End-to-end versus end-to-side esophagogastrostomy after esophageal resection: a prospective cohort study

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Background
Several medical and surgical complications arise from esophagectomy including cardiopulmonary complications and anastomotic leaks. Several techniques have been adapted to prevent these complications for better postoperative morbidity and mortality. However, there is no international standardized guideline for the diagnosis and management of anastomotic leaks.
Aim
We aim to compare end-to-end (ETE) anastomosis and end-to-side (ETS) anastomosis regarding postoperative complications mainly anastomotic leakage and stricture, operative time, and hospital stay.
Patients and methods
A prospective cohort for patients undergoing esophagectomy with either ETE anastomosis or ETS anastomosis from October 2018 to March 2020 and follow-up for 18 months.
Results
A total of 30 patients were included, 15 patients in each group. A significant anastomotic leakage (P=0.006) is detected in the ETS group compared with the ETE group. No significant difference (P=0.68) is detected between ETE and ETS anastomoses regarding postoperative morbidity and mortality. There was no significant difference between two types of anastomosis regarding operative time (ETE vs. ETS, 351.6 ± 2.68 vs. 331.6 ± 4.3, P=0.14). The average stay in hospital (days) shows no significant difference between both types of anastomosis. Postoperative stricture shows no significant difference between ETE and ETS anastomosis during 6, 12, and 18 months of follow-up. However, ETS anastomosis had a higher rate than ETE anastomosis of postoperative stricture at the first month due to postoperative edema.
Conclusion
Postoperative leakage and stricture are still the most dreaded complications of esophagectomy. Numerous techniques have been used to overcome these complications. Several randomized clinical trials are needed to study these techniques. In our study, ETE anastomosis had a lower leakage rate compared with ETS anastomosis.

Keywords:
esophagectomy, esophagogastric anastomosis, leakage, stricture

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Introduction

Several indications for esophagectomy exist, ranging from benign to malignant conditions. Almost all malignant esophageal neoplasms are treated surgically combined with neoadjuvant therapy, yet in benign conditions, esophagectomy is done when other measures of management fail. For example, primary treatment of postcorrosive strictures is dilatation. Regarding Achalasia, Heller myotomy with or without fundoplication is the gold standard in symptomatic achalasia. Esophagectomy for achalasia is done in the tortuous and massive esophagus (sigmoid esophagus) [1].

Several medical and surgical complications arise from esophagectomy. Cardiopulmonary complications and anastomotic leaks are acute postoperative complications leading to significant morbidity and mortality. On the other hand, stricture is a nonacute complication occurring a few months after surgery [2]. Several techniques have been adapted to prevent these complications for better postoperative morbidity and mortality rates [3]. Several

methods for anastomosis have been studied to decrease the incidence of anastomotic leaks including handsewn, stapled, shape of anastomosis (circular vs. triangulation), type of suture [end to end (ETE) vs. end to side (ETS)] [4–8]. Also robotic, laparoscopic, and open methods for esophagectomy have been studied [9]. However, according to an international survey done by Hagens *et al.* [10], there were no international standardized guidelines for the diagnosis and management of anastomotic leaks [10].

Few studies have compared ETE versus ETS anastomoses for esophagectomy. We aim to compare these two types of anastomoses regarding postoperative complications, mainly anastomotic leakage and stricture, operative time, and hospital stay.

Patients and methods

We conducted a prospective cohort study for patients undergoing esophagectomy with either ETE anastomosis or ETS anastomosis. We reviewed all medical records of the General Surgery Department at Ain Shams University Hospital from October 2018 to March 2020. This research was performed at the Department of General Surgery, Ain Shams University Hospitals. Ethical Committee approval and written, informed consent were obtained from all participants.

Inclusion criteria

(1) All patients above 18 years old.
(2) Patients who were indicated for esophagectomy (malignancy, postcorrosive stricture, and achalasia) with or without neoadjuvant therapy.

Exclusion criteria

Patients who had colonic or jejunal interposition.

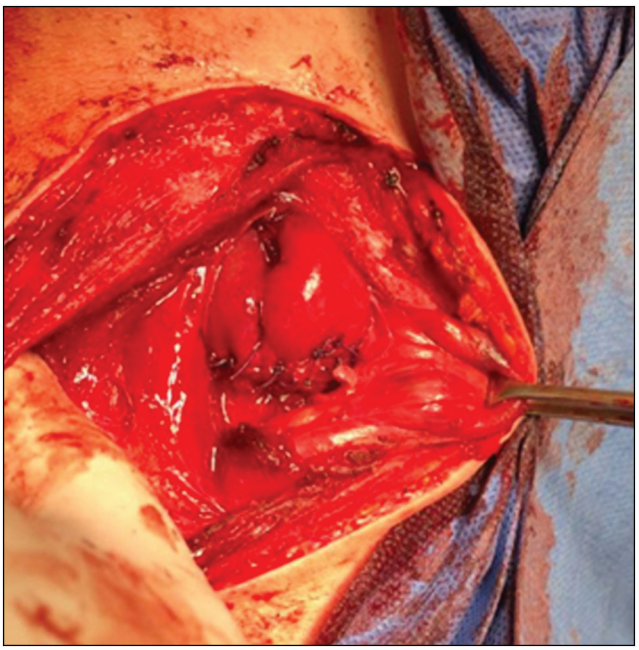
Patients who were followed up at 1, 6, 12, and 18 months later at clinics. Missing patients were called on their phones and asked to attend the next day for follow-up.

Surgical procedures

Esophagolymphadenectomy was performed through a transthoracic or transhiatal approach. The gastric tube was prepared with the linear staplers along the greater curvature with preservation of the right gastroepiploic artery. The upper end of the gastric tube was pulled up into the left side of the neck through the posterior mediastinum route.

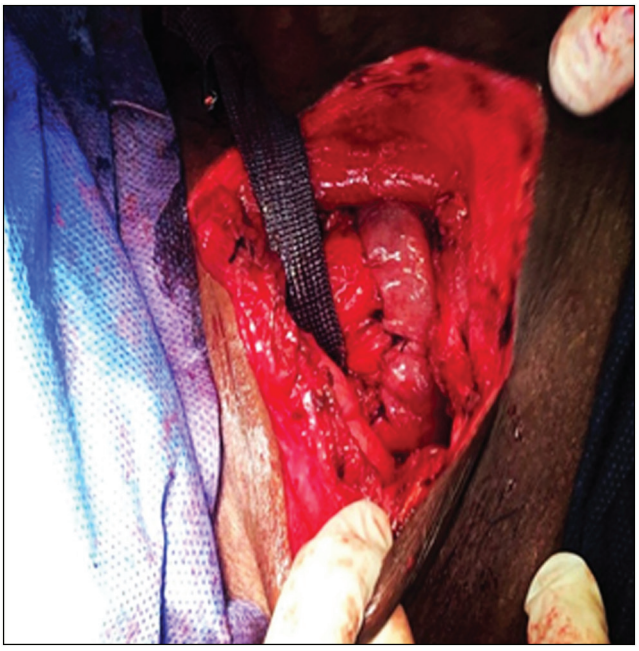
Generally, the gastric tube staple line was oversewn by hand. All esophagogas trostomies were created in the neck with a handsewn, single-layered technique (3-0 PDS). For the ETE anastomosis, the distal end of the cervical esophagus and the proximal end of the gastric conduit were connected in a straight line (Fig. 1). For the ETS anastomosis, the distal end of the cervical esophagus was positioned perpendicular to the side of the proximal gastric conduit (Fig. 2). Anastomoses were constructed by experienced surgeons. After construction of the ETS anastomosis, the tip of the gastric tube was removed with the use of a stapler (GIA, Covidien, Mansfield, Massachusetts, USA).

Figure 1



End-to-end esophagogastric anastomosis.

Figure 2



End-to-side esophagogastric anastomosis.

The pyloroplasty was applied after anastomosis and the feeding jejunostomy tube was implanted during the operation.

Results

Between October 2018 and March 2020, a total of 30 patients were included in our study, 15 patients in each group. Baseline characteristics of the patients are shown in Table 1. No significant difference is detected between both groups regarding baseline characteristics except diabetes mellitus, higher in ETS anastomosis group.

In Table 2, there was no significant difference between two types of anastomosis regarding operative time (ETE vs. ETS, 351.6 ± 2.68 vs. 331.6 ± 4.3, *P*=0.14).

The average stay in hospital (days) shows no significant difference between both types of anastomosis. Also, divided hospital stay, ward, and ICU shows no significant difference between ETE and ETS anastomosis, as shown in Table 3.

A comparison regarding postoperative stricture shows no significant difference between ETE and ETS anastomosis during 6, 12, and 18 months of follow-up. However, ETS anastomosis had higher rate than ETE anastomosis of postoperative stricture at the first month mostly due to postoperative edema (Table 4).

Table 5 shows the difference in postoperative complications (surgical and nonsurgical) between both types of anastomosis. A significant anastomotic leakage

Table 1 Baseline characteristics of included patients according to anastomosis type

	End to end	End to side	*P* value
Number of patients [*n* (%)]	15 (50)	15 (50)	NA
Age (mean±SD)	55.8 ± 9.4	59.8 ± 7.02	
Sex			0.71
Male	9	8	
Female	6	7	
Ischemic heart disease			1
Yes	3	3	
No	12	12	
DM			0.01
Yes	4	11	
No	11	4	
HTN			0.13
Yes	4	8	
No	11	7	
Cause of esophagectomy			0.68
Cancer	10	10	
Postcorrosive	3 (lower third)	2 (lower third)	
Achalasia	1	2	
Inflammatory leiomyomas	0	1	
Histological type			0.6
Adenocarcinoma	7	8	
Squamous cell carcinoma	3	2	
Site of cancer			0.32
Middle third	2	4	
Lower one-third	8	6	
Stage of cancer			0.84
Stage 1	2	3	
Stage 2	4	3	
Stage 3	4	4	
Neoadjuvant treatment			0.27
Yes	9	6	
No	6	9	
Surgical approach			0.43
Transthoracic	11	9	
Transhiatal	4	6	
Mortality			1
No	14	14	
Yes	1	1	

DM, diabetes mellitus; HTN, hypertension.

Table 2 Comparison between end-to-side anastomosis and end-to-end anastomosis regarding operative time

	End to end	End to side	*P* value
Operative time (mean±SD)	351.6±2.68	331.6±4.38	0.14

Table 3 Comparison between end-to-side anastomosis and end-to-end anastomosis regarding hospital stay including ICU and ward

	End to end	End to side	*P* value
Hospital stay (mean±SD)	10.8±1.80	11.53±1.95	0.36
ICU (mean±SD)	3±0.75	3.1±1.06	0.86
Ward (mean±SD)	7.8±1.5	8.4±1.2	0.36

Table 4 Comparison between end-to-side anastomosis and end-to-end anastomosis regarding stricture during 18 months of follow-up

Stricture	End to end	End to side	*P* value
1 month			0.028
Yes	4	10	
No	11	5	
6 months			0.23
Yes	3	6	
No	12	9	
12 months			0.62
Yes	2	3	
No	13	12	
18 months			0.14
Yes	0	2	
No	15	13	

Table 5 Comparison between end-to side-anastomosis and end-to-end anastomosis regarding postoperative complications

	End to end	End to side	*P* value
Surgical complications			0.68
No complication	9	8	
Chylothorax	1	1	
Wound infection	3	2	
Bleeding	2	2	
Leakage			0.006
Yes	0	6	
No	15	9	
Nonsurgical complication			0.70
No complication	11	9	
Pneumonia	2	3	
Mediastinitis	2	2	
MI	0	1	

(*P*=0.006) is detected in the ETS group compared with the ETE group. No significant difference (*P*=0.68) is detected between ETE and ETS anastomoses in other surgical and nonsurgical complications.

Discussion

The main goal of studying the several techniques is to reduce morbidity and mortality. In our study, we studied 30 patients undergoing esophagectomy with ETE or ETS cervical anastomosis. Our results showed no significant difference between both types of anastomosis regarding operative time, and hospital stay including ward and ICU. Surgical and medical complications, and stricture after 18 months of follow-up were indicated. ETS anastomosis was associated with significantly higher rates of postoperative leakage compared with ETE anastomosis. At 1 month of follow-up, ETS anastomosis had higher rates of anastomotic stricture, which were later managed by dilatation, compared with ETE anastomosis.

Mao and colleagues studied 252 patients with ETE or ETS anastomosis during minimally invasive esophagectomy. Their results showed no significant difference regarding anastomotic leakage, stricture, or other postoperative complications. Difference in leakage rate compared with our findings might be explained by higher diabetic patients in the ETS group compared with the ETE leading to ischemia in the anastomotic site, a crucial risk factor of anastomotic leakage. However, Mao *et al.* [11] reported that the ETS group had longer operative time and hospital stay compared with ETE anastomosis. We believe this difference might be due to different surgeons with different experience performing the surgery, in contrast to our study where only two trained surgeons were performing the operations, Haverkamp *et al.* [12] studied 390 patients with esophagectomy, 112 with ETE and 278 with ETS anastomosis. There was no significant difference between groups regarding leakage but a higher stricture rate in ETE anastomosis. Nederlof *et al.* [13] conducted an randomized clinical trial of 128 patients, 64 patients in each group (ETE vs. ETS). Stricture rates were higher in the ETE group compared with the ETS group after 1 year of follow-up, which might be due to differences between both groups in tumor histology. In contrast to our findings, the authors reported a higher leakage rate in the ETE group. No differences were detected in mortality.

Aoyama *et al.* [14] studied the risk factors contributing to postoperative anastomosis leak. The authors concluded that lymph node dissection status and preoperative serum albumins determined as risk factors contributing to postoperative anastomosis leak. Several studies have shown different techniques to prevent postoperative leak. Li *et al.* [15] proposed a pre-embedded cervical, circular, stapled anastomosis to reduce the risk of postoperative leak [16]. Nakata *et al.* [5] showed that ETS triangulating anastomosis reduced the leakage rate. On the other side, Sasaki *et al.* [17] compared the use of the greater curvature of the stomach versus lesser curvature in anastomosis. Their results showed a higher leakage rate in the greater curvature group, but stricture

was significantly higher in the lesser curvature group. Wang *et al.* [18] presented a novel technique by suturing the edge of both esophageal and stomach stump side to side and then embedding an esophageal portion into a tubular portion of the stomach. Their results showed less rate of leakage in the novel technique group compared with side-to-side anastomosis and ETS anastomosis. There were no significant differences between the three groups regarding anastomotic stricture. Our study was limited to its observational design. Leakage rate could be explained by the difference between two groups in diabetes mellitus.

Conclusion

Postoperative leakage and stricture are still the most dreaded complications of esophagectomy. Numerous techniques have been used to overcome these complications. Several randomized clinical trials are needed to study these techniques. In our study, ETE anastomosis had a lower leakage rate compared with ETS anastomosis.

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Nil.

Conflicts of interest

There is nothing to declare.

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