensity score-matched study by determining the effects of NG tube omission on leakage, pneumonia, mortality, and recovery. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-844/rc).

Highlight box

Key findings

- The use of nasogastric (NG) tubes did not result in positive patient outcomes.
- Going without NG decompression shortened the hospital stay of patients.

What is known and what is new?

- Some studies have shown that early NG tube removal can be performed safely, but few of them evaluated the influence of omitting NG tubes, and the relatively low number of patients and heterogeneity were also the limitation of those studies.
- We used the propensity score matching method to investigate whether omission of NG decompression is safe and acceptable, and provided evidence on the proper clinical management for patients with esophagectomy.

What is the implication, and what should change now?

- The omission of routine NG decompression needs to be considered.

Methods

Patients and samples

Clinical data were collected from 1,489 patients undergoing esophagectomy at the Fudan University Shanghai Cancer Center between January 2019 and December 2020. The procedures involved in this study were conducted by eight surgeons. Eligible cases for this study were required to have complete clinical data, a malignant tumor of the esophagus or the gastroesophageal junction, and included those who had undergone transthoracic or transhiatal esophagectomy with gastric tube reconstruction. Patients requiring Roux-en-Y esophagojejunostomy (n=18) or esophagocolonic anastomosis (n=2) were excluded from the study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This research was approved by the Institutional Review Board of the Fudan University Shanghai Cancer Center, Shanghai, China (No. 090977-1). Written informed consent was provided by all the included patients.

Surgical procedure

All participants received general anesthesia with or without epidural analgesia during the surgical procedures. The McKeown procedure and the Ivor-Louis esophagectomy were employed for thoracic tumors, depending on position of lesion and surgeon preference. For patients with adenocarcinoma of the esophagogastric junction, the left thoracic approach and circular stapling techniques were employed. Furthermore, radical two-field lymphadenectomy and upper mediastinal lymphadenectomy were performed during the surgery. Cervical lymphadenectomy was performed when computed tomographic or ultrasonographic findings confirmed metastasis in the lower cervical lymph node. There were no pyloroplasty or other gastric drainage procedures performed. Omitting NG decompression was not a formal change of protocol. The surgeons have the discretion depending on their own will, which is mainly judged by whether there is recurrent laryngeal nerve injury and whether the anastomosis went well.

A single-lumen NG tube sized 14-Fr was placed in patients in the NG group after induction of anesthesia.

Its intragastric position was confirmed by intraoperative palpation. If patients were physiologically stable, they would be admitted to the general surgical ward. Early mobilization and enteral nutrition by using jejunostomy tubes were encouraged on postoperative day (POD) 1. NG decompression in NG tube group was continued until patients' bowel function recovered. If there were no symptoms of anastomotic leak, they were allowed to restart oral intake on POD 6.

Our management strategies for anastomotic leak were consistent with those previously reported (10,11). They could be sorted into three levels: conservative management, endoscopic intervention, and reoperation, and which treatment would be performed depended on the symptoms and surgeons' experience. Conservative treatments were preferred for patients with mild leaks, including fasting, drainage of the anastomosis area, decompressing the conduit, parenteral or enteral nutrition, and broad-spectrum antibiotics. For asymptomatic patients with contained leaks, only fasting, nutritional support, and antibiotics were required. If patients were suspicious for uncontained leaks and infection, they were required to have an NG tube inserted in our center, as continuous decompression can empty the stomach and reduce the tension of anastomosis. Patients without an NG tube had theirs inserted under the guidance of radiography or gastroscopy.

Diagnostic criteria of postoperative complications

Postoperative complications included pneumonia, leaks, and any other complications causing delayed hospital discharge. Pneumonia was defined as the clinical manifestation of pneumonia or bronchopneumonia confirmed by computed tomographic findings. Anastomotic leak was defined as a gastroesophageal defect involving the esophagus and anastomosis confirmed by clinical or radiological diagnosis. The extended Clavien-Dindo classification was used to assess the severity of anastomotic leaks (12,13). All anastomotic leaks were divided into five grades. In-hospital mortality was defined as death from any cause in the hospital.

Statistical analysis

To reduce bias caused by the retrospective nature of the study, we used 1:1 propensity score matching (PSM) to adjust for significant differences in the patients' clinicopathologic characteristics (sex, age, history of neoadjuvant therapy, body mass index, history of smoking, chronic obstructive pulmonary disease, hypertension, diabetes, heart or brain disease, tumor location, and transthoracic approach). The match tolerance was set to 0.01. After PSM, 219 patients were included in each group for the analysis (*Figure 1*).

Data were reported as means or medians for continuous variables and as absolute numbers and percentages for categorical variables. The software SPSS 26.0 (IBM Corp., Armonk, NY, USA) was used in our analysis. Regarding patient characteristics, we used nonparametric tests to analyze continuous values, and used Pearson's Chi-squared test and Fisher's exact test to analyze categorical values. A P value of <0.05 was considered statistically significant.

Results

Patient characteristics

Among the 1,489 patients undergoing esophagectomy between January 2019 and December 2020, 1,466 patients met the inclusion criteria (*Figure 1*), encompassing 231 patients without NG tubes and 1,235 with NG tubes. The non-NG tube group had a higher prevalence of neoadjuvant therapy history (P<0.001) and smoking history (P<0.001) compared with the NG tube group. The NG tube group had a higher likelihood of undergoing video-assisted thoracoscopic surgery (VATS) (P<0.001), whereas the non-NG tube group had a higher incidence of squamous cell carcinoma (P<0.001). Other clinical factors showed no significant difference between the two groups (*Table 1*).

After PSM, 219 patients in each group were matched and included in the analysis, and baseline characteristics were well-balanced.

Clinical outcomes

Table 2 shows the clinical outcomes analyzed by PSM. In this study, there were no significant differences in total morbidity (28.8% *vs.* 25.1%, P=0.451), mortality (1.4% *vs.* 1.4%, P>0.99), and rate of intensive care unit (ICU) admissions (9.1% *vs.* 10.0%, P=0.871). The postoperative hospital stay of all patients in the NG tube group was longer than that of the non-NG tube group (median: 10 *vs.* 8 days, P<0.001).

Regarding specific complications, anastomotic leakage occurred similarly in both groups (13.7% *vs.* 11.0%,

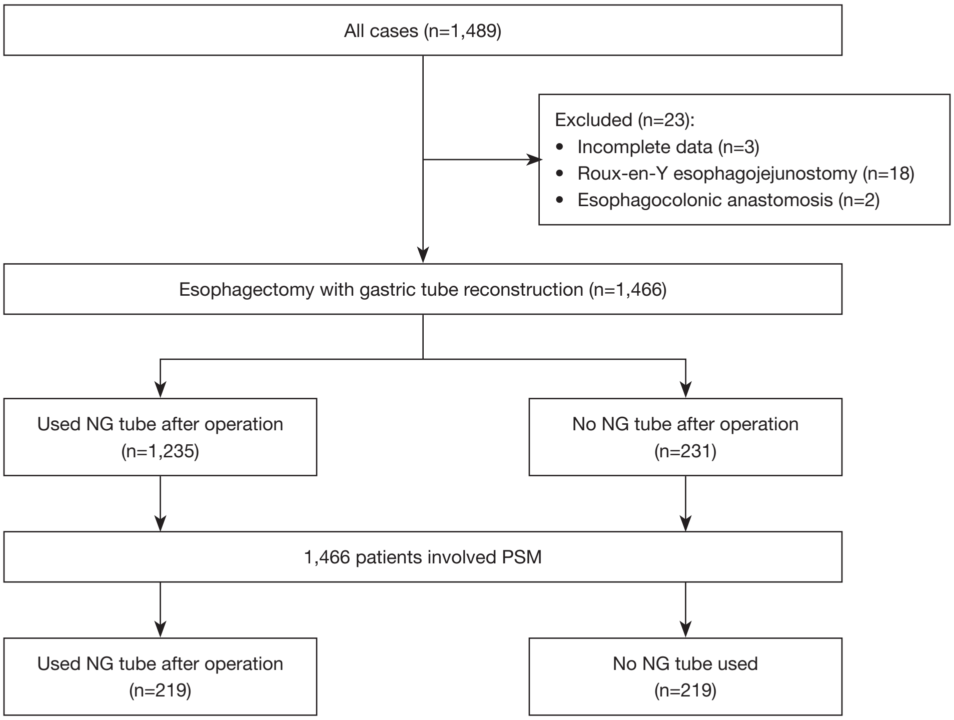

Figure 1 Flowchart of the study. NG, nasogastric; PSM propensity score matching.

P=0.460), with significantly delayed leakage in the NG tube group (median: 8 *vs.* 6 days, P=0.033). However, no between-group differences were observed in the duration of postoperative hospital stay and the severity of anastomotic leakage in patients.

Some other complications were also analyzed. The incidence of pneumonia showed no difference between the NG and non-NG groups (13.2% *vs.* 17.8%, P=0.235). Moreover, no between-group differences were found in the duration of postoperative hospital stay, rate of ICU admissions for patients with pneumonia, and the incidence of heart failure.

Reinsertion of NG tube

In this study, a subset of patients required the reinsertion of NG tubes following esophagectomy. Only patients with anastomotic leak, high risk of aspiration or gastric dilation required the insertion of NG tubes in our research. *Table 3* shows the reasons for reinsertion. Of the 219 patients in the non-NG tube group, 25 (11.4%) required reinsertion, with 4 (1.83%) doing so to prevent aspiration and 8 (3.65%) due to suspected anastomotic leakage. Anastomotic leaks were detected in 9 (4.11%) patients before reinsertion, and 4 (1.83%) patients underwent reinsertion of tubes after the detection of gastric dilatation. In the NG tube group, NG tubes were reinserted after removal in 5 (2.28%) patients. The reasons for reinsertions involved anastomotic leaks.

Discussion

The present study aimed to compare the effects of NG tube application and non-application on post-esophagectomy complications in patients who underwent esophagectomy for esophageal cancer. Although NG decompression is a standard postoperative care procedure, some studies have evaluated the effects of early NG tube removal and suggested that it could be performed safely. However, few studies have evaluated the influence of omitting NG tubes, and the results of previous studies have also been bound to the limitations of either a relatively low sample size or heterogeneous findings (5,6,14). We used PSM analysis to investigate this issue by removing baseline discrepancies in measured covariates to the utmost extent.

In our study, patients in the NG tube omission group had shorter hospital stays, which concurs with the results of previous studies (15-17). It could be because the omission of NG tubes enables early oral intake, expediting bowel

Table 1 The baseline characteristics before and after PSM

Characteristics	Overall cohort			After matching		
	Tube used (n=1,235)	No tube used (n=231)	P value	Tube used (n=219)	No tube used (n=219)	P value
Sex[†]			0.849			>0.99
Male	1,025 (83.0)	193 (83.5)		187 (85.4)	186 (84.9)	
Female	210 (17.0)	38 (16.5)		32 (14.6)	33 (15.1)	
Age (years)[†]	64.07±7.942	63.00±7.851	0.907	63.77±8.209	63.31±7.632	0.321
Neoadjuvant therapy[†]	148 (12.0)	51 (22.1)	<0.001	48 (21.9)	44 (20.1)	0.725
BMI[†]			0.254			>0.99
<25 kg/m^2	967 (78.3)	189 (81.8)		181 (82.6)	180 (82.2)	
≥25 kg/m^2	268 (21.7)	42 (18.2)		38 (17.4)	39 (17.8)	
Smoking history[†]	853 (69.1)	193 (83.5)	<0.001	184 (84.0)	182 (83.1)	0.898
Comorbidities						
Total	541 (43.8)	106 (45.9)	0.564	96 (43.8)	99 (45.2)	0.848
Hypertension[†]	471 (38.1)	90 (39.0)	0.825	81 (37.0)	68 (31.1)	0.844
COPD[†]	31 (2.5)	5 (2.2)	0.824	3 (1.8)	3 (1.4)	>0.99
Diabetes mellitus[†]	76 (6.2)	10 (4.3)	0.293	11 (5.0)	10 (4.6)	>0.99
Heart or brain disease[†]	93 (7.5)	11 (4.8)	0.162	10 (4.6)	10 (4.6)	>0.99
Tumor location[†]			0.504			0.293
Upper	66 (5.3)	16 (6.9)		20 (9.1)	12 (5.5)	
Middle	464 (37.6)	91 (39.4)		76 (34.7)	85 (38.8)	
Lower	705 (57.1)	124 (53.7)		123 (56.2)	122 (55.7)	
Transthoracic approach[†]			<0.001			0.493
Open	1,053 (85.3)	171 (74.0)		173 (79.0)	166 (75.8)	
VATS	182 (14.7)	60 (26.0)		46 (21.0)	53 (24.2)	
Pathological stage			0.424			0.245
I	243 (19.7)	44 (19.0)		50 (22.8)	39 (17.8)	
II	369 (29.9)	74 (32.0)		56 (25.6)	71 (32.4)	
III	502 (40.6)	98 (42.4)		92 (42.0)	94 (42.9)	
IV	121 (9.8)	15 (6.5)		21 (9.6)	15 (6.8)	
Histology			<0.001			0.002
Squamous cell carcinoma	1,057 (85.6)	212 (91.8)		182 (83.1)	204 (93.2)	
Adenocarcinoma	135 (10.9)	6 (2.6)		24 (11.0)	6 (2.7)	
Others	43 (3.5)	13 (5.6)		13 (5.9)	9 (4.1)	
Anastomotic position			<0.001			<0.001
Thorax	894 (72.4)	51 (22.1)		144 (65.8)	50 (22.8)	
Neck	341 (27.6)	180 (77.9)		75 (34.2)	169 (77.2)	

Data are presented as n (%) or mean ± standard deviation. [†], used for PSM. PSM, propensity score matching; BMI, body mass index; COPD, chronic obstructive pulmonary disease; VATS, video-assisted thoracic surgery.

Table 2 Clinical outcomes

Outcomes	Tube used (n=219)	No tube used (n=219)	P value
Total complication	63 (28.8)	55 (25.1)	0.451
Pneumonia	29 (13.2)	39 (17.8)	0.235
ICU admission for patients with pneumonia	10 (34.5)	18 (46.2)	0.455
Postoperative hospital stay for patients with pneumonia (days)	10 [6–40]	14 [6–97]	0.139
Anastomotic leak	30 (13.7)	24 (11.0)	0.460
Severity of anastomotic leak			
Grade 1 or 2	6 (20.0)	7 (29.2)	0.628
Grade 3	16 (53.3)	9 (37.5)	
Grade 4	6 (20.0)	7 (29.2)	
Grade 5	2 (6.7)	1 (4.2)	
Occurrence time for anastomotic leak (POD) (days)	8 [4–14]	6 [2–18]	0.033
Postoperative hospital stay for patients with anastomotic leak (days)	34.5 [8–97]	36.5 [20–97]	0.461
Heart failure	1 (0.5)	2 (0.9)	>0.99
Mortality	3 (1.4)	3 (1.4)	>0.99
ICU admission	20 (9.1)	22 (10.0)	0.871
Postoperative hospital stay (days)	10 [4–97]	8 [4–97]	<0.001
Reinsert NG tube	5 (2.3)	25 (11.4)	<0.001

Data are presented as n (%) or median [min–max]. ICU, intensive care unit; POD, postoperative days; NG, nasogastric.

Table 3 Reasons for reinsertion of NG tubes

Reason	Tube used (n=219), n (%)	No tube used (n=219), n (%)
Prevent aspiration	0	4 (1.83)
Suspicious for anastomotic leak	0	8 (3.65)
Anastomotic leak	5 (2.28)	9 (4.11)
Gastric dilatation	0	4 (1.83)

NG, nasogastric.

function recovery (7). Being free from the discomfort of NG tubes could be another reason for this result (18).

The incidence of pneumonia was similar between the two groups, which is in line with the study results of Daryaei *et al.* (19). Although NG tubes may prevent aspiration and pneumonia via drainage decompression, some studies have shown that the application of NG tubes did not reduce the occurrence of pneumonia and even increased the risk of pneumonia by impeding expectoration (20). The cause of pneumonia is likely to be multifactorial. A previous study claimed that other factors such as forced expiratory volume in the first second (FEV1), preoperative pulmonary rehabilitation, or surgical procedures may also be correlated with postoperative pneumonia, and that further analysis for independent factors is needed (21). Besides, the duration of postoperative hospital stays and rates of ICU admissions revealed no significant differences among these patients, showing that the postoperative recovery of our patients with pneumonia was not affected by NG decompression. Therefore, the omission of NG tubes is possible without necessarily increasing the risk of pneumonia in patients undergoing esophagectomy.

Anastomotic leakage is one of the main reasons for supporting traditional NG tube placement after esophagectomy. Nevertheless, there remains insufficient evidence to substantiate NG tubes' effect (22). Instead, our study revealed that there were no significant between-group differences in anastomotic leak rates, which aligns with Sun *et al.*'s and Mistry *et al.*'s research (14,18). Another study showed that a higher leak rate could be related to other factors such as diabetes, smoking, congestive heart failure, hypertension, and peripheral vascular disease. The risk of leaks after NG tube omission may possibly be neutralized if all these issues are addressed (23). In addition, there were no significant differences in the severity of anastomotic leaks or postoperative hospital stay between patients with and without NG tubes. According to the study of Markar *et al.*, Clavien-Dindo Grade III or IV leak adversely impacts patients' long-term survival and locoregional cancer recurrence (24). Given that the omission of NG tubes did not influence the severity of leaks, it can be considered proactively.

Previous studies have only evaluated whether NG tube omission increases anastomotic leak rate. We further investigated the relationship between NG tube application and the timing of anastomotic leak occurrence. We found that the anastomotic leaks were detected earlier among patients without NG tubes. This may be attributed to the subjective nature of diagnosis (25). The presence of NG tubes facilitates the clearance of gastric contents from the stomach and esophagus, leading to asymptomatic leaks that are typically diagnosed later in NG tube groups compared with non-NG tube groups.

Conversely, the application of NG tubes can negatively affect postoperative recovery. NG tubes may increase discomfort among patients by stimulating the pharynx and larynx and subsequently evoking the gag reflex (18). Some studies have suggested that omission of NG tubes may also cause patient discomfort, but other available therapies have been shown effective in ameliorating this situation (26,27). Furthermore, Nguyen *et al.* reported that some patients developed postoperative complications directly related to the NG tubes, including the gastric conduit and the anastomosis (28). Even if patients need insertion of NG tubes after the surgery, the reinsertion of NG tubes can be safely performed without adverse events or complications, which is in line with the previous studies (18,29).

Limitations of this study include the retrospective nature and the lack of ability to account for all confounding factors. In addition, a certain level of bias should be acknowledged because the timing of hospital discharge varied and whether NG decompression was performed or not depended on the surgeons' experience. Therefore, a unified discharge criterion was lacking in the included cases.

Conclusions

The omission of routine NG decompression does not significantly increase the risk of complications or prolong hospital stay. Even if NG tube reinsertion is required, it can be performed without additional risk to patients. Therefore, omitting routine NG decompression can be considered as a safe approach for patients undergoing esophagectomy.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-844/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-844/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-844/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This research was approved by the Institutional Review Board of the Fudan University

Shanghai Cancer Center, Shanghai, China (No. 090977-1). Written informed consent was provided by all the included patients.

References

1. Low DE, Kuppusamy MK, Alderson D, et al. Benchmarking Complications Associated with Esophagectomy. Ann Surg 2019;269:291-8.
2. Biere SS, van Berge Henegouwen MI, Maas KW, et al. Minimally invasive versus open oesophagectomy for patients with oesophageal cancer: a multicentre, open-label, randomised controlled trial. Lancet 2012;379:1887-92.
3. Li B, Zhang Y, Miao L, et al. Esophagectomy With Three-Field Versus Two-Field Lymphadenectomy for Middle and Lower Thoracic Esophageal Cancer: Long-Term Outcomes of a Randomized Clinical Trial. J Thorac Oncol 2021;16:310-7.
4. Weijs TJ, Kumagai K, Berkelmans GH, et al. Nasogastric decompression following esophagectomy: a systematic literature review and meta-analysis. Dis Esophagus 2017;30:1-8.
5. Nelson R, Edwards S, Tse B. Prophylactic nasogastric decompression after abdominal surgery. Cochrane Database Syst Rev 2007;2007:CD004929.
6. Nelson R, Tse B, Edwards S. Systematic review of prophylactic nasogastric decompression after abdominal operations. Br J Surg 2005;92:673-80.
7. Vetter D, Gutschow CA. Strategies to prevent anastomotic leakage after esophagectomy and gastric conduit reconstruction. Langenbecks Arch Surg 2020;405:1069-77.
8. Shackcloth MJ, McCarron E, Kendall J, et al. Randomized clinical trial to determine the effect of nasogastric drainage on tracheal acid aspiration following oesophagectomy. Br J Surg 2006;93:547-52.
9. Zhang R, Zhang L. Feasibility of complete nasogastric tube omission in esophagectomy patients. J Thorac Dis 2019;11:S819-23.
10. Ubels S, Lubbers M, Verstegen MHP, et al. Treatment of anastomotic leak after esophagectomy: insights of an international case vignette survey and expert discussions. Dis Esophagus 2022;35:doac020.
11. Hua F, Sun D, Zhao X, et al. Update on therapeutic strategy for esophageal anastomotic leak: A systematic literature review. Thorac Cancer 2023;14:339-47.
12. Katayama H, Kurokawa Y, Nakamura K, et al. Extended Clavien-Dindo classification of surgical complications: Japan Clinical Oncology Group postoperative complications criteria. Surg Today 2016;46:668-85.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-13.
14. Sun HB, Li Y, Liu XB, et al. Early Oral Feeding Following McKeown Minimally Invasive Esophagectomy: An Open-label, Randomized, Controlled, Noninferiority Trial. Ann Surg 2018;267:435-42.
15. Li C, Mei JW, Yan M, et al. Nasogastric decompression for radical gastrectomy for gastric cancer: a prospective randomized controlled study. Dig Surg 2011;28:167-72.
16. Wei ZW, Li JL, Li ZS, et al. Systematic review of nasogastric or nasojejunal decompression after gastrectomy for gastric cancer. Eur J Surg Oncol 2014;40:1763-70.
17. Sun HB, Liu XB, Zhang RX, et al. Early oral feeding following thoracolaparoscopic oesophagectomy for oesophageal cancer. Eur J Cardiothorac Surg 2015;47:227-33.
18. Mistry RC, Vijayabhaskar R, Karimundackal G, et al. Effect of short-term vs prolonged nasogastric decompression on major postesophagectomy complications: a parallel-group, randomized trial. Arch Surg 2012;147:747-51.
19. Daryaei P, Vaghef Davari F, Mir M, et al. Omission of nasogastric tube application in postoperative care of esophagectomy. World J Surg 2009;33:773-7.
20. Sato T, Takayama T, So K, et al. Is retention of a nasogastric tube after esophagectomy a risk factor for postoperative respiratory tract infection? J Infect Chemother 2007;13:109-13.
21. Shiozaki A, Fujiwara H, Okamura H, et al. Risk factors for postoperative respiratory complications following esophageal cancer resection. Oncol Lett 2012;3:907-12.
22. Yin Q, Zhou S, Song Y, et al. Treatment of intrathoracic anastomotic leak after esophagectomy with the sump drainage tube. J Cardiothorac Surg 2021;16:46.

23. Kassis ES, Kosinski AS, Ross P Jr, et al. Predictors of anastomotic leak after esophagectomy: an analysis of the society of thoracic surgeons general thoracic database. Ann Thorac Surg 2013;96:1919-26.
24. Markar S, Gronnier C, Duhamel A, et al. The Impact of Severe Anastomotic Leak on Long-term Survival and Cancer Recurrence After Surgical Resection for Esophageal Malignancy. Ann Surg 2015;262:972-80.
25. Dent B, Griffin SM, Jones R, et al. Management and outcomes of anastomotic leaks after oesophagectomy. Br J Surg 2016;103:1033-8.
26. Maus MK, Leers J, Herbold T, et al. Gastric Outlet Obstruction After Esophagectomy: Retrospective Analysis of the Effectiveness and Safety of Postoperative Endoscopic Pyloric Dilatation. World J Surg 2016;40:2405-11.
27. Nakabayashi T, Mochiki E, Garcia M, et al. Gastropyloric motor activity and the effects of erythromycin given orally after esophagectomy. Am J Surg 2002;183:317-23.
28. Nguyen NT, Slone J, Wooldridge J, et al. Minimally invasive esophagectomy without the use of postoperative nasogastric tube decompression. Am Surg 2009;75:929-31.
29. Hayashi M, Kawakubo H, Shoji Y, et al. Analysis of the Effect of Early Versus Conventional Nasogastric Tube Removal on Postoperative Complications After Transthoracic Esophagectomy: A Single-Center, Randomized Controlled Trial. World J Surg 2019;43:580-9.

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