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HOW I DO IT

Technique of Minimally Invasive Ivor Lewis Esophagogastrectomy with Intrathoracic Stapled Side-to-Side Anastomosis

Kfir Ben-David · George A. Sarosi · Juan C. Cendan · Steven N. Hochwald

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Abstract
Objective An intrathoracic linear stapled side-to-side anastomosis for gastroesophageal junction malignancy is feasible, results in low leak rates and less stenosis.
Design Retrospective case series.
Setting University tertiary care center.
Patients Between March 2008 and January 2009, six patients with gastroesophageal junction malignancy undergoing minimally invasive esophagectomy with an intrathoracic linear stapled side-to-side anastomosis were identified and their clinicopathological data analyzed.
Main Outcome Measures Technique of a 6-cm side-to-side stapled intrathoracic esophagogastric anastomosis.
Results Six patients underwent a minimally invasive esophagectomy with a side-to-side stapled intrathoracic esophagogastric anastomosis. Median age was 61.5 years. All patients had gastroesophageal junction adenocarcinoma and completed neoadjuvant chemoradiation therapy. The median operative time was 360 min. No patient received a blood transfusion. The 30-day mortality was 0. The median length of hospital stay was 8 days. The median number of nodes harvested was 18. At a median follow-up of 9 months, all patients were alive. There have been no anastomotic strictures to date.
Conclusion A 6-cm side-to-side stapled intrathoracic esophagogastric anastomosis is feasible and is associated with a low anastomotic leak rate.

Keywords Minimally invasive esophagectomy · Intrathoracic anastomosis

Introduction

Minimally invasive esophagectomy was first described by Depaula and colleagues in 1995.[1] Since then, a number of authors have contributed to the description of the technique and outcomes. Luketich et al. first described the combined thoracoscopic esophageal mobilization followed by fashioning of the gastric conduit laparoscopically and construction of a cervical esophagogastric anastomosis.[2] In his large series, he was able to illustrate that a minimally invasive esophagectomy results in a low incidence of mortality, respiratory complications, blood loss, and length of hospital stay, while still maintaining a similar oncological principle to the open technique.[3] Subsequently, the same authors published their approach for minimally invasive Ivor Lewis esophageal resection and intrathoracic anastomosis and concluded that this type of procedure is feasible. Similarly, the rate of perioperative complications, including anastomotic leak, pneumonia, and mortality were low and comparable with their established technique of minimally invasive esophagectomy[4] and cervical anastomosis. While the ideal type of minimally invasive esophageal resection and intrathoracic anastomosis is not known, most have reported the use of end to end anastomotic (EEA) stapler to facilitate the procedure. Nguyen and colleagues published their series of Ivor Lewis esophageal resection with a thoracoscopic

K. Ben-David (✉) · G. A. Sarosi · J. C. Cendan · S. N. Hochwald
Department of Surgery,
University of Florida College of Medicine,
1600 SW Archer Road, P.O. Box 100109, Gainesville,
FL 32610, USA
e-mail: kfir.bendavid@surgery.ufl.edu

anastomosis using a circular 25-mm stapled esophagogastrostomy reconstruction. Their anastomotic leak and stricture rates were 9.6% and 26%, respectively.[5] During open esophagectomy, many experienced esophageal surgeons have moved away from EEA stapled anastomosis in the right chest due to the small anastomotic lumen and need to use the end of the esophagus with possible higher leak rates and, instead, favor a stapled or sutured side-to-side anastomosis. However, a minimally invasive thoracoscopic linear side-to-side stapled anastomosis is technically more difficult than an EEA stapled anastomosis. We present our technique and outcomes in patients undergoing an intrathoracic linear stapled side-to-side anastomosis for gastroesophageal (GE) junction malignancy.

Methods

Our protocol for patient evaluation includes an endoscopic ultrasound followed by a positron emission tomography (PET) and computerized tomography (CT) scans to determine if they are appropriate surgical candidates. Patients receive preoperative neoadjuvant chemoradiation therapy as determined by our multidisciplinary team for any GE junction malignancy staged as T2–T4 or regional node positive. Following neoadjuvant therapy, patients are reassessed with an additional PET/CT scan to evaluate response and to ensure that there is no evidence of metastatic disease. Our standard approach to minimally invasive esophagectomy includes thoracoscopic mobilization of the esophagus and peri-esophageal lymph nodes, laparoscopic gastric conduit formation and lymph node dissection and a cervical anastomosis. All patients in this series were not appropriate candidates for our routine minimally invasive esophagectomy due to previous extensive left carotid surgery, the size of the tumor at the GE junction with extension on to the cardia of the stomach, previous esophageal or gastric surgery such as Nissen fundoplication or previous vagotomy, and inability for the gastric conduit to reach up to the neck. Hence, it was decided preoperatively that a thoracoscopic esophagogastrostomy would be performed using an intrathoracic 6-cm linear stapled anastomosis.

Operative Description

Abdominal Dissection

The patient is placed in the supine position and intubated with a double lumen endotracheal tube. The abdominal cavity is accessed via a 5-mm left subcostal incision under direct visualization with the aid of a 5-mm visiport. Three additional trocars are placed under direct visualization. A 5-mm 30° angle scope is utilized throughout the duration of the case. A 5-mm trocar is placed in the supraumbilical region just left of the midline for the laparoscope. A 12-mm trocar is placed in the right mid abdominal region and an additional 12-mm trocar is placed in the right subcostal region along the mid clavicular line for surgeon's right and left hand respectively. The Nathanson liver retractor is utilized through a 5-mm subxiphoid incision in order to elevate the left lobe of the liver and expose the GE junction. The surgeon stands on the patient's right side with the assistant on the opposite side operating the camera and retraction instruments via the left subcostal 5-mm trocar.

Initially, the abdomen is explored for any metastatic disease by carefully evaluating the peritoneum and liver surface. Any questionable lesions are biopsied and evaluated by our pathologist at the time of the operation. The patient is placed in a reverse Trendlenburg position and the gastrohepatic ligament is divided in order to expose the GE junction. A retrogastric window is created from the right crus to the angle of His and a Penrose is placed around this area which will later allow retraction of the GE junction during this dissection. The right and left crus of the diaphragm are widely and freely dissected from the phrenoesophageal ligament. Care is taken not to enter the thoracic cavity during this portion of the procedure. Following the utilization of neoadjuvant chemoradiation therapy, there may be inflammatory changes at the GE junction with thickening of the phrenoesophageal ligament. Care must be taken to identify the diaphragmatic crura and dissect them away from the GE junction. On occasion, it is helpful to mobilize the greater curvature of the stomach prior to attempting to define the retrogastric plane.

Next, the greater curvature of the stomach is mobilized from the origin of the right gastroepiploic artery and vein to the angle of His while preserving the right gastroepiploic arcade. All adhesions between the stomach and pancreas are divided. A limited mobilization of the first and second portions of the duodenum is performed. The left gastric artery and vein and associated lymph nodes are then elevated and both are mobilized to the origins of these vessels. Nodes along the superior border of the pancreas are reflected towards the specimen. The left gastric pedicle is then divided using a vascular load on a 60-mm stapler. On occasion, the planes near the left gastric pedicle may be edematous or difficult to visualize due to the use of neoadjuvant chemoradiotherapy or with extensive nodal disease. In this situation, meticulous dissection to separate the left gastric vein from the artery should be done with early division of the left gastric vein. Subsequently, the left gastric artery is further mobilized and lymphatic tissue along the superior border of the pancreas mobilized en bloc

with the artery. The nodal tissue is then separated from the artery utilizing the Enseal and the artery stapled and divided. The right gastric artery is also divided using a vascular stapler. A point approximately 3 cm proximal to the pylorus is chosen along the lesser curvature as the start of the formation of the gastric conduit. This is constructed with multiple firings of a laparoscopic 60-mm stapler towards the angle of His ensuring appropriate margins from the tumor. Care is taken to keep the gastric conduit approximately 6–7 cm in diameter. Three to four Lembert sutures are placed along the gastric staple line junctions to reinforce it and to provide a handle for further manipulation in the right chest. The gastric conduit is completely transected and then re-sutured to the proximal stomach along the lesser curvature side. Following completion of the gastric conduit, the distal aspect of the esophagus in the posterior mediastinum is circumferentially dissected.

A 16 French T-tube is used for our feeding jejunostomy which is placed approximately 30 cm distal to the ligament of Treitz. None of the patients had a pyloroplasty performed, while two patients underwent an intraoperative Botox injection to the pylorus. All trocars and retractors are removed, and the skin incisions are reapproximated.

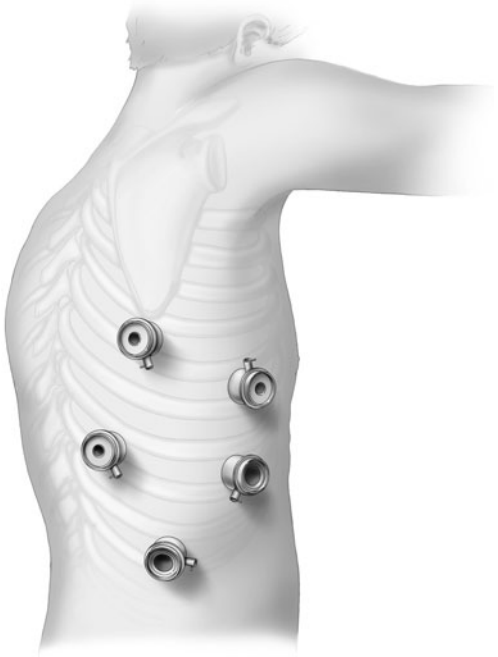

Fig. 1 Thoracoscopic trocar placement.

Thoracic Dissection

The patient is placed in the left lateral decubitus position and the right lung is collapsed. The right chest cavity is entered through a 5-mm incision in the subscapular region. This trocar is for the 5-mm 30° angled scope. Four additional trocars are placed under direct visualization. A 12-mm trocar is placed in the seventh intercostal space anterior to the mid axillary line and is used to retract the lung anteriorly. A 5-mm port is placed in the fifth intercostal along the same axes as the previously placed port and is used by the assistant for retraction. A 5-mm trocar is placed in the seventh intercostal space posterior to the mid axillary line and is used as the surgeon's left while standing posterior to the patient. Lastly, a 12-mm port is placed in the ninth intercostal space along the mid axillary line which is used as the surgeon's right hand when using the stapler and suturing (Fig. 1).

The posterior mediastinum is opened at the level of the inferior pulmonary ligament and the esophagus is circumferentially dissected with the aid of a Penrose drain and the Realize™ dissector to a point above the level of the azygos vein (Figs. 2 and 3). The azygos vein is circumferentially dissected and divided using a vascular stapler through the 12-mm trocar placed in the 10th intercostal space (Fig. 4). Once the esophagus is completely mobilized from the hiatus to 3 cm above the azygos vein, it is divided using a 60-mm stapler. The gastric conduit is delivered from the abdominal cavity up to the transected esophagus. The previously placed sutures on the gastric tube are utilized to help deliver the stomach into the right chest. The transected proximal esophagus and gastric conduit are aligned with 2–0 non-absorbable braided suture. An esophagotomy is created at the distal end of the transected esophagus. To facilitate this, a large bore nasogastric tube or bougie dilator is carefully placed down the esophagus and an esophagotomy performed using the tube as a guide. Similarly, a gastrotomy is performed 8 cm proximal to the end of the gastric conduit. With the aid of the previously placed traction sutures, a side-to-side intrathoracic 6-cm linear stapled esophagogastrostomy is performed (Fig. 5) by placing the envil portion of the stapler through the esophagotomy and the cartridge through the gastrotomy.

Once the isoperistaltic anastomosis is completed, the common opening of the gastrotomy and esophagotomy are sutured with an absorbable braided inner layer followed by a non-absorbable outer layer suture using the Endo Stitch™ device. This enables us to suture with fewer difficulties and at various angles within the thoracic cavity. The anastomosis is then inspected with endoscopy to ensure patency and that no leak is present during insufflation of intraluminal air while submerging the anastomosis under fluid. The gastric tube is sutured to the diaphragm with two sutures and to the pleura if necessary. Following this, the specimen is removed through a 3-cm non-rib spreading incision along the sixth intercostal space. A 24 French thoracostomy tube is placed along the posterior mediastinum. The nasogastric tube was left in place for four days. All six patients underwent a gastrograffin swallow on postoperative day 5

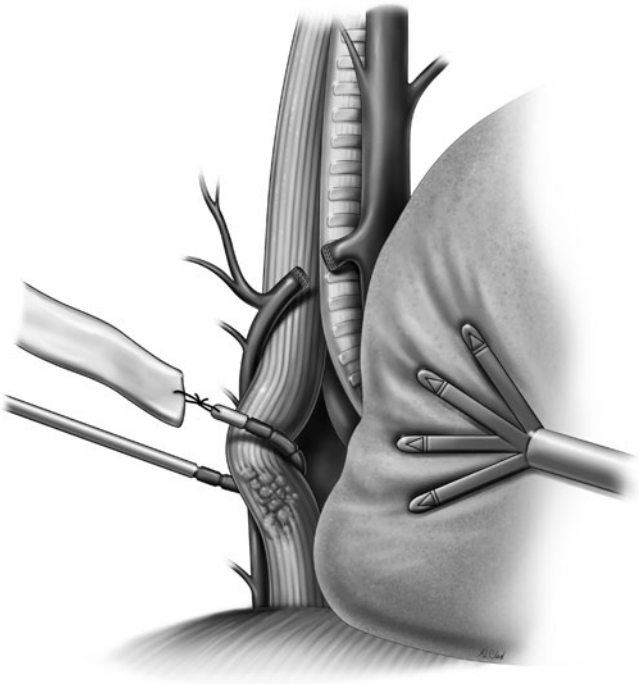

Fig. 2 Circumferential dissection of the esophagus with the aid of a Penrose drain and the Realize™ dissector.

with no evidence of leak and adequate emptying of the stomach confirmed. All were discharged on postoperative day eight tolerating a diet.

Results

Six male patients underwent the procedure with a median age of 61.5 years (range=43–66). The median American Society of Anesthesiologists (ASA) grade was 3 and body mass index was 23 (range=22–28). All six patients had gastroesophageal junction adenocarcinoma and completed neoadjuvant chemoradiation therapy for ≥T2 or node positive disease as noted by endoscopic ultrasound or imaging. Two patients had a previous Nissen Fundoplication

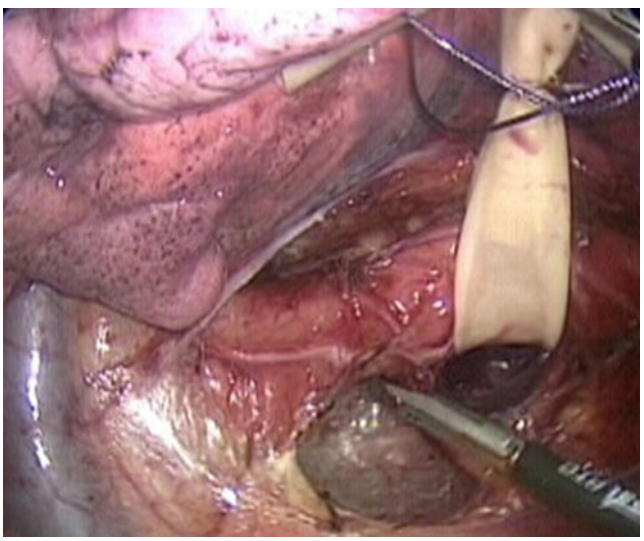

Fig. 3 Mobilization of the intrathoracic esophagus.

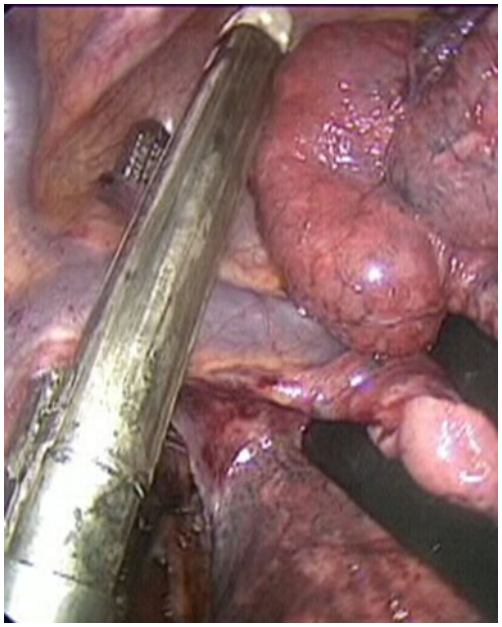

Fig. 4 Division of the azygos vein.

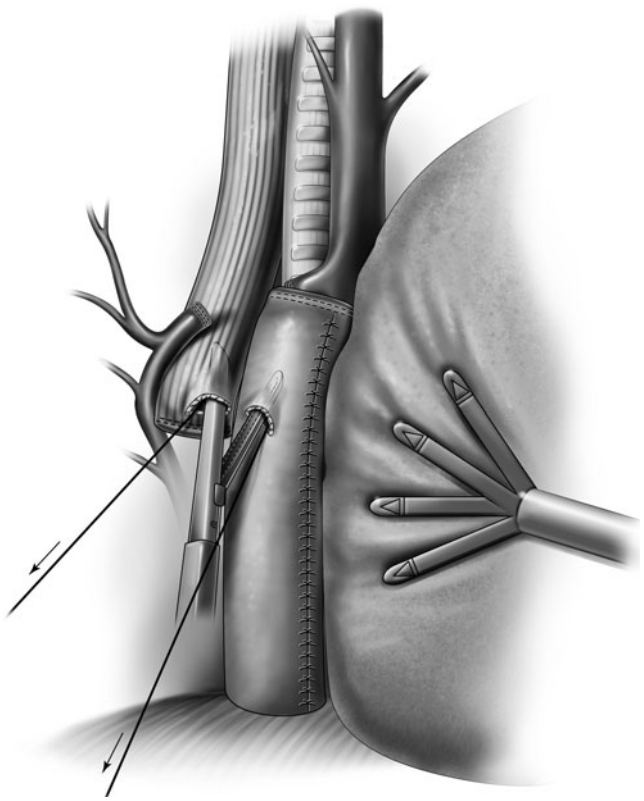

Fig. 5 Side-to-side intrathoracic stapled esophagogastric anastomosis.

Table 1 Characteristics of the Six Patients

Age	Median, 61.5 years (range, 43–66)
Gender	6 males
American Society of Anesthesiologists grade	3
Body mass index	23 kg/m^2 (range, 22–28)
Neoadjuvant chemoradiation	6
Operative time	360 min (range, 300–480)
Blood transfusion	0
Pyloroplasty	0
Intraoperative Botox Injection to pylorus	2
30-day mortality	0
Active smoker	4 yes, 2 no
Neoadjuvant therapy	4 docetaxel, cisplatin, fluorouracil
	2 cisplatin, fluorouracil
	RT dose, 4,500–5,400
Time from neoadjuvant therapy to surgery	Median 7 weeks (range, 5–8)
Length of hospital stay	Median 8 days (range, 6–8)

and the remaining four patients had a large gastroesophageal junction tumor extending 3 to 5 cm onto the proximal stomach. The median duration of operation was 360 min (range=300–480). No patients received a blood cell transfusion. The 30-day mortality was 0 (Table 1). Transient postoperative dysphagia developed in one patient, and there were no documented incidences of aspiration or delayed gastric empting. The median length of hospital stay was 8 days (range=7–8). The median number of nodes harvested was 18 (range, 6–30). The wide range in nodal yield appeared to be related to the use of neoadjuvant chemoradiotherapy. The sites of the tumors resected and pathologic stages are given in Table 2. At a median follow-up of 9 months, all six patients were alive. There have been no postoperative strictures to date. One patient had complaints of dysphagia in the early postoperative period that has subsequently resolved.

Discussion

Various laparoscopic, thoracoscopic, and robotic techniques for minimally invasive esophagectomy have been described with varying opinions regarding the location and technique of esophagogastric anastomosis.[5–15] Avoiding anastomotic complications is essential for minimizing the morbidity and maximizing the operative outcome. Anastomotic leaks have been reported to occur up to 15% of the time and are the most frequent cause of immediate postoperative mortality. In addition, anastomotic leaks can result in long-term stricture formation in up 50% of resected patients[16,17] impacting long-term functional results and quality of life.[18,19] Behzadi et al. concluded that a linear stapled anastomosis is associated with lower leak rates and need for long-term dilatation as compared to a hand sewn anastomosis regardless of the anastomotic location.[16] Similarly, the Mayo Clinic and University of Pittsburgh have both shown that a side-to-side isoperistaltic anastomosis resulted in lower rates of stenosis.[16,20,21] Hence, a successful anastomosis is essential for decreasing long-term morbidity associated with patients undergoing an esophagectomy. It is for these reasons, that we perform an intrathoracic 6-cm side-to-side linear stapled anastomosis for patients that are not appropriate candidates for our traditional thoracoscopic esophageal mobilization, laparoscopic gastric conduit formation, and cervical esophagogastrostomy. Therefore, this procedure is best suited for patients with gastric cardia, GE junction or distal esophageal tumors or for patients where there is not enough stomach available for a cervical anastomosis.

Although our results are very compelling, yet limited by our sample size, the difficulty of performing this procedure is challenging and requires expertise in both minimally invasive surgery and esophageal surgery. This technique

Table 2 Tumor Characterization and Survival

Patient	Preoperative clinical stage	Postoperative pathologic stage	Postoperative pathologic diagnosis	Number of lymph nodes harvested
1	T3N0	T3N1	Poorly differentiated adenocarcinoma	17
2	T3N1	T2N1	Moderately differentiated adenocarcinoma	6
3	T2N1	T2N1	Moderately differentiated adenocarcinoma	19
4	T2N0	T0N0	No residual tumor	10
5	T2N0	T2N1	Moderately differentiated adenocarcinoma	21
6	T3N1	T2N0	Poorly differentiated adenocarcinoma	30

requires being able to suture in the thoracic cavity that is not as easily adaptable as the abdomen. Potential advantages of a long (6 cm) side-to-side stapled anastomosis results includes lower leak rates and long-term stenosis. The disadvantages of an intrathoracic esophagogastric anastomosis are well known including increased morbidity to the patient if a leak were to occur. The advantages of an intrathoracic anastomosis include avoidance of cervical dissection of the esophagus with increased risk for recurrent laryngeal nerve injury and postoperative strictures.

In summary, we describe a new and technically feasible thoracoscopic technique for construction of an esophagogastrostomy using a 6-cm side-to-side linear stapled anastomosis. This method is applicable to patients who require an intrathoracic anastomosis. More importantly, the large size of the anastomosis should result in decreased anastomotic leaks and strictures. Although performing this complex procedure requires a unique learning curve, this procedure can be mastered when performed by surgeons interested in performing intrathoracic side-to-side stapled anastomosis rather than a circular stapled anastomosis. As with any new technique, having the prerequisite technical skills will ensure safe and similar results as those described in this article.

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