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ORIGINAL ARTICLE

Comparison of wide and narrow gastric conduit in esophageal cancer surgery

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Abstract

Background: Gastric conduit is most widely used method for esophageal reconstruction. Despite its popularity, certain complications, such as anastomotic leakage and strictures, remain to be resolved. In the present study, we reviewed the outcomes of narrow gastric conduit compared to wide gastric conduit reconstruction.

Methods: We retrospectively reviewed 493 patients with esophageal cancer who received esophagectomy with reconstruction in Taichung Veteran General Hospital, Taiwan between January 2010 and December 2019. We performed gastric conduit reconstruction with two different methods, narrow gastric conduit made of multistaples (more than four staples) and wide gastric conduit made of two or three staples. Among the 493 patients, 170 patients underwent wide gastric conduit formation and 323 patients underwent narrow gastric conduit. After propensity score matching, 140 patients from each group were matched by 1:1.

Results: The average anastomotic leakage rate is 80 of 493 (16.23%). The leakage rate, length of hospital stay, intensive care unit (ICU) admission, and ICU stay were significantly lower in the narrow gastric conduit group than in the wide gastric conduit group. The need for postoperation dilatation was significantly higher in wide gastric conduit group (19.41% vs 11.76%, $p = 0.0217$), and the time to first dilatation was similar in both groups ($p = 0.9808$). Similar results were observed even after propensity score matching. In univariate analysis, the narrow gastric conduit, circular stapler, video-assisted thoracic surgery, and laparoscopic surgery were associated with a reduced risk of anastomotic leakage. However, these factors are not statistically significant in a multivariate logistic regression analysis.

Conclusion: The narrow gastric conduit is not inferior to the wide gastric conduit and can be considered an alternative option for gastric conduit preparation.

Keywords: Anastomotic leakage; Dilatation; Esophagectomy; Propensity score; Veterans

1. INTRODUCTION

Esophageal reconstruction is a crucial step during esophagectomy. Anastomotic leakage is a common complication after reconstruction and will result in great morbidity. Choices for reconstruction include the stomach, small intestine, and colon. The gastric conduit compared with the jejunum flap or colon interposition, has lower leakage rate because of less surgical complexity and fewer number of anastomosis and therefore are more widely used.[1] Some studies have shown fewer postoperative digestive tract complications, earlier recovery, and a better quality of life when patients received gastric conduit reconstruction.[2] The right gastric and gastroepiploic arteries are generally preserved for the gastric conduit.[3,4] Creating an ideal gastric conduit is crucial because the blood supply may not be able to reach the anastomotic site, thus resulting in leakage, fistula, and even graft necrosis. Anastomotic leakage results in a longer hospital stay and potential tumor metastasis which leads to a decreased overall survival and disease-free survival rate.[5] An ideal gastric conduit should have an adequate lumen diameter for a tension-free anastomosis without compromising blood supply. The more staples we used, the longer the gastric conduit and a more tension-free status we can achieve. However, the blood supply was more compromised at the cervical anastomosis, and the diameter also became narrow as the gastric conduit became longer. In addition, the number of staples we use to create the gastric conduit plays an important role. To lengthen the gastric conduit, we developed a stapling technique to create narrow gastric conduit for reconstruction. In the present study, we compared the 10-year outcomes of the narrow gastric conduit with a wide gastric conduit.

2. METHODS

We retrospectively reviewed all patients in Taichung Veterans General Hospital who underwent esophagectomy with a cervical anastomosis from 2010 to 2019 (the study was approved by the institute review board of TCVGH, CE21162B-1). Patients with the history of gastric surgery, reconstruction with ileo-colon, esophago-jejunostomy, or combination with total laryngectomy surgery were excluded (Fig. 1). A total of 493 patients were enrolled in this study. The clinicopathological characteristics of gender, clinical staging, tumor location, histology, and neoadjuvant therapy were documented. The methods of gastric conduit creation were divided into two groups. The creation of wide gastric conduit required fewer staples (two or three with endoscopic gastrointestinal

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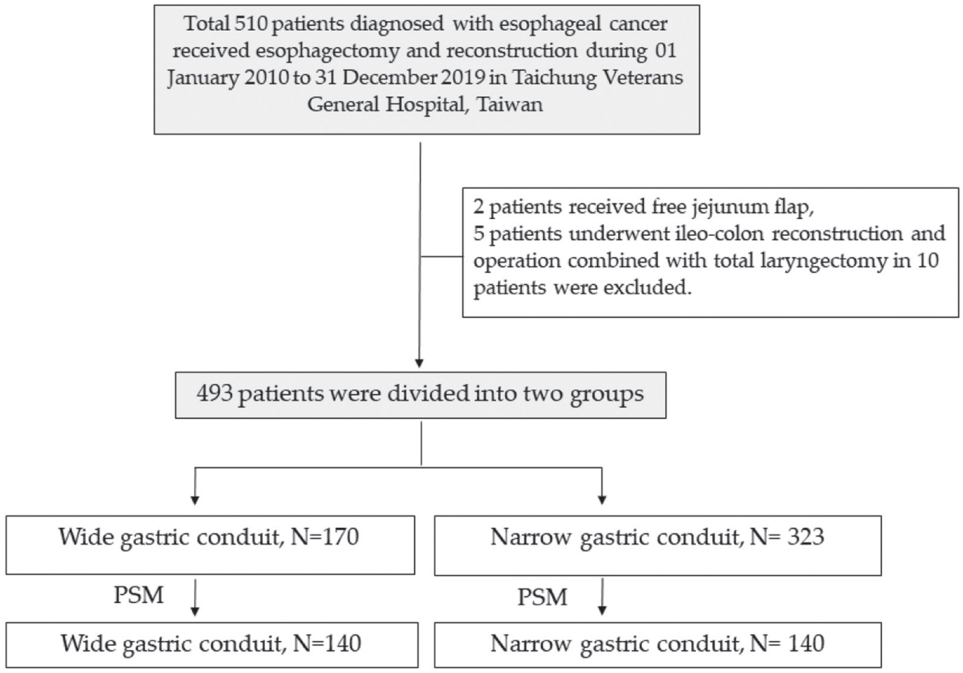

Fig. 1 Flowchart describing the study population selection. PSM = propensity score matching.

anastomosis [Endo-GIA] 80-4.8 mm staples or endo-GIA 60-4.8 mm, respectively, Figs. 2A and 3A), which went linearly and obliquely from right to left and ended at fundus. The average width of wide gastric conduit was above 5 cm. On the other hand, the narrow gastric conduit was created with multiple staples (more than four staples, mostly used with endo-GIA 45-4.1 × 5, Figs. 2B and 3B), which ran along the great curvature to fundus and resected half to two third of stomach. The average width of narrow gastric conduit was 2.85 cm. There were two kinds of reconstruction route, retrosternal or posterior mediastinal route. In our study, the definition of anastomotic leakage included cervical wound with discharge, radiological diagnosis or fever with leukocytosis, sepsis combined with intrathoracic leakage requiring decortication. Chest radiograph with water-soluble oral contrast was not routinely performed. Most patients suffered from dysphagia after operation and asked for dilatation. Postoperation dilatation for anastomotic stenosis was defined as first time dilatation with <40 French. Patient characteristics and outcomes were documented using a standardized data collection form.

MedCalc version 20.110 (Mariakerke, Belgium) was used to conduct statistical analysis. For the significance of the study, Fisher exact test and Chi-square test for categorical variables, and the independent t test and Mann-Whitney test for continuous variables. Variables with $p < 0.01$ on univariate analysis were included in a multivariate logistic regression analysis. To minimize the difference between wide and narrow gastric conduit, a retrospective propensity score matching (PSM) analysis was performed to control the confounding factors. SPSS software (v.25.0 for Windows; SPSS Inc., Chicago, IL) was used to calculate the propensity score with a multivariable logistic regression model. Continuous variables were expressed as mean value ± SD, whereas categorical variables were expressed as number and percentages. A comparison between the two groups was performed, in which Fisher exact test and Chi-square test were used for categorical variables, and t test for continuous variables. The statistical significance was defined as $p < 0.05$.

3. RESULTS

3.1. Patient characteristics

Among the 493 patients, 170 patients underwent wide gastric conduit formation and 323 patients underwent narrow gastric

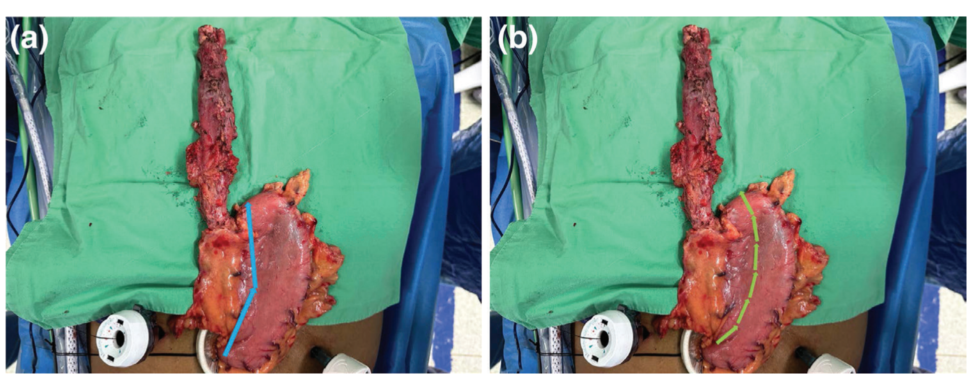

Fig. 2 Different types of gastric conduit. A, Wide gastric conduit. The wide gastric conduit creation with fewer staples (two staples with endo-GIA 80-4.8 mm or three staples with endo-GIA 60-4.8 mm). B, Narrow gastric conduit. The narrow gastric conduit with more staples (more than four staples, most used with endo-GIA 45-4.1 × 5). Endo-GIA = endoscopic gastrointestinal anastomosis.

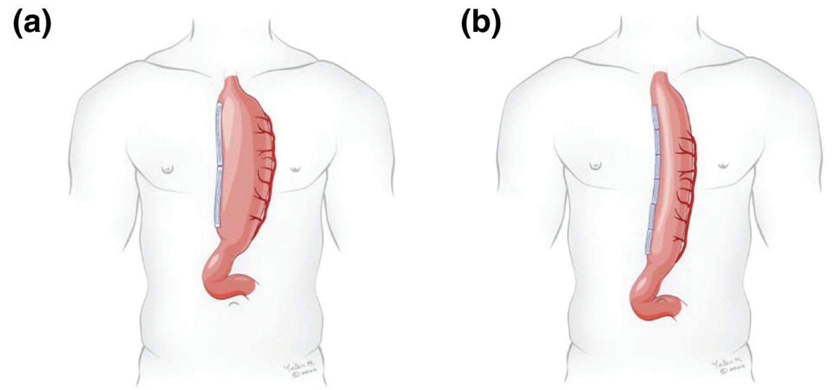

Fig. 3 Different types of gastric conduit. A, Wide gastric conduit. B, Narrow gastric conduit. The narrow gastric conduit can achieve more tension-free. Illustration by Yu-Sin Huang, ©2022 Yu-Sin Huang.

conduit. Patient characteristics are demonstrated in Tables 1 and 2. Not much difference was observed in patients' underlying comorbidities, such as diabetes, coronary artery disease, liver disease, hypertension, and cerebral vascular accident and clinical staging between wide and narrow gastric conduit groups. The histology was mostly composed of squamous cell carcinoma and adenocarcinoma in the wide gastric conduit group, whereas the narrow gastric conduit group was mostly composed of squamous cell carcinoma. Rare histologies, such as neuroendocrine and adenosquamous, in wide gastric conduit group, sarcoma, and melanoma in narrow gastric conduit group were found. However, more patients in the narrow group received neoadjuvant therapy (71.21% vs 51.76%, p < 0.001). Neoadjuvant therapy gave rise to the down-staging of esophageal cancer. As a result, pathology T staging was more advanced in the wide gastric conduit group than in the narrow gastric conduit group, mostly the T3 stage (41.18% vs 24.77%, p = 0.004). More patients received retrosternal route for reconstruction in wide gastric conduit group (91.76% vs 81.73%, p < 0.001), whereas video-assisted thoracic surgery (VATS) and laparoscopic surgery were performed more in narrow gastric conduit group. We calculated the propensity score with a multivariable logistic regression model including all the significant factors; however, only 63 patients from each group were matched. The sample size was small. As a result, we chose histology, neoadjuvant therapy, pathological T stage, pathological N stage, and pathological M stage for matching. After PSM with fiver significant factors, 140 patients from each group were matched by 1:1. Further data for PSM including all the significant factors are provided in Supplementary Data 1, http://links.lww.com/JCMA/A213 and 2, http://links.lww.com/JCMA/A214.

3.2. Postoperative outcomes

Table 3 reveals the outcomes between the two groups before and after PSM. The length of the gastric conduit was longer in the narrow gastric conduit group (28.53 ± 5.42 cm vs 19.38 ± 3.64 cm, p < 0.001). The width of the gastric conduit was greater in wide gastric conduit group (5.64 ± 0.48 cm vs 2.82 ± 0.22 cm, p < 0.0001). The leakage rate was significantly higher in the wide gastric conduit group (n = 41, 24.12%) than in the narrow gastric conduit group (n = 39, 12.07%, p < 0.001). However, the result in Supplementary Data 2, http://links.lww.com/JCMA/A214 revealed the trend of decreased leakage rate in narrow gastric conduit group without significance (23.81% vs 11.11%, p = 0.061). The 90-day mortality was twice more in narrow gastric conduit group without significance (2.35% vs 4.64%, p = 0.324). The cause of 90-day mortality in narrow gastric conduit group included six patients with anastomotic leakage with tracheal fistula, vessels bleeding, or severe sepsis, four patients with postoperation pneumonia, two patients with distant metastasis, and three patients with other underlying disease. In wide gastric conduit group, three patients died of anastomotic leakage with tracheal fistula or vessels bleeding, one patient died of distant metastasis, and one patient died of chronic obstructive pulmonary disease (COPD) with acute exacerbation. The length of stay was shorter in the narrow gastric conduit group (p < 0.001) than in the wide gastric conduit. In general, patients routinely admitted to the intensive care unit (ICU) for precise management of fluid status and vital sign monitoring, including artery blood gas test, urine specific gravity, and central venous pressure measurement. However, total 22 (4.46%) patients in both groups were not admitted to ICU after operation in Table 3. Our alternative policy for ICU admission is that patients will stay in recovery room overnight and are transferred to general ward on the next day under stable condition. ICU patients will be transferred out after endotracheal tube and nasogastric tube removal and adequate enteral nutrition via jejunostomy. ICU admission and stay were less in the narrow gastric conduit group (ICU admission, 93.50% vs 99.41%, p = 0.002; ICU stay, 4.62 ± 3.57 vs 6.88 ± 8.91 days, p = 0.002). The need for postoperation dilatation was higher in the wide gastric conduit group (n = 33, 19.41% vs n = 38, 11.76%, p = 0.0217). The duration from the operation to the first dilatation was no significant difference in both groups (2 month vs 2 months, p = 0.9808). In Table 3, the result of leakage rate, conduit length, conduit width, length of stay, ICU admission, ICU stay, and duration to first dilatation were still similar even after PSM.

3.3. Clinical factors of anastomotic leakage

On univariable analysis in Table 4, age, gender, underlying comorbidity with coronary artery disease, diabetes mellitus, liver disease and COPD, tumor location, and neoadjuvant therapy were not significant clinical factors affecting anastomotic leakage. Patients with hypertension had a trend of affecting anastomotic leakage but were not statistically significant (odds ratio [OR] = 1.55, 95% CI: 0.85-2.44, p = 0.059). The occurrence of anastomotic leakage seemed to be reduced in circular stapler usage (p = 0.002), VATS (p = 0.0028), and laparoscopic surgery (p = 0.001). The gastric conduit preparation tended to leak less in the narrow gastric conduit group (p = 0.001). The retrosternal route had a higher risk of leakage (OR = 2.40, 95% CI: 1.19-4.84, p = 0.014) compared to posterior mediastinal route. The results of the multivariate analysis are presented in

Table 1

The demographic characteristics of each group

	All patients			
	Total (n = 493)	Wide gastric conduit (n = 170)	Narrow gastric conduit (n = 323)	*p*
Age (years old)				0.209
Mean ± SD	56.67 ± 8.87	57.39 ± 9.82	56.28 ± 8.33	
Gender				0.064
Male	471 (95.5%)	158 (92.94%)	313 (96.90%)	
Female	22 (4.5%)	12 (7.06%)	10 (3.10%)	
Hypertension	118 (23.94%)	41 (24.12%)	77 (23.84%)	0.945
Coronary artery disease	15 (3.04%)	5 (2.94%)	10 (3.10%)	0.924
Diabetes mellitus	41 (8.32%)	15 (8.82%)	26 (8.05%)	0.864
Cerebrovascular accident	11 (2.23%)	3 (1.76%)	8 (2.48%)	0.756
Liver disease	71 (14.40%)	23 (13.53%)	48 (14.86%)	0.788
COPD	73 (14.81%)	18 (10.59%)	55 (17.03%)	0.062
Tumor location				0.419
Upper	55 (11.16%)	17 (10.00%)	38 (11.76%)	
Middle	181 (36.71)	69 (40.59%)	112 (34.67%)	
Lower	257 (52.13%)	83 (49.41%)	173 (53.56%)	
Histology				0.003
Squamous	473 (95.94%)	156 (91.76%)	318 (98.45%)	
Adenocarcinoma	13 (2.64%)	11 (6.47%)	2 (0.62%)	
Neuroendocrine	3 (0.61%)	2 (11.76%)	1 (0.31%)	
Adenosquamous	1 (0.2%)	1 (0.59%)	0 (0.00%)	
Melanoma	1 (0.2%)	0 (0.00%)	1 (0.31%)	
Sarcoma	1 (0.2%)	0 (0.00%)	1 (0.31%)	
Clinical T stage				0.497
I	53 (10.75%)	16 (9.41%)	37 (11.46%)	
II	37 (7.51%)	10 (5.88%)	27 (8.36%)	
III	388 (78.70%)	141 (82.94%)	247 (76.47%)	
IV	6 (1.22%)	1 (0.59%)	5 (1.55%)	
In situ	9 (1.83%)	2 (1.18%)	7 (2.17%)	
Clinical N stage				0.068
0	122 (24.75%)	38 (22.35%)	84 (26.01%)	
I	235 (47.67%)	90 (52.94%)	145 (44.89%)	
II	114 (23.12%)	31 (18.24%)	83 (25.70%)	
III	22 (4.46%)	11 (6.47%)	11 (3.41%)	
Clinical M stage				0.118
M0	491 (99.59%)	168 (98.82%)	323 (100.00%)	
M1	2 (0.41%)	2 (1.18%)	0 (0.00%)	
Neoadjuvant CCRT				<0.001
No	175 (35.50%)	82 (48.24%)	93 (28.79%)	
Yes	318 (64.50%)	88 (51.76%)	230 (71.21%)	
VATS				<0.001
No	89 (18.05%)	82 (48.24%)	7 (2.17%)	
Yes	404 (81.95%)	88 (51.76%)	316 (97.83%)	
Laparoscopic				<0.001
No	39 (7.91%)	164 (96.47%)	75 (23.22%)	
Yes	254 (51.52%)	6 (3.53%)	248 (77.78%)	
Retrosternal route				<0.001
No	73 (14.81%)	14 (8.24%)	59 (18.27%)	
Yes	420 (85.19%)	156 (91.76%)	264 (81.73%)	
Circular stapler				<0.001
No	230 (46.65%)	82 (48.24%)	93 (28.79%)	
Yes	263 (53.35%)	88 (51.76%)	230 (71.21%)	
Pathological T stage				0.004
0	150 (30.43%)	40 (23.53%)	110 (34.05%)	
I	109 (22.11%)	33 (19.41%)	76 (23.53%)	
II	67 (13.59%)	20 (11.76%)	47 (14.55%)	
III	150 (30.43%)	70 (41.18%)	80 (24.77%)	
IV	9 (1.82%)	4 (2.35%)	5 (1.55%)	
In situ	8 (1.62%)	3 (1.77%)	5 (1.55%)	

(Continued)

Table 1

(Continued)

	All patients			
	Total (n = 493)	Wide gastric conduit (n = 170)	Narrow gastric conduit (n = 323)	*p*
Pathological N stage				0.033
0	306 (62.07%)	93 (54.71%)	213 (65.94%)	
I	119 (24.14%)	44 (25.88%)	75 (23.22%)	
II	49 (23.12%)	23 (13.53%)	26 (8.05%)	
III	19 (3.85%)	10 (5.88%)	9 (2.79%)	
Pathological M stage				0.01
M0	482 (97.77%)	162 (95.29%)	320 (99.07%)	
M1	11 (2.23%)	8 (4.71%)	3 (0.93%)	

Fisher exact test and Chi-square test for categorical variables, *t* test for continuous variables, $p < 0.05$.
CCRT = concurrent chemoradiation therapy; COPD = chronic obstructive pulmonary disease; VATS = video-assisted thoracic surgery.

Table 4 and no factors were statistically associated with leakage. As shown in Fig. 4, patients without anastomotic leakage tended to have better 5-year survival but were not statistically significant (42.41% vs 32.38%, $p = 0.177$).

4. DISCUSSION

Anastomotic leakage is a nightmare for both surgeons and patients and leads to longer hospital stays, readmission rates, and more medical costs.[6] In our study, there is a trend of a lower 5-year survival rate in the anastomotic leakage group despite no statistical significance in Fig. 4 (42.41% vs 32.38%, $p = 0.177$). One study indicated that pneumonia was a statistically significant negative impact on overall survival after esophagectomy, whereas anastomotic leakage did not show such an impact.[7] Furthermore, current meta-analysis showed that both pulmonary complications and anastomotic leakage resulted in poorer 5-year survival.[8] The average leakage rate ranges from 10% to 25%.[9,10] Patients suffering from anastomotic leakage often present with fever and leukocytosis after the operation. Especially, severe cases also demonstrated empyema, mediastinitis, or conduit necrosis and encountered re-operation, such as decortication, debridement, and even conduit removal with cervical esophagostomy. It took more time for antibiotics injection and recovery. Some patients might need to postpone adjuvant treatment. In addition, there were some disastrous leakage cases with vessels bleeding and tracheal fistula resulted in death in 90 days.

There have been reported some risk factors related to anastomotic leakage. Takeda et al[11] indicated risk factors for anastomotic leakage were gastric conduit perfusion, obesity, heart failure, coronary heart disease, vascular disease, smoking, and cervical anastomosis. Van Kooten et al[12] published a systemic review and meta-analysis that renal disease, vascular comorbidity, diabetes, pulmonary, hypertension, cardiac comorbidity, American Society of Anaesthesiologists' (ASA) score C III, male sex, and adenocarcinoma tumor histology were prognostic factors for anastomotic leakage. In addition, diabetes mellitus can be a significant risk factor for anastomotic leakage for patients undergoing esophagectomy.[13] Thus, in our study, hypertension with marginal significance affecting anastomotic leakage may be due to the reduction of microcirculation of tissues.[14] The minimally invasive procedure (VATS and laparoscopic surgery) plays an important role in dissecting tissue delicately, hemostasis promptly, reducing tension carefully, and declining postoperation pulmonary complications compared with open surgery.[15,16] Consequently, better oncological outcomes and less anastomotic leakage were noted in the minimally invasive procedure.[17] Moreover, circular staplers provide anastomosis consistency, the ability to access difficult locations, and time savings.[18] The leakage rate was also improved with circular staplers usage in our data and we mostly adopted 21 mm for anastomosis.

However, a debate remains about how to create an ideal gastric conduit. The main points in gastric conduit preparation are blood supply and tension-free.[3] A combination of linear and radial staples contributes to better blood flow in gastric conduits according to previous study.[19] One meta-analysis also indicated gastric conduit group had better outcomes of anastomotic leakage and less reflux esophagitis than the whole stomach group.[20] Besides, there were still other methods to prevent anastomotic leakage, such as omentoplasty.[21] Since 2020, we adopted indocyanine green (ICG) scope to check the perfusion of the conduit. Most of the blood supply could reach the anastomosis in narrow gastric conduit group. From our experience, the method of narrow gastric conduit not only maintained the circulation of anastomosis but also released the tension.

Some papers demonstrated stretched gastric conduits or flexible gastric conduits with better outcomes.[3,22] In addition, the reconstruction methods affected the quality of life, and some patients suffered from dysphagia, nausea, and vomiting after the operation.[23] The lumen in the narrow gastric conduit group was smaller than the wide gastric conduit group; however, no significant increase in esophageal dilatation was found. It may be due to more leakage leading to anastomotic stenosis sooner, thus requiring dilatation because of wound healing with scarring.[24] The narrow gastric conduit group also had shorter ICU stay and length of stay possibly because less anastomotic leakage we encountered and no second operations was required. Apart from that, there were more patients in the narrow gastric conduit group receiving neoadjuvant therapy (71.21% vs 51.76%, $p < 0.001$, Table 1) but neoadjuvant therapy was not a major clinical factor of anastomotic leakage. In one study, preoperation therapy, particularly chemotherapy was an influencing factor for anastomotic leakage.[25] One report also showed that significantly decreased skeletal muscle mass and body weight during neoadjuvant therapy resulted in postoperative anastomotic leakage.[26] However, our patients routinely received percutaneous endoscopic gastrostomy as an alternative route for oral intake. Hence, this method minimized the condition of malnutrition and sarcopenia. The retrosternal route for gastric conduit reconstruction is longer than the posterior mediastinum route. It leads to less blood supply reaching the tip of gastric conduit. It ended up with clinical factors of leakage rate but the advantage of the retrosternal route is more space for radiation therapy when tumor recurrence was encountered. There were still some advantages about retrosternal route. Anastomotic leak and surgical site infection were significantly higher in the retrosternal group but the incidence of pneumonia was lower.[27]

Table 2

The demographic characteristics of each group after PSM

	PSM patients		
	Wide gastric conduit (n = 140)	Narrow gastric conduit (n = 140)	*p*
Age (years old)			0.882
Mean ± SD	56.93 ± 9.53	57.09 ± 8.05	
Gender			0.063
Male	129 (92.14%)	136 (97.10%)	
Female	11 (7.86%)	4 (2.9%)	
Hypertension	33 (23.57%)	35 (25.00%)	0.780
Coronary artery disease	4 (2.86%)	5 (3.60%)	1.000
Diabetes mellitus	11 (7.86%)	15 (10.70%)	0.410
Cerebrovascular accident	3 (2.14%)	3 (2.10%)	1.000
Liver disease	22 (15.71%)	18 (12.90%)	0.495
COPD	18 (12.86%)	24 (17.10%)	0.315
Tumor location			0.363
Upper	12 (8.57%)	16 (11.4%)	
Middle	60 (42.86%)	49 (35.00%)	
Lower	68 (48.57%)	75 (53.6%)	
Histology			1.000
Squamous	139 (99.29%)	139 (99.29%)	
Adenocarcinoma	1 (0.71%)	1 (0.71%)	
Neuroendocrine	0 (0.00%)	0 (0.00%)	
Adenosquamous	0 (0.00%)	0 (0.00%)	
Melanoma	0 (0.00%)	0 (0.00%)	
Sarcoma	0 (0.00%)	0 (0.00%)	
Clinical T stage			0.547
I	14 (10.00%)	20 (14.27%)	
II	9 (6.43%)	13 (9.30%)	
III	114 (81.43%)	102 (72.90%)	
IV	1 (0.71%)	2 (1.43%)	
In situ	2 (1.43%)	3 (2.10%)	
Clinical N stage			0.236
0	34 (24.29%)	48 (34.30%)	
I	74 (52.86%)	59 (42.10%)	
II	26 (18.57%)	28 (20.00%)	
III	6 (4.28%)	5 (3.60%)	
Clinical M stage			0.498
M0	138 (98.57%)	140 (100.00%)	
M1	2 (1.43%)	0 (0.00%)	
Neoadjuvant CCRT			0.810
No	60 (42.86%)	62 (44.29%)	
Yes	80 (57.14%)	78 (55.71%)	
Pathological T stage			0.995
0	36 (25.72%)	36 (25.72%)	
I	29 (20.72%)	32 (22.86%)	
II	17 (12.14%)	17 (12.14%)	
III	54 (38.57%)	52 (37.14%)	
IV	1 (0.71%)	0 (0.00%)	
In situ	3 (2.14%)	3 (2.14%)	
Pathological N stage			0.924
0	83 (59.29%)	85 (60.71%)	
I	38 (27.13%)	39 (27.86%)	
II	13 (9.29%)	12 (8.57%)	
III	6 (4.29%)	4 (2.86%)	
Pathological M stage			1.000
M0	138 (98.57%)	137 (97.86%)	
M1	2 (1.43%)	3 (2.14%)	

Fisher exact test and Chi-square test for categorical variables, *t* test for continuous variables, $p < 0.05$.
CCRT = concurrent chemoradiation therapy; COPD = chronic obstructive pulmonary disease; PSM = propensity score matching.

This was a retrospective study from a tertiary medical center in Taiwan; however, there were still some biases and limitations. The study included 10-year data and there were undoubtedly some differences during the time. We used the narrow gastric conduits mostly in 2014, and the surgery also began to shift to VATS and laparoscopic surgery simultaneously (Fig. 5) and

Table 3

Postoperative outcomes before and after PSM

	All patients				PSM patients		
	Total	Wide gastric conduit (n = 170)	Narrow gastric conduit (n = 323)	*p*	Wide gastric conduit (n = 140)	Narrow gastric conduit (n = 140)	*p*
Conduit length, cm				<0.001			<0.001
Mean ± SD	25.37 ± 6.54	19.38 ± 3.64	28.53 ± 5.42		19.75 ± 3.65	28.55 ± 3.98	
Median	24	16	30		20.25	30	
Conduit width, cm				<0.0001			<0.0001
Mean ± SD	3.41 ± 1.18	5.64 ± 0.48	2.82 ± 0.22		5.65 ± 0.47	2.84 ± 0.21	
Median	2.92	5.58	2.85		5.53	2.85	
Leakage				<0.001			0.017
No	413 (76.67%)	129 (75.88%)	284 (87.93%)		104 (74.29%)	120 (85.71%)	
Yes	80 (16.23%)	41 (24.12%)	39 (12.07%)		36 (25.71%)	20 (14.29%)	
90-d mortality				0.324			0.2387
No	474 (96.15%)	166 (97.65%)	308 (95.36%)		136 (97.14%)	132 (94.29%)	
Yes	19 (3.85%)	4 (2.35%)	15 (4.64%)		4 (2.86%)	8 (5.71%)	
Length of stay, d				<0.001			<0.001
Mean ± SD	18.15 ± 10.33	21.61 ± 13.31	16.33 ± 7.77		21.54 ± 14.24	16.57 ± 8.15	
Median	15	18	14		17	14	
ICU admission				0.002			0.002
No	22	1 (0.59%)	21 (6.50%)		0 (0.00%)	13 (9.29%)	
Yes	471	169 (99.41%)	302 (93.50%)		140 (100%)	127 (90.71%)	
ICU stay, d				0.002			0.0005
Mean ± SD	5.40 ± 6.07	6.88 ± 8.91	4.62 ± 3.57		7.00 ± 9.54	4.21 ± 3.02	
Median	4	5	4		5	4	
Postoperation dilatation				0.0217			0.0791
No	422 (85.60%)	137 (80.59%)	285 (88.24%)		111 (79.29%)	122 (87.13%)	
Yes	71 (14.40%)	33 (19.41%)	38 (11.76%)		29 (20.71%)	18 (12.86%)	
Duration to dilatation, mo				0.9808			0.1329
Mean ± SD	2.77 ± 2.19	2.57 ± 1.21	2.95 ± 2.76		1.94 ± 2.23	3.31 ± 5.98	
Median	2	2	2		1	2	

Chi-square test, Fisher exact test, *t* test and Mann-Whitney test. $p < 0.05$.
ICU = intensive care unit; PSM = propensity score matching.

Table 4

Univariate and multivariate analysis for clinical factors of anastomotic leakage

	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*	OR	95% CI	*p*
Age	1.00	0.98-1.02	0.915			
Gender (male)	1.57	0.52-4.74	0.421			
Hypertension	1.55	0.85-2.44	0.059			
Coronary artery disease	1.06	0.33-3.39	0.920			
Diabetes mellitus	1.23	0.61-2.48	0.570			
Cerebrovascular accident	1.09	0.29-4.19	0.895			
Liver disease	0.83	0.45-1.50	0.528			
COPD	0.65	0.35-1.21	0.178			
Tumor location						
Upper	Ref.					
Middle	1.10	0.56-2.17	0.773			
Lower	0.78	0.40-1.51	0.455			
Neoadjuvant therapy	1.14	0.74-1.74	0.556			
Gastric tube						
Wide	Ref.					
Narrow	0.49	0.33-0.75	0.001**	0.81	0.41-1.60	0.548
Retrosternal route	2.40	1.19-4.84	0.014*	1.93	0.93-4.00	0.075
Circular stapler	0.52	0.34-0.78	0.002**	0.94	0.51-1.74	0.845
VATS	0.58	0.35-0.94	0.028*	0.79	0.42-1.47	0.451
Laparoscopic surgery	0.50	0.33-0.76	0.001**	0.95	0.49-1.84	0.874
Histology						
Squamous	Ref.					
Adenocarcinoma	1.31	0.40-4.34	0.657			

Logistic regression,
*$p < 0.05$,
**$p < 0.01$.
COPD = chronic obstructive pulmonary disease; OR = odds ratio; VATS = video-assisted thoracic surgery.

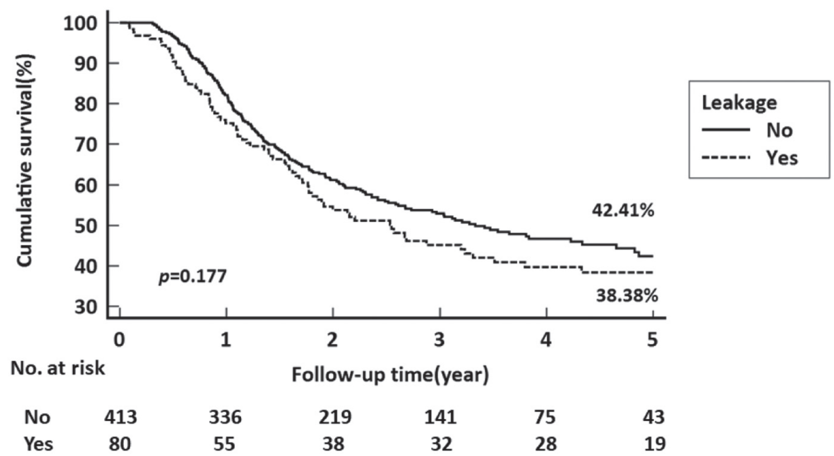

Fig. 4 Five-year survival in patient with or without anastomotic leakage.

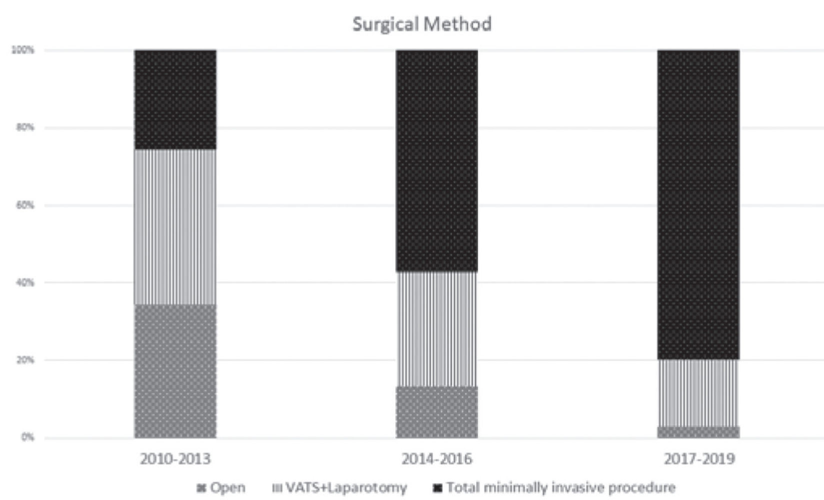

Fig. 5 Surgical methods by calendar year. VATS = video-assisted thoracic surgery.

circular stapler usage. These clinical factors may be correlated to one another. To minimize the difference between the two groups, we tried to calculate the propensity score with all the significant factors. Only 63 patients from each group were matched, and the sample size was small. As a result, we only chose some factors for PSM. A small sample size was one of the limitations, therefore, a bigger sample size was further needed. Moreover, it was difficult to design a standardized parameter and collect data. Nowadays, we also adopt new equipment with ICG scope for evaluation of the blood flow of gastric conduit since 2020. This method is convenient and able to recognize suitable places for anastomosis.[28,29] It can also provide an objective view of the perfusion of the gastric conduit.

In conclusion, an optimal approach to create a gastric conduit is considered to reduce the incidence of anastomotic leakage. In our study, the narrow gastric conduit method is not inferior to the wide gastric conduit method in anastomotic leakage. Therefore, further prospective research or randomized controlled trials about gastric conduit creation is needed.

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APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://links.lww.com/JCMA/A213 and http://links.lww.com/JCMA/A214.

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