



Minimally Invasive Ivor Lewis Esophagectomy Without Patient Repositioning

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Abstract

Introduction The standard technique for Ivor Lewis minimally invasive esophagectomy involves a two-stage approach necessitating repositioning mid-procedure.

Technique We describe our technique for a one-stage hand-assisted minimally invasive esophagectomy that allows sequential access to the chest and abdomen within the same surgical field, eliminating the need for repositioning. The patient is positioned in a “corkscrew” configuration with the abdomen supine and the chest rotated to the left to allow access to the right chest. The abdomen and chest are prepped into a single operative field. This technique allows sequential access to the abdomen for gastric mobilization, chest for division of the esophagus, abdomen for construction of the gastric conduit, and chest for intrathoracic anastomosis.

Conclusion This approach enables extracorporeal construction of the conduit, which helps ensure a clear distal margin on the specimen and facilitates conduit length by placing the stomach on stretch during stapling.

Keywords Esophageal neoplasms · Esophagectomy · Laparoscopic surgery · Thoracoscopic surgery · Minimally invasive surgical procedures · Anastomotic leak

Introduction

Esophagectomy is a complex surgical procedure with substantial associated morbidity, much of which is related to pulmonary and anastomotic complications, such as leak, stricture, or postoperative dysphagia and aspiration. To reduce complications and improve outcomes, several minimally invasive techniques have been devised. The first was a thoracoscopic approach,¹ followed by others, including the minimally invasive version of the “three-hole” McKeown esophagectomy² and the minimally invasive Ivor Lewis approach.³ Most approaches, however, utilize intracorporeal laparoscopic construction of the gastric conduit. Compared with an open

approach, intracorporeal laparoscopic construction of the conduit makes it more difficult to place the stomach on stretch and to identify invasion of tumor into the gastric cardia. Crenshaw et al. demonstrated fewer anastomotic leaks and a decreased incidence of positive margins with the use of extracorporeal creation of the gastric conduit during minimally invasive esophagectomy.⁴ A positive distal margin has been reported in up to 12% of patients after esophagectomy.⁵ This is primarily a concern for tumors of the gastroesophageal junction, which may invade the gastric cardia and approach the superior aspect of the proposed gastric conduit. We reasoned that extracorporeal construction of the gastric conduit creation could reduce the anastomotic leak rate and avoid a positive distal resection margin. Extracorporeal construction of the conduit, however, requires that the intrathoracic esophagus be divided prior to construction of the conduit, so that the distal esophagus, gastroesophageal junction, and stomach can be exteriorized via an upper midline extraction incision. Nanson previously published a technique for a synchronous approach for abdomino-thoraco-cervical open esophagectomy in 1975,⁶ which has since been slightly modified by others.⁷ By further modifying their technique, we were able to devise a positioning system which provides access to the abdominal and thoracic cavities sequentially via a minimally invasive approach.

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With access to both chest and abdomen cavities, we could then divide the operation into four phases: an initial abdominal phase for gastric mobilization and dissection of the inferior mediastinum, followed by a thoracic phase for division of the esophagus. The distal esophagus and gastroesophageal junction are then delivered into a sub-xiphoid extraction incision for extracorporeal construction of the gastric conduit during a second abdominal phase. An intrathoracic anastomosis is constructed during a second thoracic phase. This manuscript describes our technique for one-stage minimally invasive esophagectomy using a single surgical field, which facilitates extracorporeal construction of the gastric conduit.

Methods

From February 2013 through June 2018, 190 patients underwent minimally invasive Ivor Lewis esophagectomy via the one-stage approach. General anesthesia is induced, and the patient is intubated with a dual-lumen endotracheal tube. We routinely insert an arterial line and Foley catheter and selectively use central venous lines.

Positioning

Once appropriate access is obtained, the patient's upper torso and shoulders are rotated toward the left with the right arm brought across chest into the "corkscrew" position. Because the patient is not fully lateral, an axillary roll is not used. Lateral body supports (Allen Medical Systems, Acton, MA, USA) are placed bilaterally at the hips and at the left chest wall. The right chest is rotated toward the patient's left with another lateral body support behind the right scapula, taking care to ensure that the inferior angle of the scapula can be prepped into the sterile field. The patient's right arm is supported on a padded arm support (Skytron, LLC., Grand Rapids, MI, USA) and secured in place with gauze (Figs. 1 and 2). The abdomen, right chest, and right axilla are all

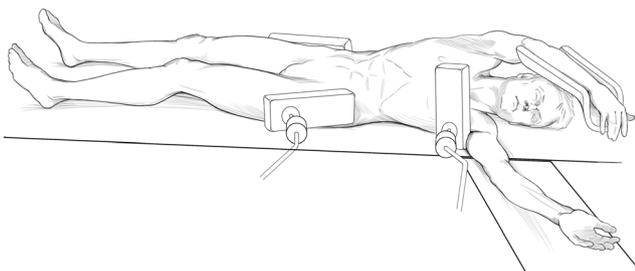


Fig. 1 Patient positioning for one-stage minimally invasive esophagectomy, anterior view. The patient's upper torso and shoulders are rotated, with the right arm brought across chest into the "corkscrew" position and supported on a padded Skytron® arm support. Lateral body supports are placed bilaterally at the hips and at the left chest wall

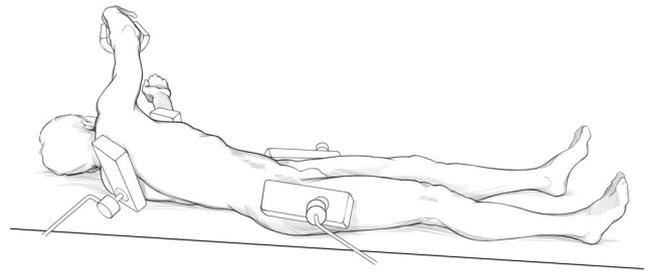


Fig. 2 Patient positioning for one-stage minimally invasive esophagectomy, posterior view. The right chest is rotated toward the patient's left with a lateral body support behind the right scapula, exposing the inferior angle of the scapula so that it can be prepped into the sterile field

prepped into the sterile field. The operation is performed in four phases.

Phase I: laparoscopy part 1

The OR table is tilted 15–20° to the right. A 7-cm midline incision is made in the epigastrium for placement of a hand port. Three 5-mm ports are placed in the left upper quadrant inferior to the costal margin. Most of the first phase involves foregut mobilization beginning with mobilization of the greater curve of the stomach with a bipolar energy device. The stomach is then retracted anteriorly, exposing the origin of the left gastric artery and the celiac trunk. Nodal tissue around the left gastric artery and celiac axis is dissected and remains with the specimen. The left gastric artery is divided with a vascular load linear stapler. The duodenum is mobilized with a generous Kocher maneuver. The peritoneum anterior to the esophagogastric junction is incised and the fat pad and paraesophageal nodes in the lower mediastinum harvested. The right pleura is then entered widely lateral to the aorta and posterior to the esophagus.

Phase II: thoracoscopy part 1

The OR table is tilted 20° to the left and the right lung is deflated. A 5-mm optical port is used to enter the right chest inferior to tip of scapula, which is insufflated with 8 mmHg CO₂. Two 12-mm ports are placed along the anterior axillary line, a 5-mm posterior-inferior port is positioned, and a 3-cm incision made for the circular stapler. The esophagus is dissected to obtain sufficient length to ensure adequate margins and to allow for a tension-free anastomosis, and then divided with a linear stapler. In general, the esophagus is transected at or above the level of the azygous vein. Periesophageal lymph nodes are harvested with the specimen, stripping nodal tissue from the aorta, pericardium, and left pleura. Dissection of paratracheal nodes is performed only for tumor of the middle third of the esophagus. The right pleura is incised both anterior

and posterior to the esophagus to optimize lymph node harvest.

Phase III: laparoscopy part 2

The OR table is again tilted 15–20° to the right for the second laparoscopic phase. The distal esophagus and stomach are delivered from the abdomen through the hand port. The specimen is then splayed out, placing gentle tension on the greater curvature to avoid the risk of foreshortening the gastric staple line. The decussation of the right and left gastric arteries is identified approximately 10 cm proximal to the pylorus and divided. We use a combination of Doppler and intraoperative indocyanine green fluorescence angiography to ensure good vascular supply of the gastric conduit which in our experience is associated with fewer anastomotic leaks.⁸ The conduit is constructed from the greater curvature with multiple firings of a linear stapler to construct a 5-cm wide tube. Frozen sections are obtained from the specimen of the proximal and distal margins. A gastric drainage procedure is performed, followed by a jejunostomy. The conduit is now placed into the right chest through the hiatus. Three 19 Fr Blake drains are now placed: left pleura through the hiatus, right pleura through the hiatus, and abdomen.

Phase IV: thoracoscopy part 2

The OR table is again tilted 20° to the left and the lung reflected. The azygous vein is divided with a linear stapler. The esophageal staple line is fenestrated to allow passage of a 25 mm OrVil™ device (Covidien, North Haven, CT, USA) as described by Nguyen et al.⁹ The gastric conduit is then positioned in the posterior mediastinum and opened along the lesser curve staple line. A 25 mm DST Series™ EEA™ XL stapler (Covidien, North Haven, CT, USA) is then placed into the conduit and the spike is brought out through the greater curvature. The stapler components are docked and the stapler fired, and the anastomosis is completed with a linear stapler. Ultrasound is used to guide the placement of an 18 Fr nasogastric tube within the gastric conduit. The right pleural 19 Fr Blake drain is positioned posterior to the conduit adjacent to the anastomosis. A 28 Fr chest tube is placed into the right chest and the lung is reinflated, and the thoroscopic incisions are closed.

Postoperatively, patients are admitted to the intensive care unit and are either extubated immediately or are aggressively weaned from the ventilator upon arrival. We start tube feedings on the day of surgery via the jejunostomy tube. Drain output is checked daily for elevated amylase. A limited upper GI series with water-soluble contrast is performed between the second and fourth post-operative day to evaluate gastric emptying prior to nasogastric tube removal. If there are clinical signs of anastomotic leak or elevation in drain amylase levels,

a computed tomography esophagram is performed. Patients are started on sips of water immediately after removal of the nasogastric tube and are discharged taking high-protein shakes.

Results

One hundred ninety patients underwent one-stage minimally invasive Ivor Lewis esophagectomies at Carolinas Medical Center from 2013 to 2018. The median age was 65, ranging from 30 to 84 years. Eighty-one percent of patients were male, and 92% were Caucasian. Resection was for adenocarcinoma in 159 (84%), squamous cell carcinoma in 24 (13%), carcinoid and gastrointestinal stromal tumor each in 1 patient (0.5%), and benign disease in 5 (3%) patients.

Conversion from laparoscopy to laparotomy was performed in three patients, primarily due to adhesive disease. Thoracotomy was performed as initial surgical approach in one patient and ten patients were converted from thoracoscopy to thoracotomy, primarily for inability to obtain satisfactory one-lung anesthesia. Positioning did not impede the ability to perform thoracotomy. Intrathoracic-stapled anastomosis was performed in 188 patients. In two cases, a positive proximal margin on frozen section led to conversion to a “three-hole” McKeown technique with a total esophagectomy and cervical anastomosis.

Anastomotic leak occurred in 8 patients (4.2%) and pneumonia occurred in 15 patients (7.9%). Prolonged ventilation (greater than 48 h) was required in 31 patients (16.3%). Atrial arrhythmia occurred in 47 patients (24.7%) and 4 patients (2.1%) developed myocardial infarction.

Positive histologic margins occurred in 14 patients (7.4%), which in most cases was due to a positive radial margin. No patients had a positive distal margin. Median lymph node harvest was 17 nodes (range 4 to 59). Median length of stay was 8 days (range 4 to 60). There was no mortality within the first 30 days. In-hospital and 90-day combined mortality was 7 patients (3.7%).

Discussion

Numerous techniques for minimally invasive esophagectomy in the management of esophageal cancer have been described without significant differences in outcomes between these techniques.^{1–3,10} Most reported techniques utilize a two- or three-stage approach, which necessitates repositioning of the patient, inherently introducing inefficiency into the operation. Another option approaches the thoracic mobilization of the esophagus through a right prone posterior approach¹¹; however, this technique also requires repositioning of the patient and introduces further difficulty if the need for conversion to

thoracotomy arises. Almost all reports, however, utilize laparoscopic intracorporeal construction of the gastric conduit. Two reports have shown reduced anastomotic leak rates with extracorporeal creation of the gastric conduit.^{4,12}

The “one-stage,” or “synchronous approach,” was first described for open esophagectomy by Nanson,⁶ and a small randomized trial reported a one-stage approach in open esophagectomy resulted in shorter operative time, but higher mortality than a conventional Ivor Lewis approach.¹³ While the two-stage approach for minimally invasive esophagectomy remains the most commonly utilized, the optimal approach remains unclear.

We initially performed a two-stage esophagectomy in approximately 84 patients.¹⁴ We began to experiment with a one-stage approach based upon our review of the literature with the goal of decreasing operative time and facilitate the construction of a conduit using an extracorporeal approach. Based upon our experience, we now utilize a one-stage approach almost exclusively in our institution for minimally invasive Ivor Lewis esophagectomy, reserving the two-stage approach for patients with morbid obesity (BMI > 40) ($n = 2$). This is the largest published series to date utilizing a one-stage Ivor Lewis minimally invasive esophagectomy. Advantages to this technique include shorter operative times and the opportunity for extracorporeal construction of the conduit. This has been shown in a prior study to reduce anastomotic leaks and results in fewer positive distal gastric margins.⁴ In conclusion, we find this technique simple, safe, and reliable.

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Compliance with Ethical Standards

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

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