Impact of nasogastric decompression on gastric tube size after McKeown minimally invasive esophagectomy: A retrospective controlled cohort study

Duo Jiang
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Xian-Ben Liu
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Wen-Qun Xing
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Pei-Nan Chen
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Shao-Kang Feng
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Jun-Xiao Liu
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital
Hai-Bo Sun (zlyysunhaibo2122@zzu.edu.cn)
Affiliated Tumor Hospital of Zhengzhou University: Henan Cancer Hospital

Research Article

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Abstract

Purpose: This retrospective study evaluated the impact of nasogastric decompression (NGD) on gastric tube size to optimize the Enhanced Recovery After Surgery protocol after McKeown minimally invasive esophagectomy (MIE).

Methods: Overall, 640 patients were divided into two groups according to nasogastric tube (NGT) placement intraoperatively. Using propensity score matching, 203 pairs of individuals were identified for gastric tube size comparisons on postoperative days (PODs) 1 and 5.

Results: Gastric tubes were larger in the non-NGD group than the NGD group on POD 1 (vertical distance from the right edge of the gastric tube to the right edge of the thoracic vertebra, 22.2 [0–34.7] vs. 0 [0–22.5] mm, p <0.001). No difference was noted between the groups on POD 5 (18.5 [0–31.7] vs. 18.0 [0–25.4] mm, p =0.070). Univariate and multivariate analyses showed that non-NGD was an independent risk factor for gastric tube distention on POD 1. No difference in the incidence of complications (Clavien–Dindo（CD）≥2) (40 (23.0%) vs. 46 (19,8%), p =0.440), pneumonia (CD≥2) (29 [16.8%] vs. 30 [12.9%], p =0.280) or anastomotic leakage (CD≥3) (3 [1.7%] vs. 6 [2.6%], p =0.738) were noted between the without gastric tube distention group and with gastric tube distention group.

Conclusion: Intraoperative NGT placement reduces gastric tube distention rates after McKeown MIE on POD 1, but the complications are similar to those of unconventional NGT placement. This finding is based on NGT placement or replacement at the appropriate time postoperatively through bedside chest X-ray examination.

Introduction

Esophageal cancer is one of the most common digestive tract malignancies, and surgery remains the cornerstone of its treatment [1]. Most thoracic surgeons will perform nasogastric decompression (NGD) after esophagectomy to drain gastric fluid; detect postoperative bleeding; reduce the incidence of postoperative complications such as anastomotic dehiscence and aspiration pneumonia; and prevent abdominal distension and gastric emptying disorder. However, with the application of Enhanced Recovery After Surgery (ERAS) in esophagectomy, it is safe and feasible to take food by mouth early after esophagectomy when NGD is not routinely performed or the nasogastric tube (NGT) is removed early after esophagectomy [2-4]. Several studies have mentioned that NGD can prevent gastric tube distension. However, no studies have confirmed this view, and there is no standard definition for gastric tube distension [5-7]. Therefore, the aim of this study was to evaluate the impact of NGD on gastric tube size to optimize the ERAS protocol after McKeown minimally invasive esophagectomy (MIE).

Patients And Methods

Patients

We retrospectively reviewed the clinical charts of 952 esophageal cancer patients who underwent esophagectomy in the Thoracic Surgery Unit of the Affiliated Cancer Hospital of Zhengzhou University between January 2018 and March 2021. Among them, patients who underwent McKeown MIE were selected for this study.

Operation

All patients underwent McKeown MIE with 2-field or 3-field lymph node dissection, gastric conduit reconstruction (approximately 4 cm in diameter), and left cervical esophagogastric anastomosis. Intraoperative pyloroplasty or pyloromyotomy was not performed. The surgery was performed by 2 surgical teams with extensive experience in esophageal surgery (greater than 100 esophagectomies per year). According to our previous research [3] and the different habits of surgeons, one of the surgical teams still considered it necessary to place an NGT during surgery, while another surgical team chose a more radical ERAS treatment protocol and did not place an NGT during the operation. The patients were divided into the non-NGD and NGD groups based on whether an NGT was placed during the operation.

Perioperative management

All patients underwent pretreatment staging according to the 8th UICC TNM system [8]. This staging process included history taking; physical examination; pulmonary function testing; electrocardiography; routine hematologic and biochemical testing; endoscopic ultrasonography with biopsies; upper gastrointestinal contrast; cardiac and cervical ultrasonography; and computed tomography (CT) scans of the brain, thorax, and abdomen, and bone scintigraphy. Positron emission tomography with fluorodeoxyglucose was used when distant metastasis was suspected. All esophageal cancer patients were discussed by a multidisciplinary team before any treatment.

All patients in this study were treated with the same ERAS postoperative management protocol. On postoperative day (POD) 1, all patients underwent a bedside chest X-ray examination in the semi-recumbent position, and all patients underwent a chest and upper abdominal CT examination in the supine position on POD 5. The chest drain was removed if the chest drainage volume was < 300 ml and there were no signs of anastomotic leakage. In the NGD group, the NGT was removed, and oral feeding started if there was no gastric tube distension or anastomotic leakage on POD 1. Given the lack of a standard definition for gastric tube distension, surgeons made the diagnosis by bedside chest X-ray examination. In the non-NGD group, the NGT was placed if gastric tube distension or anastomotic leakage was observed. On PODs 1 and 2, liquid foods were administered. On POD 3, semiliquid foods and soft solid foods were allowed. The discharge criteria were the presence of normal vital signs, total oral feeding without parenteral nutrition support, no signs of a postoperative complication that needed to be treated at the hospital, ability to perform normal daily activities and tolerable pain on oral analgesia.

Outcomes

The gastric tube size was calculated by bedside chest X-ray examination on POD 1 and CT examination on POD 5; the measurement method is presented in Figure 1. We measured the vertical distance from the right edge of the gastric tube to the right edge of the thoracic vertebra thrice in succession and calculated the mean value using a computer medical imaging system. If the gastric tube boundary was observed on bedside chest X-ray examination or CT examination, it was defined as gastric tube distention. Conversely, there was no gastric tube distention, and the gastric tube size was defined as 0.

Based on bedside chest X-ray examination on POD 1, we compared the rate of postoperative complications (pneumonia and anastomotic leakage), length of postoperative stay, intensive care unit (ICU) readmission or length of ICU stay >24 h, unscheduled readmission within 30 days, in-hospital mortality and need for NGT placement/replacement between the with gastric tube distention group and without gastric tube distention group. Postoperative complications were defined according to the Esophagectomy Complications Consensus Group (ECCG) definition criteria (2015) [9], and the severity was graded based on the Clavien–Dindo (CD) classification [10].

Statistical analysis

Categorical variables are expressed as absolute counts and percentages and were compared with the chi-square test or Fisher's exact test. Continuous variables are expressed as medians and interquartile ranges and were compared with a two-sample (unpaired) Student's t test or the Mann–Whitney U test. Univariate and multivariate logistic regression analyses were conducted to assess the correlation of NGD with preoperative and intraoperative related variables.

We used propensity score matching to control for potential selection bias and confounding factors. Patients were matched according to ten variables (age, sex, body mass index (BMI), tumor location, histology, pathological stage, neoadjuvant therapy, operation time, mode of anastomosis and number of lymph nodes dissected). Propensity scores for all patients were estimated with a multivariable logistic regression model. Within the 2 groups, namely, the non-NGD group and the NGD group, 1:1 propensity score matching without replacement was performed using the maximize execution performance and randomize the case order method when drawing matches within a caliper of 0.02. Statistical analysis was performed using SPSS ver. 26 for Macintosh (IBM, Chicago, IL). A two-sided $p<0.05$ was considered statistically significant except for the logistic regression analysis where statistical significance was considered for $p<0.1$.

Results

The flow chart of the study is presented in Figure 2. Between January 2018 and March 2021, a total of 640 patients who underwent McKeown MIE and bedside chest X-ray examination on POD 1 were enrolled in this study. There were 208 (32.5%) patients in the non-NGD group and 432 (67.5%) patients in the NGD group. The baseline demographic and clinical characteristics of the study patients before and after propensity score matching are provided in Table 1. Hand-sewn anastomosis (192 [94.2%] vs. 380 [90.0%], $p=0.013$) and dissection of an adequate number of lymph nodes (26 [20–32] vs. 23.5 [19–29], *p*=0.007) were more likely in the non-NGD group than in the NGD group. Following 1:1 propensity score matching, a total of 203 patient pairs were selected.

Gastric tube size

Table 2 provides the details of the gastric tube size before and after propensity score matching. On POD 1, a significant difference was found in gastric tube size (22.2 [0–34.7] vs. 0 [0–22.5] mm, $p<0.001$) and the number of patients with gastric tube distention (139 (68.5%) vs. 93 (45.8%), $p<0.001$) between the non-NGD and NGD groups. However, on POD 5, no difference was found in gastric tube size (18.5 [0–31.7] vs. 18.0 [0–25.4] mm, $p=0.070$) or number of patients with gastric tube distention (135 (66.5%) vs. 133 (65.5%), $p=0.834$) between the two groups.

Logistic regression analysis

Univariable logistic regression showed that non-NGD (OR=2.569, 95% CI: 1.714-3.851, $p<0.001$) was associated with a higher incidence of gastric tube distention on POD 1. Similarly, multivariate analysis showed that non-NGD (OR=2.590, 95% CI: 1.724-3.891, $p<0.001$) was still an independent risk factor for gastric tube distention (Table 3).

NGT placement or replacement

In the non-NGD group, NGT insertion was performed after the operation in 42 of 203 cases (20.7%) based on the following reasons: gastric tube distention (according to the bedside chest X-ray examination on POD 1), 28 cases (13.7%); anastomotic leakage, 3 cases (1.5%); severe pneumonia, 5 cases (2.5%); and recurrent laryngeal nerve paralysis, 6 cases (3.0%). In the NGD group, late NGT removal was performed in 24 of 203 cases (11.8%) based on the following reasons: gastric distention (according to the bedside chest X-ray examination on POD 1), 10 cases (4.9%); anastomotic leakage, 1 case (0.5%); severe pneumonia, 4 cases (2.0%); recurrent laryngeal nerve paralysis, 5 cases (2.5%); and abnormal color of NGT drainage fluid, 4 cases (2.0%). NGT reinsertion after the operation was performed in 3 of 203 cases (1.5%) based on the following reasons: anastomotic leakage, 1 case (0.5%); and recurrent laryngeal nerve paralysis, 2 cases (1.0%).

Postoperative outcomes

The postoperative outcomes of patients before and after propensity score matching are provided in Table 4. No difference was found in the incidence of complications (CD≥2) (40 (23.0%) vs. 46 (19,8%), $p=0.440$), pneumonia (CD≥2) (29 [16.8%] vs. 30 [12.9%], $p=0.280$), or anastomotic leakage (CD≥3) (3 [1.7%] vs. 6 [2.6%], $p=0.738$), the CD classification (CD=2, 21 [12.1%] vs. 22 [9.5%], CD=3, 11 [6.3%] vs. 18 [7.8%], CD=4, 7 [4.0%] vs. 3 [1.3%], CD=5, 1 [0.6%] vs. 2 [0.9%], $p=0.379$), the incidence of ICU readmission or length of ICU stay >24 h (8 [4.6%] vs. 5 [2.2%], $p=0.167$), the length of postoperative stay (8 [7–11] vs. 8 [7–11] days, $p=0.739$), the incidence of unscheduled readmission within 30 days (2 [1.1%] vs. 1 [0.4%], $p=0.579$) or the in-hospital mortality rate (1 [0.6%] vs. 2 [0.9%], $p=1$) between the without gastric tube distention group and the with gastric tube distention group

Discussion

Previous studies have demonstrated that early NGT removal or no NGT placement after esophagectomy dose not increase the incidence of postoperative complications, reduces the postoperative length of stay and improves the quality of life compared with traditional late NGT removal [5-7]. With the application of the ERAS protocol in the perioperative period of esophagectomy at our center, we found that the rate of gastric tube distention was higher without NGD than with NGD after esophagectomy through bedside chest X-ray examination. However, to date, few studies have reported the impact of NGD on gastric tube size after esophagectomy. The traditional viewpoint assumes that gastric tube distention causes anastomotic tension, anastomotic dehiscence, decreased lung function, aspiration and reflux and thus affects the long-term quality of life of patients after esophagectomy. However, these findings lack evidence-based support. In the present study, we sought to identify an optimal treatment for this condition. The NGT was not routinely placed during the operation. According to the degree of gastric tube distention through bedside chest X-ray examination on POD 1, we judge whether an NGT needs to be placed to achieve the same postoperative recovery effect as achieved by NGT placement during the operation by assessing rates of complications and the length of the postoperative hospital stay, to avoid routine NGT placement during the operation.

The results of our study show that gastric tubes were larger in the non-NGD group than in the NGD group on POD 1. On univariate and multivariate analysis, non-NGD was significantly associated with an increased risk for gastric tube distention on POD 1. It has been demonstrated that NGT placement is helpful for preventing gastric tube distention. However, in the NGD group, a considerable number of patients still had gastric tube distention. The finding can be partly attributed to the incorrect gastric tube positioning during the minimally invasive approach. Furthermore, we observed that most cases of gastric tube distention occurred in the upper part of the gastric tube. This finding may be due to injury of the vagus nerve during the operation, lack of gastric tube contraction function in the early stage, negative pressure of the thoracic cavity, high resistance of the pylorus, and receptive relaxation of the stomach mainly in the proximal stomach [11-14]. In the non-NGD group, the proportion of gastric tube distention on POD 5 was similar to that on POD 1. However, in the NGD group, the proportion of gastric tube distention on POD 5 was significantly greater than that noted on POD 1. In the NGD group, most patients had the NGT removed on POD 1, which caused gastric tube distention in some patients. This further demonstrated the impact of NGD on gastric tube size.

Nguyen *et al.* [6] concluded that the need for NGD after MIE is noted in less than 5% of cases. In cases that develop postoperative gastric conduit distention, an NGT can be safely placed under fluoroscopic guidance. A parallel-group randomized trial showed that the NGT reinsertion rate was 30.7% in the early removal group and 9.3% in the conventional delayed NGT removal group [5]. These findings are similar to our results. Therefore, the vast majority of patients can avoid the discomfort caused by the placement of NGTs. Clinically, it is safe and easy to place NGTs after esophagectomy, and we did not observe complications directly related to the placement of an NGT after the operation. For patients with anastomotic leakage, an NGT can be safely placed under fluoroscopic guidance to prevent the dehiscence from becoming larger.

Gastric tube distention into the esophageal bed in the posterior mediastinum into the right chest can cause further compression of the right chest, limiting right lung expansion and thereby affecting the patient's postoperative lung function and quality of life. NGD helps encourage early mediastinal fixation [11]. However, in our study, the incidence of pneumonia in patients without gastric tube dilatation was not lower than that in patients with gastric tube dilatation. Therefore, it might not be justified to practice NGD for fear of pneumonia caused by tube gastric dilatation. A large number of studies have also demonstrated that esophagectomy followed by no or short-term postoperative NGD is safe and feasible [5-7, 15-17]. In a parallel-group, randomized trial, 150 patients were randomized to 2 groups. In total, 75 patients were assigned to the early removal arm, and 75 patients were assigned to the conventional late removal arm. No significant difference was found in the occurrence of major pulmonary or anastomotic complications between the two arms, and patient discomfort could be significantly reduced by early NGT removal. Sato *et al.* [16] removed the NGT and performed gastrostomy, and concluded that the retention of an NGT can impede expectoration and yield a significantly higher rate of postoperative respiratory tract infection than gastrostomy in the postoperative management of esophagectomy patients. Similarly, a retrospective analysis showed that the incidence of respiratory complications was lower in the retrograde jejunogastric decompression group compared with the NGT group [18]. However, the merit and safety of using retrograde jejunostomy instead of NGT for decompression remain to be demonstrated. A randomized clinical trial [17] found that the use of a sump-type tube can significantly reduce aspiration compared with the use of a single-lumen NGT or no tube, whereas compared with no tube, the use of a single-lumen NGT cannot reduce aspiration. Patients in the no tube group experienced more respiratory complications than those in the other two groups. This difference could be attributed to the small sample size of 36 patients in the study. In addition, Mahmoodzadeh *et al.* [4] evaluated the outcomes of early and late oral feeding after the surgical resection of esophageal and gastric tumors. They found that the clinical outcomes of the patients in the early oral feeding group were significantly better; and these patients had a shorter time to physiological gastrointestinal function recovery and hospital discharge.

Anastomotic leakage is the most feared postoperative complication after esophagectomy. Clinically, we hypothesize that gastric tube distention increases anastomotic tension and causes local ischemia, thus causing anastomotic leakage. However, sufficient studies are lacking to provide evidence for this hypothesis. In this study, we did not observe an increased incidence of anastomotic leakage in the gastric tube distention group. Daryaei *et al*. [7] concluded that the incidence of anastomosis leakage was significantly increased in patients who used nasogastric tubes after esophagectomy. They believed that the NGT may press this angled anastomosis and may cause necrosis and leakage. However, more robust evidence needs to be established to substantiate this theory.

Our study has certain limitations, mainly because it is a single-center retrospective analysis. We cannot prospectively collect data regarding foreign body sensation, dry throat, pharyngalgia, nausea, vomiting and other discomfort caused by an indwelling NGT, or chest tightness after eating caused by gastric tube distention. Therefore, we cannot further weigh the advantages and disadvantages of the non-NGD and NGD strategies. Moreover, most patients in the NGD group were extubated on POD 1; patients who were traditionally extubated on POD 7 were not collected. It is necessary to design a prospective trial to verify our results and further evaluate changes in gastric tube size after NGD placement in the non-NGD group.

Conclusions

NGT placement during surgery can reduce the rate of gastric tube distention after McKeown MIE on POD 1, but the incidence of complications is similar to that of unconventional NGT placement. Of course, this finding is based on NGT placement or replacement at an appropriate time through bedside chest X-ray examination after the operation.

Declarations

Author contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by all authors. The first draft of the manuscript was written by Duo Jiang, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Availability of data and material Data that supports the finding of this study is available upon reasonable request from the authors.

Code availability N/A

Ethics approval The study protocol was reviewed and approved by the Affiliated Cancer Hospital of Zhengzhou University Ethics Committee on August 13, 2021 (2021-292-001). Given the retrospective nature of the study, the need for informed consent was waived.

Consent to participate Informed consent was waived by the Affiliated Cancer Hospital of Zhengzhou University Ethics Committee in view of the retrospective nature of the study.

Consent for publication N/A

Conflict of interest The authors declare that they have no conflict of interest.

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Tables

TABLE 1. Baseline Demographic and Clinical Characteristics of the Study Patients Before and After Propensity Score Matching.

Variables	Entire study cohort			Propensity-matched cohort		
	Non-NGD group (n=208)	NGD group (n=432)	*p*	Non-NGD group (n=203)	NGD group (n=203)	*p*
Age, y	66 (61–71)	67 (60–71)	0.656	67 (59–71)	66 (61–71)	0.732
Sex			0.376			0.326
Male	152 (73.1%)	301 (69.7%)		148 (72.9%)	139 (68.5%)	
Female	56 (26.9%)	131 (30.3%)		55 (27.5%)	64 (31.5%)	
BMI, kg/m^2	23.4 (21.1–25.1)	23.3 (21.4–25.5)	0.540	23.1 (21.2–25.5)	22.4 (21.1–25.1)	0.941
Tumor location			0.604			0.875
Upper	22 (10.6%)	58 (13.4%)		22 (10.8%)	23 (11.3%)	
Middle	111 (53.4%)	230 (53.2%)		109 (53.7%)	108 (53.2%)	
Lower	68 (32.7%)	124 (28.7%)		65 (32.0%)	63 (31.0%)	
Esophagogastric junction	3 (1.4%)	12 (2.8%)		3 (1.5%)	6 (3.0%)	
Multiple	4 (1.9%)	8 (1.9%)		4 (2.0%)	3 (1.5%)	
Histology			0.691			0.768
Squamous cell carcinoma	185 (88.9%)	372 (86.1%)		180 (88.7%)	175 (86.2%)	
Adenocarcinoma	6 (2.9%)	18 (4.2%)		6 (3.0%)	9 (4.4%)	
Atypical hyperplasia	10 (4.8%)	21 (4.9%)		10 (4.9%)	13 (6.4%)	
Others	7 (3.4%)	21 (4.9%)		7 (3.4%)	6 (3.0%)	
Pathological stage			0.423			0.718
0	10 (4.8%)	22 (5.1%)		10 (4.9%)	14 (6.9%)	
I	70 (33.7%)	164 (38.0%)		69 (34.0%)	69 (34.0%)	
II	61 (29.3%)	113 (26.2%)		59 (29.1%)	56 (27.6%)	
III	60 (28.8%)	117 (27.1%)		59 (29.1%)	56 (27.6%)	
IV	7 (3.4%)	16 (3.7%)		6 (3.0%)	8 (3.9%)	
Neoadjuvant therapy	78 (37.5%)	168 (38.9%)	0.735	76 (37.4%)	76 (37.4%)	1
Operation time, min	255 (240–294)	270 (240–309)	0.095	265 (225–300)	255 (240–295)	0.850
Mode of anastomosis			0.013			0.836
Hand-sewn anastomosis	192 (94.2%)	380 (90.0%)		191 (94.1%)	190 (93.6%)	
Stapler anastomosis	12 (5.8%)	52 (12.0%)		12 (5.9%)	13 (6.4%)	
No. of lymph nodes dissected	26 (20–32)	23.5 (19–29)	0.007	25 (20–30)	26 (19–31)	0.804

BMI, body mass index; NGD, nasogastric decompression.

TABLE 2. Gastric Tube Size Before and After Propensity Score Matching.

Variables	Entire study cohort			Propensity-matched cohort		
	Non-NGD group (n=208)	NGD group (n=432)	*p*	Non-NGD group (n=203)	NGD group (n=203)	*p*
POD 1						
Gastric tube size	22.1 (0–35.1)	0 (0–23.0)	< 0.001	22.2 (0–34.7)	0 (0–22.5)	< 0.001
No. of patients with gastric tube distention	143 (68.8%)	193 (44.7%)	< 0.001	139 (68.5%)	93 (45.8%)	< 0.001
POD 5						
Gastric tube size	18.6 (0–31.6)	18.0 (0–26.3)	0.056	18.5 (0–31.7)	18.0 (0–25.4)	0.070
No. of patients with gastric tube distention	139 (66.8%)	277 (64.1%)	0.501	135 (66.5%)	133 (65.5%)	0.834

POD, postoperative day; NGD, nasogastric decompression.

Table 3. Univariate and multivariate logistic regression of risk factors for nasogastric decompression on POD 1.

Variables	Univariate			Multivariate		
	OR	95%CI	*p*	OR	95%CI	*p*
Non-NGD	2.569	1.714-3.851	<0.001	2.590	1.724-3.891	<0.001
Age	0.989	0.965-1.014	0.389			
Sex	0.882	0.571-1.362	0.570			
BMI	1.062	0.995-1.133	0.069	1.065	0.997-1.139	0.062
Tumor location						
Upper			0.125			
Middle	7.200	0.799-64.889	0.078			
Lower	9.388	1.111-79.351	0.040			
Esophagogastric junction	7.474	0.874-63.873	0.066			
Multiple	3.000	0.239-37.672	0.395			
Histology						
Squamous cell carcinoma			0.230			
Adenocarcinoma	2.925	0.695-12.317	0.143			
Atypical hyperplasia	3.184	0.962-10.534	0.058			
Others	1.969	0.416-9.317	0.393			
Pathological stage						
0			0.982			
I	1.400	0.372-5.268	0.618			
II	1.379	0.459-4.147	0.567			
III	1.367	0.450-4.151	0.581			
IV	1.280	0.421-3.888	0.663			
Neoadjuvant therapy	0.801	0.532-1.205	0.287			
Operation time	0.999	0.995-1.003	0.614			
Mode of anastomosis	1.248	0.555-2.806	0.592			
No. of lymph nodes dissected	0.995	0.975-1.017	0.667			

BMI, body mass index; NGD, nasogastric decompression.

TABLE 4. Postoperative Outcomes of the Study Patients After Propensity Matching.

Variables	Entire study cohort			Propensity-matched cohort		
	Without gastric tube distention (n=304)	With gastric tube distention (n=336)	*p*	Without gastric tube distention (n=174)	With gastric tube distention (n=232)	*p*
Complications (CD≥2)	72 (23.7%)	69 (20.5%)	0.337	40 (23.0%)	46 (19,8%)	0.440
Pneumonia (CD≥2)	49 (16.2%)	46 (13.7%)	0.369	29 (16.8%)	30 (12.9%)	0.280
Anastomotic leakage (CD≥3)	7 (2.3%)	6 (1.8%)	0.630	3 (1.7%)	6 (2.6%)	0.738
CD classification			0.259			0.379
2	37 (12.2%)	36 (10.7%)		21 (12.1%)	22 (9.5%)	
3	24 (7.9%)	26 (7.7%)		11 (6.3%)	18 (7.8%)	
4	8 (2.6%)	4 (1.2%)		7 (4.0%)	3 (1.3%)	
5	3 (1.0%)	2 (0.6%)		1 (0.6%)	2 (0.9%)	
ICU readmission or length of ICU stay >24 h	14 (4.6%)	8 (2.4%)	0.123	8 (4.6%)	5 (2.2%)	0.167
Length of postoperative stay, days	8 (7–11)	8 (7–11)	0.910	8 (7-11)	8 (7-11)	0.739
Unscheduled readmission within 30 days	4 (1.3%)	1 (0.3%)	0.196	2 (1.1%)	1 (0.4%)	0.579
In-hospital mortality	3 (1.0%)	2 (0.6%)	0.672	1 (0.6%)	2 (0.9%)	1

ICU, intensive care unit; CD, Clavien–Dindo.

Figures

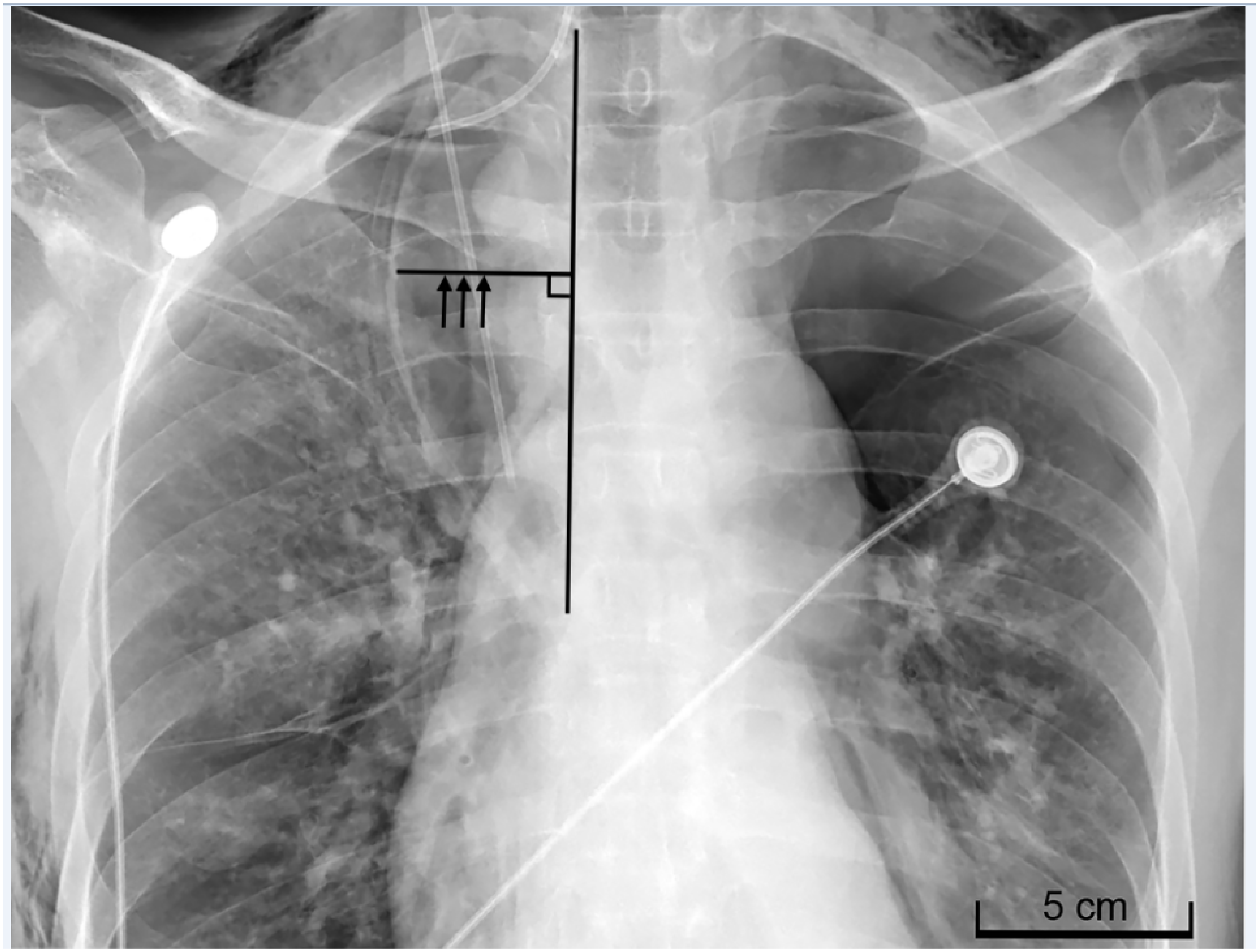

Figure 1

Gastric tube size measurement method based on bedside chest X-ray examination. The arrows indicate the vertical distance from the right edge of the gastric tube to the right edge of the thoracic vertebra.

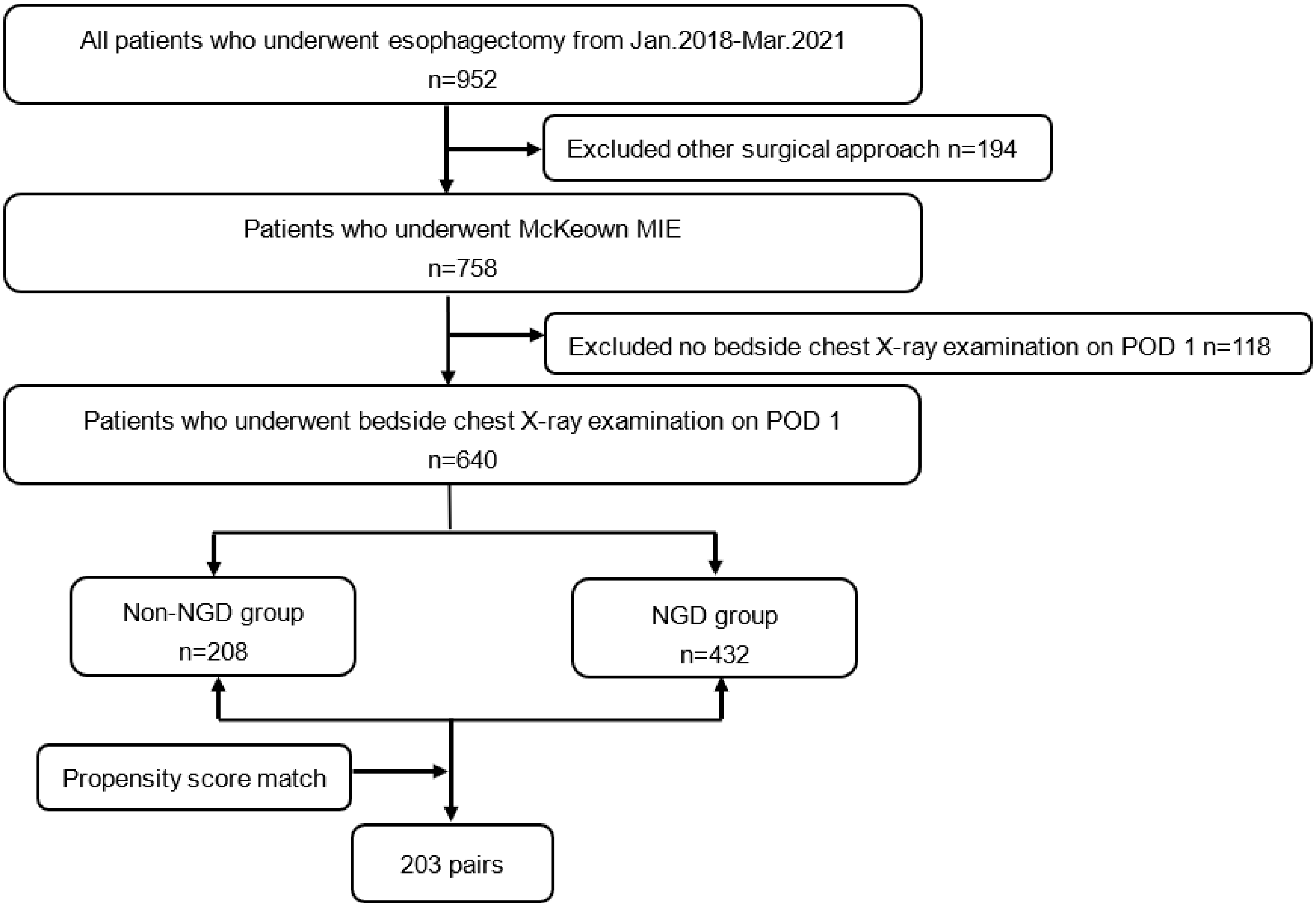

Figure 2

Flow chart of the study. MIE, minimally invasive esophagectomy; NGD, nasogastric decompression; POD, postoperative day.