



## Original Article

# The influence of side-to-side stapled esophagogastric anastomosis on the postoperative anastomotic complications among patients undergoing esophagectomy

Ahmed Daoud, Moustafa Elhamami, Walid Abu Arab

Department of Cardiothoracic Surgery, Faculty of Medicine, Alexandria University, Alexandria, Egypt

### Abstract

**Background:** Esophageal cancer is among the most challenging tumors facing thoracic surgeons that entails a highly complex surgical procedure carrying a very high rate of morbidity and mortality. Esophagectomy procedure could be completed using several techniques depending on many factors like tumor location and surgeon preference. There are different techniques for anastomosis construction either stapled or hand sewn and there is a big debate about the ideal method for anastomosis regarding the technique and the location of construction. Our study aimed to clarify the feasibility of performing a side-to-side stapled cervical esophagogastric anastomosis and to study its effect on the short-term outcomes after surgery.

**Methods:** We have conducted a prospective study for 29 consecutive patients diagnosed with esophageal carcinoma and who received esophagectomy as a curative treatment starting from January 2020 to January 2024. The study was held in Alexandria Main University Hospital.

**Results:** The mean age for our study group was 63.34 years  $\pm$  5.31 years and females represented about 34.5%. Regarding tumor location, 13 patients (44.8%) had lower third esophageal tumor, 9 patients (31%) had middle third neoplasm, and 7 patients (24.1%) had gastroesophageal junction tumor. Regarding the anastomotic technique used, circular stapled anastomosis was done in 21 patients (72.41%). Hand sewn cervical anastomosis was used in 5 patients (17.24%) and side to side stapled cervical anastomosis was used in 3 patients (10.34%). Correlation between type of anastomosis and occurrence of leakage and dysphagia showed that anastomotic leakage has occurred in one patient with circular stapled anastomosis and in 2 patients with hand sewn anastomosis, while the side-to-side stapled anastomosis was not associated with any cases of leakage. Regarding the dysphagia resulting from anastomotic stricture, the side-to-side stapled anastomosis was not associated with dysphagia on the follow up period, while dysphagia has occurred in one patient with circular stapled anastomosis and another patient with handsewn anastomosis.

**Conclusion:** Side to side stapled esophagogastric anastomosis is a feasible technique and it could be associated with reduced incidence of early postoperative anastomotic leakage as well as reduced rates of late postoperative anastomotic stricture and dysphagia.

### KEYWORDS

Esophagectomy;  
Anastomosis;  
Side-to-side;  
Esophagogastric;  
Stapled

### Article History

Submitted: 5 Nov 2024  
Revised 1: 19 Nov 2024  
Revised 2: 13 Dec 2024  
Accepted: 17 Dec 2024  
Published: 1 July 2025



## Introduction

Esophageal cancer remains one of the most challenging tumors facing thoracic surgeons as it entails a highly complex surgical procedure which carry a very high rate of morbidity and mortality [1].

Esophagectomy procedure could be completed using several techniques depending on many factors like tumor location and surgeon preference [1].

Ivor-Lewis [2] esophagectomy is still one of the most commonly used surgical procedures with a laparotomy and right thoracotomy incisions and an intrathoracic anastomosis.

Transhiatal esophagectomy is another technique which gained popularity as it avoids thoracic incision and consequently has much decreased the postoperative pulmonary complications like pneumonia, atelectasis and pleural effusion [3,4].

Another popular technique is the three-field or Mc Keown [5] esophagectomy which is suitable for higher thoracic tumors to allow more extensive lymphadenectomy and construction of cervical anastomosis with adequate oncological margins [5].

In the recent years, with the advancement of endoscopic instruments and technology, minimally invasive esophagectomy is markedly replacing the traditional open techniques.

Minimally invasive esophagectomy has markedly reduced the morbidity related to the big thoracic and abdominal incisions. In addition, it has a lower rate of pulmonary complications, operative blood loss and has much reduced the postoperative hospital stay [6-9].

Anastomotic leakage is one of the most devastating complications after esophagectomy and this is the reason why anastomosis construction is the most crucial part of the procedure.

There are different techniques for anastomosis construction either stapled or hand sewn and there is a big debate about the ideal method for anastomosis regarding the technique and the location of construction [10].

Cervical esophagogastric anastomosis is used when performing three field esophagectomy or transhiatal esophagectomy and mostly the left side of the neck is the site of the anastomosis due to the normal esophageal curvature to the left side of the neck [10-12].

On the other hand, when performing Ivor Lewis esophagectomy and left thoracic or thoraco-abdominal approaches, the anastomosis is constructed in the intrathoracic region.

While the intrathoracic anastomosis has the advantage of less leakage incidence than the cervical anastomosis, the morbidity resulting from intrathoracic anastomotic leakage is much more serious, life threatening and have the risk of devastating complications like mediastinitis [10,13].

Although the leakage from cervical anastomosis can be mostly managed conservatively without a risk of serious complications like mediastinitis, the long term sequelae could be devastating as a great portion of cervical anastomosis leakage can lead to subsequent stricture formation and necessitates the need for future endoscopic dilatation [13].

Esophagogastric anastomosis could be accomplished using several techniques. Hand-sewn technique is usually preferred when the location of the anastomosis is in the cervical region and could be done either in a continuous manner or interrupted sutures.

On the other hand, mechanical anastomosis or anastomosis using staplers has been a growing technique that has developed in the recent decades after the great improvement in surgical instruments and staplers' technology [10-15].

Circular esophagogastric end to side anastomosis using the circular type of stapler is usually used during the intrathoracic anastomosis either in the Ivor Lewis esophagectomy or left thoracoabdominal approach as it offers a safe and fast way to construct the intrathoracic anastomosis [14,15].

Side to side stapled esophagogastric anastomosis is another modality of mechanical anastomosis types and it could be completely stapled or semi-mechanical type if a part of the anastomosis is completed with hand sewn sutures [14].

This technique was first described by Collard [11] in 1998, then it was modified by Orringer [10] several years later and both of them reported the advantage of this technique over other anastomotic technique regarding the reduction of anastomotic complications.

Side to side technique can be either done in the cervical region or thoracic part as it provides a fast, easy and safe technique for anastomosis construction.

One of the main advantages of this technique is that it could be done easily during minimally invasive Ivor Lewis esophagectomy, and the intrathoracic anastomosis could be constructed easily during the thoracoscopic procedure which was a very difficult task when using the circular staplers which usually necessitates performing a thoracotomy incision.

In addition, using the cervical side to side stapled esophagogastric anastomosis was found to reduce the frequency of anastomotic leakage and later anastomotic stricture in comparison with other anastomotic techniques [17-19].

Our study aimed to clarify the feasibility of performing a side-to-side stapled cervical esophagogastric anastomosis and to study its effect on the short-term outcomes after surgery.

## Patients and Methods

### Design and patients

We have conducted a prospective study for 29 consecutive patients diagnosed with esophageal carcinoma and who received esophagectomy as a curative treatment starting from January 2020 to January 2024. The study was held in Cardiothoracic Surgery Department, Alexandria Main University Hospital.

The postoperative short term as well as long term outcomes were evaluated for the 29 patients including postoperative ICU stay, postoperative anastomotic leakage, presence of major postoperative complications, postoperative hospital stay and the presence of dysphagia on follow up after discharge from hospital.

Patients who have received side to side stapled cervical anastomosis were compared with patients who have received circular stapled thoracic anastomosis and hand-sewn cervical anastomosis regarding the previous outcomes.

### Inclusion criteria

All patients diagnosed with esophageal cancer or cancer of the esophagogastric junction either in an early stage or locally advanced stage after receiving neoadjuvant therapy.

### Exclusion criteria

Severely debilitated or high surgical risk patients with comorbidities who cannot tolerate surgery as well as patients with poor tumor response after neoadjuvant therapy were excluded.

After explaining the details and potential drawbacks of the surgical intervention, all cases provided informed written consent. The study was also approved by the Institutional Review Board and the Ethics Committee. All patients signed written consent for the publication of medical data without revealing their identities.

### Preoperative workup

All patients enrolled in our study were subjected to careful clinical evaluation and laboratory investigations including complete blood count, renal and liver function tests as well as imaging techniques to evaluate the tumor stage including endoscopy for upper gastrointestinal

tract, endoscopic ultrasound, and CT scan of the chest and abdomen.

### Operative techniques

#### 1. The open esophagectomy procedures:

In our study, we have used 3 methods for open esophagectomy procedure, Ivor Lewis [2] esophagectomy, three-incision esophagectomy (Mc Keown esophagectomy) [5] and left thoracotomy approach (sweet approach) [16]

#### A. Three incisions (Mc Keown) [5] esophagectomy:

Thoracic part: Right thoracotomy is performed with the patient in the left lateral decubitus position and the right lung is isolated using single left lung ventilation. Esophagus is mobilized from above downwards beginning with dissection of the posterior esophageal surface, then the anterior surface.

Cervical part: the cervical esophagus is mobilized using a longitudinal left cervical incision along the medial border of the sternomastoid muscle with the patient in the supine position.

Abdominal part: Upper midline laparotomy is performed. Division of the short gastric vessels and mobilization of the greater omentum along the greater curvature of the stomach preserving the right gastroepiploic arcade. The opening of the phreno-esophageal membrane and circumferential dissection of the distal esophagus is done.

The gastric tube is delivered to the cervical region by pulling up the silk thread carefully taking care to avoid rotation of the gastric conduit.

#### B. Left thoracic approach (Sweet procedure) [16]:

The patient is placed in the right lateral decubitus position after insertion of a double-lumen endotracheal tube for left lung isolation. A left posterolateral thoracotomy incision is made in the 6th intercostal space. Blunt and sharp dissection of the esophagus is made using an electrocautery knife and energy sealing device to separate the esophagus from the descending aorta.

A 5-6 cm radial incision in the diaphragm is made and the abdominal cavity is entered. The stomach is mobilized through the left thoracic cavity preserving the right gastroepiploic arcade. The left gastric vessels are divided using linear staplers or ligated by double clipping and cut at their base.

The preparation of the gastric tube in the left thoracic cavity is established through the left diaphragmatic incision.

#### C. Ivor Lewis [2] esophagectomy approach:

Abdominal phase: With the patient in supine position and a double lumen endotracheal tube inserted an upper midline laparotomy is performed.

Mobilization of the stomach is performed using energy sealing device in the same manner as McKeown esophagectomy dividing the greater omentum, short gastric vessels and lesser omentum.

Left gastric artery is ligated and divided or stapled using vascular stapler. Distal esophagus is circumferentially dissected, and the diaphragmatic hiatus is completely dissected all around the esophagus.

Thoracic phase: Patient position is modified to left lateral decubitus position and right posterolateral thoracotomy is performed with the right lung completely isolated and collapsed.

Azygous vein is ligated and divided, and the thoracic esophagus is mobilized posteriorly in relation to the descending aorta then anteriorly from the pericardium and lung.

Nylon tape is inserted to encircle the esophagus to make the dissection easier. The lowermost part of the esophagus is mobilized, and the esophagus is dissected from the diaphragm then pulling on the esophagus to deliver the stomach in the right chest.

Linear cutter GIA stapler is used to fashion the stomach as a gastric tube and the proximal

esophagus is divided using scissors and the tumor specimen is excise.

## 2. The minimally invasive esophagectomy procedure (MIE):

The thoracic part: four ports right Video assisted thoracoscopy was done with the patient in the left lateral decubitus position.

The thoracic esophagus is completely mobilized from above downwards till the diaphragmatic hiatus using diathermy hook and energy sealing device. The azygous vein is ligated and cut using clips or vascular stapler.

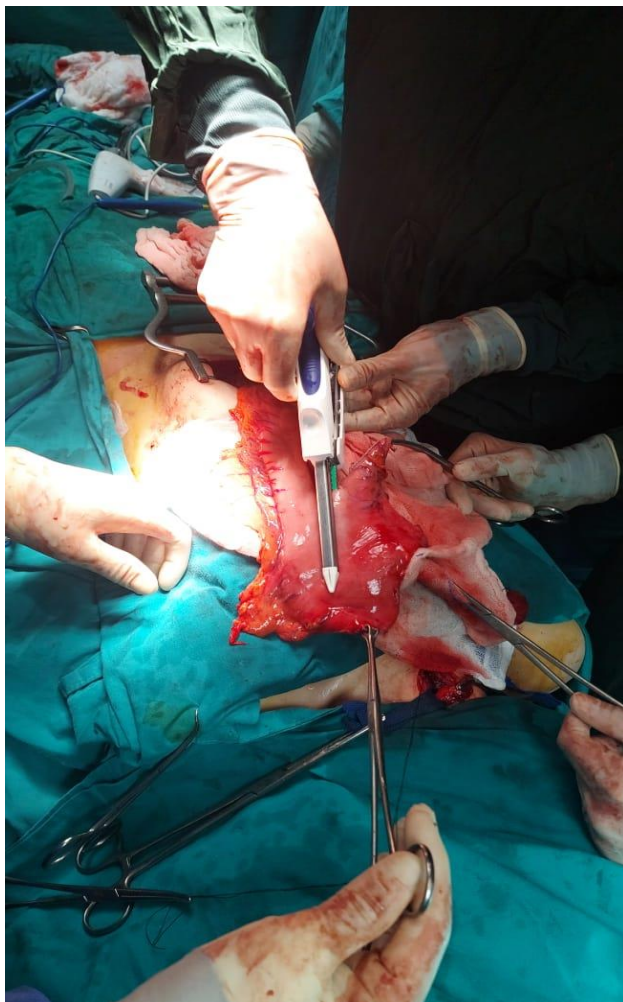


Figure 1: Gastric tube construction using linear cutter stapler

Cervical esophagus dissection and exposure: Patient is turned to supine position and cervical esophagus is dissected via left cervical longitudinal incision. After dissection, the cervical esophagus is cut using diathermy knife, the proximal end is grasped with a clamp and distal end is tied with a silk suture.

The laparoscopic part: Five port laparoscopy is used to mobilize the stomach using an energy sealing device with preservation of the right gastroepiploic arcade.

Gastric tube construction: midline laparotomy 3cm in length is made in the place of the 10 mm trocar and 4 cm wide gastric tube is made using linear cutter stapler. The proximal cardiac end of the stomach as well as the esophagus containing the tumor is removed through the laparotomy. Two layers of continuous vicryl 3/0 sutures was taken to reinforce the stapler line. (Figure 1)

## 3. Hybrid esophagectomy procedure:

In our study group we performed hybrid Mc Keown [5] procedure or three- stage esophagectomy. The thoracic phase of the procedure is done using thoracoscopy in the same manner as the minimally invasive technique.

Midline laparotomy incision was used for stomach mobilization and gastric tube formation after exposing the cervical esophagus and cutting it via left cervical incision.

## Anastomosis techniques:

Three types of anastomoses were used in our study as follows:

### 1. Circular stapled anastomosis:

Circular anastomosis was used during construction of an intrathoracic anastomosis either in the right chest during the Ivor Lewis [2] procedure or in the left chest during the sweet procedure.

Size 25 or 28 circular stapler was used according to the size of the esophagus. The detachable anvil is inserted in the cut end of the proximal esophagus and two purse string sutures are placed to secure the anvil to the esophageal end. The circular stapler is introduced through 2cm gastrotomy which is made in the gastric tube near the greater curve. The stapler is fired and an end to side circular stapled anastomosis is constructed.

### 2. Hand sewn anastomosis:



This type of anastomosis was used when constructing cervical anastomosis. Three-layer hand sewn anastomosis was constructed between the proximal esophageal end and the gastric tube. The end to side technique utilized 3/0 vicryl sutures to construct the three-layer hand sewn anastomosis to approximate the outer and inner seromuscular layer of the stomach and the esophagus in an interrupted fashion. The mucosa was sutured in a continuous fashion using vicryl 3/0 suture.



Figure 2: Introducing Endo-GIA stapler to construct cervical side to side stapled anastomosis

### 3. Side to side stapled esophagogastric anastomosis:

Side to side semi-mechanical stapled anastomosis was used when constructing a cervical anastomosis in the same way as described by Orringer [10] or modified Collard technique [11].

A linear endo-GIA stapler 30mm or 45mm was used to create this type of anastomosis. Orringer [10] technique was used to construct the anastomosis via introducing the blades of the linear stapler through the proximal esophageal end and a 1.5 cm gastrotomy made in the anterior

wall of the gastric tube. After firing the linear stapler, the posterior esophageal wall is stapled to the gastric tube creating the posterior stapled part of the anastomosis.

The remaining anterior wall of the anastomosis is completed using interrupted silk 3/0 sutures. (Figure 2)

### Post-operative care

The principles of treatment in the perioperative period were nearly identical for both groups. The patients were routinely transferred to the ICU after recovery from anesthesia. Discharge from ICU after 24 hours was routinely done after stabilization of the patient hemodynamics and respiratory status. If the patient experienced respiratory or cardiovascular complications, ICU stay could be prolonged as required.

All the patients in our study group stayed off oral for at least 5 days until contrast radiological study was done to confirm absence of leakage.

Oral feeding is started at day 5 postoperative starting with fluids and semisolid food. The patient could be discharged from hospital after confirming that the patient can tolerate oral feeding without difficulty and can actively move around in the ward without problems.



Figure 3: Day five postoperative Barium swallow after Ivor Lewis esophagectomy

### Post-operative follow-up:

All of our study group were followed up at one month and three-month period after discharge from hospital and were asked about the presence of difficulty of swallowing.

Oral contrast radiological study is ordered for the patient only if complaining from dysphagia. (Figure 3, 4)



Figure 4: Postoperative Barium swallow after hybrid Mc Kewoen esophagectomy with side to side stapled cervical anastomosis

### Statistical analysis

The study sample size was limited to the number of all cases who were operated in our hospital throughout the study duration due to rarity of cases. The data were tabulated and analyzed using IBM SPSS software version 24.0 (IBM Inc., Chicago, IL, USA). Qualitative data were described using the number and percent. Continuous quantitative variables were assessed for normality using the One-Sample Kolmogorov-Smirnov Test; normally distributed variables were reported as mean and standard deviation (SD). The non-parametric Kruskal-Wallis H test was used to compare the events in different techniques. Confidence intervals (95%CI) were calculated.

## Results

### Patient Characteristics and preoperative data:

The mean age for our study group was 63.34 years  $\pm$  5.31 years. Regarding sex, our patients included 10 females representing about 34.5% and 19 males. Comorbidities were found in 14 patients; 8 patients had hypertension (27.6%), 4 patients were only diabetics (13.8%) and 2

patients (6.9%) were diabetic and hypertensive. (Table 1). Regarding tumor location, 13 patients (44.8%) had lower third esophageal tumor, 9 patients (31%) had middle third neoplasm, and 7 patients (24.1%) had gastroesophageal junction tumor.

Regarding preoperative histopathology, adenocarcinoma was found in 19 patients (65.5%), while 10 patients (34.5%) were diagnosed pathologically with squamous cell carcinoma. Early-stage tumors were found in 3 patients (10.3%) T1b N0M0, while the rest of the patients were having locally advanced stages. T2N0M0 stage and T3N0M0 stage were found in 14 patients (48.3%) and 12 patients (41.4%) respectively. Regarding the preoperative neoadjuvant therapy, 17 patients (58.6%) have received preoperative chemotherapy. (Table 1)

Table 1: Preoperative and demographic characteristics for the study group

Variable	Patients (n=29)
<b>Demographics</b>	
Age at surgery (years)	
Mean $\pm$ SD	63.34 $\pm$ 5.31
Range	54-71
Male/ Female, n	19/ 10
Female gender, n (%)	10 (34.5)
<b>Comorbidities</b>	
Hypertension, n (%)	8 (27.6)
Diabetes, n (%)	4 (13.8)
Hypertension and diabetes, n (%)	2 (6.9)
<b>Site of the tumor</b>	
Middle Third	9 (31)
Lower third	13 (44.8)
Junction	7 (24.1)
<b>Pathology</b>	
Adenocarcinoma	19 (65.5)
Squamous cell carcinoma	10 (34.5)
<b>Clinical Stage</b>	
T1bN0M0	3 (10.3)
T2N0M0	14 (48.3)
T3N0M0	12 (41.4)
<b>Neo-adjuvant treatment</b>	
Yes	17 (58.6)
No	12 (41.4)

### Operative data:

Regarding the surgical approach, 19 patients (65.5%) have received Ivor Lewis esophagectomy,

5 (17.2%) patients received Mc Keown esophagectomy. Minimally invasive esophagectomy was performed in 2 patients (6.9%), while sweet procedure and hybrid Mc Keown esophagectomy was performed in 2 patients (6.9%) and 1 patient (3.4%) respectively.

Regarding the anastomotic technique used, circular stapled anastomosis was done in 21 patients (72.41%). Hand sewn cervical anastomosis was used in 5 patients (17.24%) and side to side stapled cervical anastomosis was used in 3 patients (10.34%) (Table 2).

Table 2: Operative data for all patients in our study group

Operative data	Patients (n=29)
<b>Surgical procedure</b>	<b>n (%)</b>
Hybrid Mc Keown	1 (3.4)
Ivor Lewis	19 (65.5)
Mc Keown	5 (17.2)
MIE Mc Keown	2 (6.9)
Sweet	2 (6.9)
<b>Anastomosis</b>	
Circular	21 (72.41)
Hand Sewn	5 (17.24)
Linear	3 (10.34)
<b>Total</b>	<b>29 (100)</b>

### Postoperative course, complications and post operative follow up:

The mean postoperative ICU stay for our study group was 1.93 days  $\pm$ 0.753 days, while the mean postoperative hospital stay for our study group was 9.69 days  $\pm$ 2.965 days. There were no major postoperative complications in 23 patients (79.3%), while pneumonia and pleural effusion had occurred in 3 patients (10.34%) and 1 (3.45%) respectively. (Table 3)

Only one of our patients had experienced postoperative arrhythmia in the form of atrial fibrillation. In addition, chylothorax occurred in 1 patient (3.45%).

Postoperative anastomotic leakage occurred in 3 patients (10.3%). Dysphagia resulting from anastomotic stricture was found on the follow up in 2 patients (6.9%). (Table 3)

Correlation between type of anastomosis and occurrence of leakage and dysphagia showed that anastomotic leakage has occurred in one patient with circular stapled anastomosis and in 2 patients with hand sewn anastomosis, while the side-to-side stapled anastomosis was not associated with any cases of leakage (Figure 5).

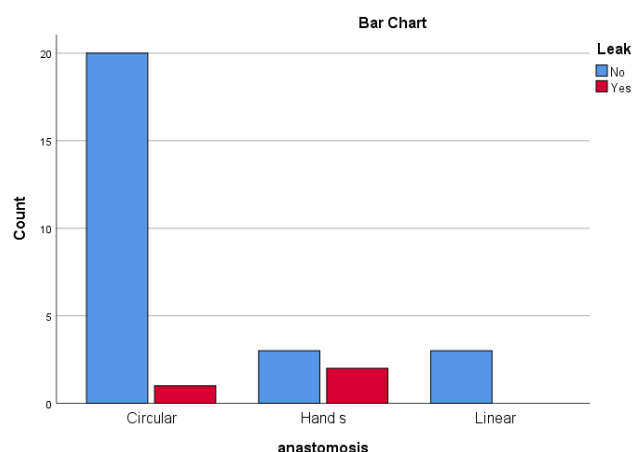


Figure 5: Bar chart showing correlation between type of anastomosis and leakage

Regarding the dysphagia resulting from anastomotic stricture, the side-to-side stapled anastomosis was not associated with dysphagia on the follow up period, while dysphagia has occurred in one patient with circular stapled anastomosis and another patient with handsewn anastomosis. (Table 3)

### Discussion

Esophagectomy procedure remains a highly complex procedure which could have significant morbidity on the patients like pulmonary complications and anastomotic leakage.

Anastomotic complications either early in the form of leakage or late complications like stricture are not uncommon after the procedure and that is why anastomosis construction is considered the most important part in the esophageal resection procedure [1-5].

One of the main limitations in our study was the small sample size as the number of esophageal cancer patients presented to our department is extremely few. In addition, most of the cases were lower esophageal tumors which usually affect the



Table 3: post-operative data and complications in all patients

Postoperative data	Patients (n=29)	p
<b>ICU stay (days)</b>		
Mean $\pm$ SD	1.93 $\pm$ .753	
Range	1-3	
<b>Postoperative stay (days)</b>		
Mean $\pm$ SD	9.69 $\pm$ 2.965	
Range	7-17	
<b>Major complications</b>	<b>n (%)</b>	
None	23 (79.3)	
Arrhythmia	1 (3.45)	
Chylothorax	1 (3.45)	
Pleural effusion	1 (3.45)	
Pneumonia	3 (10.34)	
<b>Anastomotic leak</b>	<b>3 (10.3)</b>	
Circular	1/21 (4.76)	<b>P= 0.05*</b> <b>Kruskal-Wallis H= 5.59</b> <b>df= 2</b> <b>95%CI [0.084-0.095]</b>
Hand Sewn	2/5 (40)	
Linear	0/3 (0)	
<b>Dysphagia on F/U</b>	<b>2 (6.9)</b>	
Circular	1/21 (4.76)	<b>P=0.43</b> <b>Kruskal-Wallis H= 1.65</b> <b>df= 2</b> <b>95%CI [-5.6-0.59]</b>
Hand Sewn	1 (20)	
Linear	0/3	

surgeon's preference to construct an intrathoracic anastomosis using the circular stapler.

We preferred to construct a cervical side to side stapled anastomosis in our first few cases as cervical leakage could have less morbidity and could be easily managed in contrast to the thoracic anastomotic leakage and we believe that other studies should be conducted with bigger sample size and including the thoracic side to side anastomosis to get more reliable results.

Orringer [10] et al. have conducted a study to determine the effect of constructing a side-to-side linear stapled esophagogastric anastomosis after transhiatal esophagectomy on postoperative anastomotic leakage and they concluded that side to side stapled cervical anastomosis has greatly reduced the frequency of anastomotic leakage and later anastomotic stricture. Their results showed that among 111 patients who received transhiatal esophagectomy with side-to-side stapled anastomosis, only 3 patients experienced clinically significant leakage (2.7%), while in the

other group of patients who received transhiatal esophagectomy with manual hand sewn anastomosis, the percentage of leakage among 1000 patients was 10-15%.

Collard [11] et al. have conducted a study to compare between the cross-sectional area of the side-to-side stapled semi-mechanical anastomosis two months after esophagectomy using barium swallow versus hand sewn end to side esophagogastric anastomosis. Their results showed that the cross-sectional area was  $225 \pm 15.7$  mm<sup>2</sup> for side to side semi mechanical technique versus  $136 \pm 15$  mm<sup>2</sup> for the manual hand sewn anastomosis (p=0.0001).

In addition, Fabbri [13] et al. have concluded in their study about the totally minimally invasive Ivor Lewis esophagectomy with side-to-side stapled anastomosis that the anastomotic technique was safe and feasible and associated with reduced rates of leakage and later stricture formation.

Their results showed that the incidence of anastomotic leakage was 5.6% and in-hospital mortality rate was 2.8% [13].

Side to side esophagogastric stapled anastomosis could be also safely performed in thoracic cavity with the advantage of being easier to perform using thoracoscopy.

Aslan [15] et al. has described his technique of uniportal VATS for Ivor Lewis [2] esophagectomy in which he described his technique of construction of intrathoracic side to side completely stapled anastomosis [15].

On the other hand, Ercan [17] et al. have conducted a study to compare the outcome of patients who had received hand sewn cervical anastomosis and who received side to side stapled cervical anastomosis during esophagectomy procedure.

They have reported a statistically significant difference regarding freedom from cervical wound infection (92% versus 71%,  $p=0.001$ ), freedom from anastomotic cervical leakage (96% versus 89%,  $p=0.09$ ) and absence of esophageal stricture or need for dilatation (34% versus 10%,  $p<0.0001$ ) for side-to-side stapled cervical anastomosis versus hand sewn cervical anastomosis respectively [17].

Sugimura [18] and his working group have also conducted study to compare between hand sewn cervical anastomosis technique and side to side stapled cervical esophagogastric technique and they concluded that the side-to-side stapled anastomosis was superior to hand sewn one in terms of reduction of postoperative anastomotic stricture. Their results showed that the rate of anastomotic stricture was significantly reduced among patients who received side to side stapled anastomosis than among patients with hand sewn anastomosis technique (13% versus 59%,  $p<0.001$ ) [18].

Takeoka [19] and his working group have conducted another study which compared modified collard technique of anastomosis versus circular stapled cervical anastomosis in the

prevention of post operative anastomotic stenosis. [19] Their results showed that the incidence of postoperative leakage and subsequent stenosis was significantly reduced for the modified collard technique versus circular stapled anastomosis (3% versus 10.5%,  $p=0.0014$  and 11.1% versus 34.3%,  $p<0.001$  respectively) [19].

Side to side stapled esophagogastric anastomosis, either completely stapled or semi-mechanical is a feasible, easy and safe method of anastomosis for esophagectomy patients. It could be constructed either in the cervical region or intrathoracic location. In addition to being associated with reduced rates of cervical anastomotic leakage and stricture, it could be easily constructed during minimally invasive esophagectomy with intrathoracic anastomosis better than circular stapled one which is more difficult to construct using thoracoscopy [17-19].

Side to side stapled anastomosis could be more popularized as it is easy, convenient and safe method reducing many postoperative complications for esophagectomy patients.

### Limitations

The main limitation to our study was the small number of patients presenting to our center throughout the study period as well as the small number of patients who require the cervical anastomosis location as many factors could affect the decision like, tumor location and surgeon preference.

The small number of adverse events makes the subgroup analysis liable to a higher likelihood of Type II statistical errors leading to low statistical power. Fifty nine percent of the patients received neoadjuvant treatment and the clinical stage did not show statistical significance compared to the complications probably due to the low sample size and small number of events.

### Conclusion

Side to side stapled esophagogastric anastomosis is a feasible technique and it could be associated with reduced incidence of early postoperative anastomotic leakage as well as

reduced rates of late postoperative anastomotic stricture and dysphagia

**Funding:** Self-funded

**Conflict of interest:** Authors declare no conflict of interest.

## References

1. Carr RA, Molena D. [Minimally invasive esophagectomy: anastomotic techniques](#). *Annals of Esophagus*. 2021; 25;4.
2. LEWIS I. [The surgical treatment of carcinoma of the oesophagus; with special reference to a new operation for growths of the middle third](#). *Br J Surg*. 1946; 34: 18-31.
3. Orringer MB, Marshall B, Stirling MC. [Transhiatal esophagectomy for benign and malignant disease](#). *The Journal of Thoracic and Cardiovascular Surgery*. 1993; 105(2):265-77.
4. Orringer MB, Marshall B, Iannettoni MD. [Transhiatal esophagectomy: clinical experience and refinements](#). *Annals of surgery*. 1999; 230(3): 392.
5. Mckeown KC. [Total three-stage esophagectomy for cancer of the esophagus](#). *Br J Surg* 1976; 63: 259-62.
6. Luketich JD, Pennathur A, Franchetti Y, et al. [Minimally invasive esophagectomy: results of a prospective phase II multicenter trial—the Eastern Cooperative Oncology Group \(E2202\) study](#). *Annals of surgery*. 2015;261(4):702-7.
7. Daoud A, Elhamami M, Keshk S, Agha MM, Li Y. [Comparative study between minimally invasive and open esophagectomy for the treatment of esophageal cancer](#). *The Egyptian Cardiothoracic Surgeon*. 2023 Jul;5(4):64-73.
8. Meng F, Li Y, Ma H, Yan M, Zhang R. [Comparison of outcomes of open and minimally invasive esophagectomy in 183 patients with cancer](#). *Journal of thoracic disease*. 2014;6(9):1218.
9. Rodham P, Batty JA, McElnay PJ, Immanuel A. [Does minimally invasive oesophagectomy provide a benefit in hospital length of stay when compared with open oesophagectomy?](#) *Interactive Cardiovascular and Thoracic Surgery*. 2016;22(3):360-7.
10. Orringer MB, Marshall B, Iannettoni MD. [Eliminating the cervical esophagogastric anastomotic leak with a side-to-side stapled anastomosis](#). *The Journal of thoracic and cardiovascular surgery*. 2000;119(2):277-88.
11. Collard JM, Romagnoli R, Goncette L, Otte JB, Kestens PJ. [Terminalized semimechanical side-to-side suture technique for cervical esophagogastronomy](#). *The Annals of thoracic surgery*. 1998;65(3):814-7.
12. Behzadi A, Nichols FC, Cassivi SD, Deschamps C, Allen MS, Pairolero PC. [Esophagogastrrectomy: the influence of stapled versus hand-sewn anastomosis on outcome](#). *Journal of gastrointestinal surgery*. 2005; 9:1031-42.
13. Fabbi M, De Pascale S, Ascari F, Petz WL, Fumagalli Romario U. [Side-to-side esophagogastric anastomosis for minimally invasive Ivor-Lewis esophagectomy: operative technique and short-term outcomes](#). *Updates in surgery*. 2021;73(5):1837-47.
14. Li Y, Daoud A, Chen X, Qin J, Wang Z, Li J. [Non-fasting, tubeless, minimally invasive esophagectomy: A simplified procedure](#). *Multimedia manual of cardiothoracic surgery: MMCTS*. 2019;2019.
15. Aslan S, Batirel H. [Uniportal video-assisted thoracoscopic surgery Ivor Lewis esophagectomy: surgical technique](#). *Video-Assisted Thoracic Surgery*. 2023; 30;8.
16. Churchill ED, Sweet RH. [Transthoracic resection of tumors of the esophagus and stomach](#). *Annals of surgery*. 1942;115(6):897.
17. Ercan S, Rice TW, Murthy SC, Rybicki LA, Blackstone EH. [Does esophagogastric anastomotic technique influence the outcome of patients with esophageal cancer?](#) *The Journal of thoracic and cardiovascular surgery*. 2005;129(3):623-31.
18. Sugimura K, Miyata H, Matsunaga T, et al. [Comparison of the modified Collard and hand-sewn anastomosis for cervical esophagogastric anastomosis after esophagectomy in esophageal cancer patients: A propensity score-matched analysis](#). *Annals of gastroenterological surgery*. 2019;3(1):104-13.
19. Takeoka T, Miyata H, Sugimura K, et al. [Modified Collard technique is more effective than circular stapled for cervical esophagogastric anastomosis in prevention of anastomotic stricture: a propensity score-matched study](#). *Diseases of the Esophagus*. 2023;36(5):doac077.