Early Outcomes of Video-assisted Thoracic Surgery (VATS) Ivor Lewis Operation for Esophageal Squamous Cell Carcinoma: The Extracorporeal Anastomosis Technique

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Purpose: Although the use of a minimally invasive approach in esophageal cancer surgery is gradually increasing, it is generally performed using cervical anastomosis because of the difficulty of intrathoracic anastomosis. Here, we describe our technique for performing intrathoracic esophagogastrostomy using a typical video-assisted thoracic surgery (VATS) approach.

Methods: Between September 2009 and July 2011, VATS esophagectomy and intrathoracic anastomosis was performed in 31 esophageal cancer patients with a utility incision made by a segmental rib resection to enhance the extracorporeal insertion of the end-to-end stapler. We retrospectively reviewed the clinical records of these patients.

Results: There were no intraoperative events related to the VATS procedure. The mean VATS time was 180.2 ± 39.2 min. The mean postoperative hospital stay was 15.2 days (range, 11 to 38 d). No significant pulmonary complications were observed. Five patients developed vocal cord palsy due to radical mediastinal lymphadenectomy. No anastomotic complications such as leaking or stricture were observed. Only 1 patient had postoperative pain requiring analgesics.

Conclusions: Our technique can be safely and effectively performed for intrathoracic anastomosis in esophageal surgery with favorable early outcomes and reduced postoperative pulmonary complications.

Key Words: esophageal cancer, VATS, esophagectomy, intrathoracic esophagogastrostomy

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Surgery remains the gold standard for the treatment of esophageal cancer in terms of cure and palliation of dysphagia. However, because of the relatively high mortality and morbidity associated with radical surgery for esophageal cancer, there have been many efforts to reduce its invasiveness. In the early 90s, some centers started to use video-assisted thoracic surgery (VATS) for esophageal cancer treatment,[1–3] but the initial outcomes were not satisfactory and it was only recommended for centers with a large patient volume and extensive experience.[4,5]

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As techniques and equipment for VATS have continuously evolved, minimally invasive surgery (MIS) for esophageal cancer is becoming more popular and regarded as one of the standards.[6–11] However, radical mediastinal lymph node dissection and intrathoracic anastomosis of the gastric graft with the esophagus is still technically challenging and not well established. With the help of newly developed thoracoscopic devices, we have designed a safe, efficient, and reproducible approach for VATS esophagectomy and esophagogastrostomy.

MATERIALS AND METHODS

Patient Enrollment

Between September 2009 and July 2011, 66 patients with esophageal squamous cell carcinoma underwent transthoracic esophagectomy and intrathoracic anastomosis by an Ivor Lewis operation performed by a single surgeon at the Samsung Medical Center, Korea. A VATS technique for the thoracic procedure was planned in 34 patients. Candidates for VATS esophagectomy were selected using the following criteria: (a) esophageal cancer in the mid to low esophagus region without definite T4 invasion or overt lymph node metastasis based on preoperative clinical evaluation; (b) no administration of neoadjuvant treatment for esophageal cancer and no previous history of major thoracic or abdominal surgery; and (c) no visible pleural thickening or inflammation based on preoperative chest computed tomography (CT).

Preoperative evaluation of the patients included a routine laboratory examination: a pulmonary function test; enhanced chest CT scan, integrated positron emission tomography and CT scan (PET-CT); endoscopic examination of the esophagus, stomach, and duodenum; and an endoscopic ultrasound exam of tumor invasiveness and regional lymph node metastasis.

Operative Technique

A typical abdominal procedure using a midline laparotomy was used for gastric preparation. The right gastroepiploic artery was used as the main feeding vessel for the gastric graft. Division and coagulation of the gastrocolic omentum and short gastric artery were easily achieved using the Harmonic Ace 36-mm curved shears (Ethicon Endo-Surgery Inc., Cincinnati, OH). Pyloroduodenal release by the Kocher maneuver and a gastric drainage procedure by pyloromyotomy were performed in all patients. After the gastric graft was fully released, the graft was tubularized with a linear stapler (Proximate linear cutter, 75 mm; Ethicon Endo-Surgery Inc.) to facilitate intrathoracic anastomosis and to prevent later distension of the graft (Fig. 1).

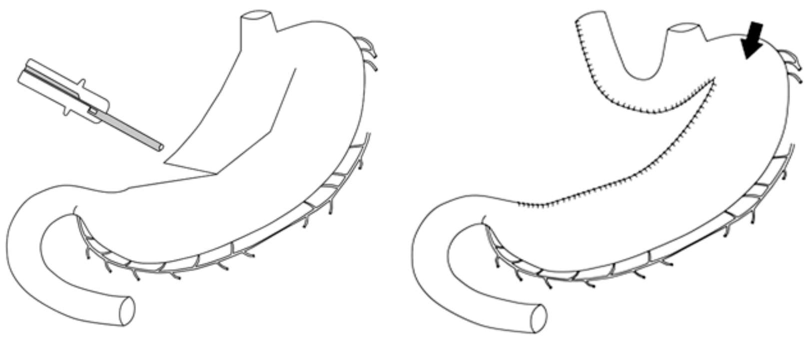

FIGURE 1. Preparation of the gastric graft and tubularization by stapling. The right gastroepiploic artery was saved and prepared as the main graft feeder. After full release, the gastric graft was tubularized at the lesser curvature side using 3 linear staplers (Proximate linear cutter, 75-mm; Ethicon Endo-Surgery Inc.). The stapling line was carefully designed to avoid graft spiralization, which can cause malrotation or distortion in the mediastinum. The fundus of the stomach was not fully divided, and about 4 cm of the fundus was left unstapled (arrow) for the insertion of an end-to-end anastomosis stapler. The esophagogastric junction was not divided to facilitate pulling of the gastric graft up into the thoracic cavity.

A typical lateral decubitus position was used for the thoracic procedures. The 4-port configuration for the VATS is illustrated in Figure 2. The utility port was made by resecting a short segment (3 to 4 cm) of the fifth rib to ensure easy access to the gastric graft along with a 28-mm end-to-end anastomosis (EEA) stapler (DST EEA 28; Tyco Healthcare, Norwalk, CT) by an extracorporeal technique. The azygos vein was divided with an Echelon-Flex 60-mm Endocutter (Ethicon Endo-Surgery Inc.). After the esophagus was fully circumferentially released from the diaphragm to the thoracic inlet using the Harmonic Ace curved shears and electrocautery, a purse-string suture was applied around the proximal esophagus just beneath the thoracic inlet. Thereafter, the anvil of the EEA was inserted into the proximal esophagus using an Anvil grasper (Aesculap AG, Am Aesculap Platz, Tuttlingen, Germany) and fixed with a purse-string suture tie. No additional purse-string sutures were required to hold the anvil securely. In esophageal cancer surgery at our institution, the paraesophageal lymph nodes, both the recurrent laryngeal nerve nodes, the subcarinal and nearby hilar nodes, the aortopulmonary window nodes, and the paralymphatic fat tissues are routinely explored and completely dissected. After lymph node dissection, the gastric graft was pulled up and extracted from the pleural cavity through the utility port to facilitate stapler insertion (Fig. 3). With these procedures, the shape and viability of the graft could be fully inspected with both direct vision and a thoracoscope, and the EEA stapler could be inserted exactly at the lower fundus. The graft (along with the EEA stapler tip) was then reinserted into the pleural cavity and the intrathoracic esophagogastrostomy was completed by engaging the stapler tip into the anvil. All the anastomoses were safely performed at the thoracic inlet level in all cases. We called this the "extracorporeal anastomosis technique."

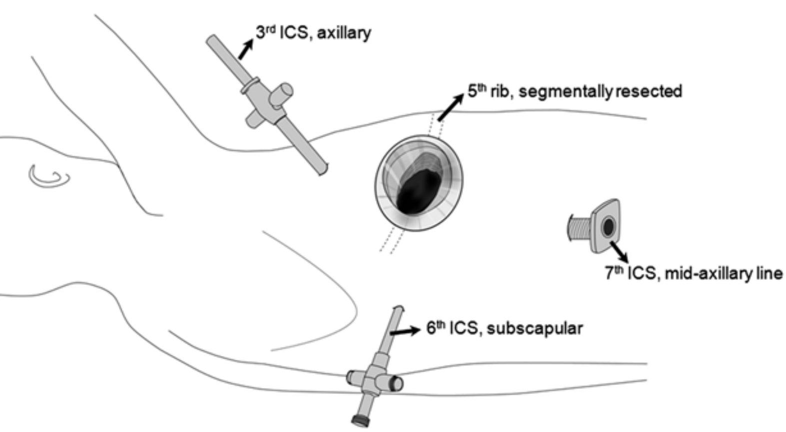

FIGURE 2. VATS port configuration and utility port formation by segmental rib resection during the thoracic phase of the surgery. A port configuration similar to that used for a VATS lobectomy was used. The utility port was made at the anterior axillary line by resecting a short (3-4 cm) segment of the fifth rib for easy access of the gastric graft along with a 28-mm end-to-end anastomosis stapler. A self-expandable wound retractor (Alexis wound retractor; Applied Medical, CA) was placed to protect the port. A 13-mm port was placed at the midaxillary line of the seventh or eighth intercostal space (ICS) for the ultrasonic endoshears (Harmonic Ace Curved Shears 36 mm; Ethicon Endo-Surgery Inc.), endoscopic electrocautery, and staplers. This is almost the same as with our 3-port configuration for VATS lobectomy. If needed, an additional 10-mm axillary port at the third ICS was made and used for the esophageal retractor. The subscapular 5-mm port for esophageal manipulation was placed at a slightly more anterior position than that of the VATS lobectomy because of the location of the esophagus deep inside the mediastinum. VATS indicates video-assisted thoracic surgery.

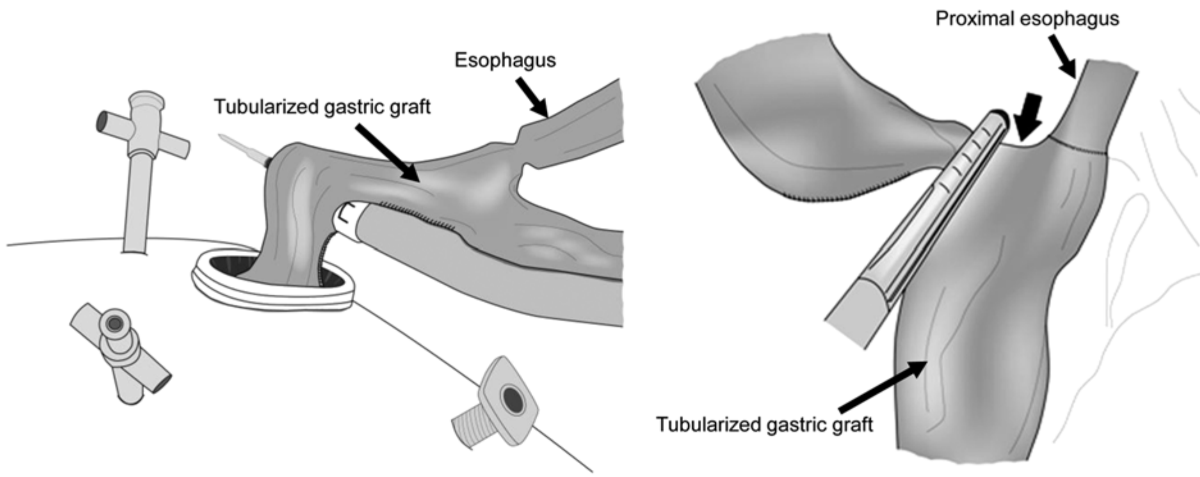

FIGURE 3. Extracorporeal insertion of the stapler outside of the thoracic cavity and intrathoracic anastomosis. In the extracorporeal anastomosis technique, the resected esophagus and uppermost portion of the tubularized gastric graft was extracted out of the thorax through the utility port, which made it easier to insert the end-to-end anastomosis (EEA) stapler (DST EEA 28; Tyco Healthcare) without unnecessary tension and damage to the graft. The opening for the stapler was made along the stapler line at the uppermost portion of the stomach. The EEA stapler was placed at the lowermost portion of the fundus or, if possible, at the upper body of the gastric graft to secure blood supply to the anastomosis. The gastric graft (penetrated by the stapler tip) was reinserted through the utility port, and the anastomosis was completed by engaging the tip of stapler into the anvil. Thereafter, the entry site of the EEA stapler was resected using a flexible, multiraw endoscopic linear stapler (Echelon-Flex 60 mm Endocutter; Ethicon Endo-Surgery Inc.), along with the resected distal esophagus. About 3 cm of the fundus portion of the gastric graft (thick arrow) was left unstapled to safely secure the blood supply to the anastomosis.

The donut-shaped margin of the cross-section made by the stapler was inspected for completeness, and the anastomosis site was explored for dehiscence and bleeding by advancing the thoracoscope deep inside the graft. The EEA stapler entry was resected with the remaining esophagus and fundus using the Echelon-Flex 60-mm Endocutter. A short segment (about 3 cm) of fundus between this stapling and the esophagogastrostomy was left unstapled to secure blood supply to the anastomosis (Fig. 3). In patients with double primary cancers in the esophagus and stomach, the colon was selected as a substitute graft and prepared after total gastrectomy, followed by an almost identical thoracic procedure. Finally, the overlying opened mediastinal pleura was resutured to cover the graft. A follow-up contrast esophagography was performed on the 10th postoperative day to confirm the integrity of the anastomosis and to check for possible swallowing problems (Fig. 4).

RESULTS

Among the 34 patients, 3 patients did not undergo the VATS procedure: 1 patient had gross tumor metastasis to the perigastric lymph nodes, 1 patient had definite visual aortic invasion, and 1 patient had dense pleural adhesions throughout the entire right pleural cavity. Patient demographics and operative and pathologic data for the enrolled patients are shown in Table 1. One patient had double primary cancers in the esophagus and stomach. In this patient, after total gastrectomy and colon preparation, an intrathoracic esophagocolostomy was performed instead of esophagogastrostomy by the same procedure. Intrathoracic anastomosis was easily performed in all cases without any intraoperative events. Mediastinal lymph node dissection was accomplished to the same extent as open thoracotomy without any visible remnants. All the cross-sections of the anastomosis formed a complete donut-shape of even thickness.

There were no cases of complications related to the VATS procedure or the conversion to open thoracotomy. No operative mortality was observed. Morbidity occurred in 8 cases. Two patients had mild pneumonia but soon recovered with conservative management. Another patient had laparotomy wound dehiscence. The other 5 patients developed postoperative vocal cord palsy, and 2 of them underwent injection thyroplasty with Artecoll, which is a soft-tissue filler consisting of a suspension of polymethyl methacrylate microspheres in a 3.5% solution of bovine collagen. In the remaining patients, transient palsy soon improved after swallowing practice.

No anastomotic leaks were observed, as confirmed by postoperative esophagography. No patients experienced anastomosis stricture after a median follow-up period of 10 months (range, 1 to 24 mo). One patient out of 31 had postoperative pain that required the administration of intermittent oral analgesics for 1 month, and the rest did not ask for postoperative pain management. One patient had mild regurgitation, and there were no other significant complications regarding graft motility or obstruction.

DISCUSSION

The complication rate after curative resection of esophageal cancer is still very high despite improvements in diagnosis, surgery, and postoperative care.[10] MIS for esophageal cancer has been gradually adopted, and many authors have reported comparable operative outcomes and better quality of life compared with open surgery, using various approaches.[6–9,11–14] MIS for esophageal cancer has 2 separate phases, namely, the thoracic and abdominal phases. The thoracic phase of MIS consists of 2 separate procedures, thoracic esophagectomy and intrathoracic anastomosis of the graft with the remaining esophagus. These procedures can be performed using either VATS or robotic assistance.

FIGURE 4. Postoperative esophagography, 7 days after surgery. Postoperative esphagography at the seventh postoperative day showed securely located esophagogastrostomy at the level of thoracic inlet without evidence of leakage or stenosis.

TABLE 1. Patient Characteristics (Pathologic and Operative Data)

Age	64.2 ± 6.9 y
Sex	28 male/3 female
Pathologic stage	
pT1a/bN0	19
pT2N0	1
pT1N1	6 (4 patients had cT1N0)*
pT2N2	1
pT3N0	3 (1 patient had cT1N0)
pT3N1	1 (in patients with cT1N1)
Tumor size	2.40 ± 2.04 cm (0.7-11.0 cm)
Mean no. dissected LN	28.3
Mean no. dissected LN stations	7.9
Mean VATS time†	180.2 ± 39.2 min
Mean postoperative hospital stay	15.2 d (11 to 38 d)

*These 4 unexpected lymph node metastases, which had not been detected on preoperative evaluation, were found at recurrent laryngeal nerve stations in 3 cases and in an aortopulmonary lymph node in one.

†VATS time was calculated as the duration from the point of position change (from supine to lateral decubitus) to the end of general anesthesia.

LN indicates lymph node; VATS, video-assisted thoracic surgery.

For the VATS approach, either the left lateral decubitus or a prone position can be used, and both have their own pros and cons. At our institution, the first case of VATS esophagectomy was performed in the prone position. However, in the prone position, it was difficult to manipulate the endoscopic instruments and to set the thoracoscope port at an optimal position. Thus, we switched to using the left lateral decubitus position. As shown in Figure 2, we were able to use a similar port configuration as used in the VATS lobectomy in the lateral decubitus position with a more familiar angle of view. In addition, combined procedures for the lung or mediastinum could have been simultaneously performed if needed. Furthermore, if a conversion to thoracotomy was required, it could have been achieved easily and promptly by just extending the utility port without changing the patient position or surgical drape. The lung was effectively retracted using a retractor through the axillary port, and the esophagus was exposed from the thoracic inlet to the hiatus after division of the azygos vein without much difficulty.

The intercostal space in an average Asian is typically too narrow for the entry of an EEA stapler (even 25 mm-sized one). Squamous cell carcinoma occupies over 95% of esophageal carcinoma. Therefore, almost all the intrathoracic anastomoses for esophageal cancer were made at the level of the thoracic inlet at our hospital; therefore, the EEA stapler could not reach from the level of the sixth or lower intercostal space that was usually used in other reports. However, in those reports, adenocarcinoma was the dominant pathology, and, consequently, most anastomoses were made at the level of the carina or azygos vein. In contrast, the acute insertion angle from the fifth intercostal space made the intrathoracic insertion of the stapler more difficult. Early in the study period we first tried the fifth intercostal space as a utility window before rib resection; however, even the 25-mm EEA stapler could not pass through the ICS without crushing muscle and neurovascular structures in over 90% of patients. Therefore, to secure enough space for the entry of the EEA stapler and to prevent rib spreading and unnecessary trauma to the intercostal nerve, a short segment (3 or 4 cm) of the fifth rib was resected in our extracorporeal anastomosis technique, but the intercostal nerve and vessel were carefully preserved without any trauma or thermal injury. A self-expandable wound retractor (Alexis wound retractor; Applied Medical, CA) was applied to protect the bare muscles of the utility port. After thoracic esophagectomy, the gastric graft was extracted through this utility port to facilitate stapler insertion under direct vision, and reinserted into the thoracic cavity to reach the thoracic inlet for anastomosis. The anastomosis procedure was performed without unnecessary tension. The remaining stomach and opening for the stapler insertion were divided using flexible endosurgical staplers. This type of approach could be applied in intrathoracic anastomosis using other grafts, such as in the colon (which was used in 1 case in this series) or the jejunum, without significant modification.

We also performed tubularization of the gastric graft in the abdominal phase to enhance graft manipulation, increase the length of the graft, and to prevent malrotation and distortion of the graft in the mediastinum. So far, we have not used the laparoscopic approach for the abdominal phase of surgery for the following reasons: (a) most postoperative pain and complications of esophageal cancer surgery are related to the thoracotomy and thoracic procedures; (b) a feeding jejunostomy is our routine procedure; (c) we wished to prevent graft spiralization under direct vision during stapling to make the gastric tube; and (d) a complete abdominal lymph node dissection is necessary. Furthermore, we made the intrathoracic anastomosis at the level of the thoracic inlet. For this, careful preparation of the gastric graft is very important to obtain sufficient graft length and preserve the blood supply to the anastomosis site. However, as more experience accumulates, these problems would be resolved toward total MIS in esophageal cancer surgery.

An ultrasonic endoshear (Harmonic Ace curved shears) is very useful in esophageal cancer surgery because it can simultaneously divide the tissue and coagulate the microvessels and lymphatics, and it is very ergonomic with its scissor-like action. Because of these advantages, we used it to divide the omentum and short gastric artery in the stomach preparation, for esophageal dissection and hemostasis of feeding vessels, and for mediastinal lymph node dissection.

Mediastinal lymph node dissection for esophageal cancer is very important for accurate staging and adequate treatment. In a report by Pennathur et al,[15] esophagogastrostomy was established 2 cm above the carina, and upper mediastinal lymph node dissection was not performed thoroughly because most patients had distal esophageal or esophagogastric junction tumors. However, in our experience, unexpected lymph node metastasis was found most frequently in both recurrent laryngeal nerve lymph nodes. On the basis of this, we performed aggressive lymph node dissection, especially on the recurrent laryngeal nerve nodes, even if we had to risk thermal or tractional injury to the nerve. VATS offers a magnified view of mediastinal structures compared with the direct vision of open surgery, and all the visible mediastinal lymph nodes can be completely removed. During the lymph node dissection, we could trace the course of both recurrent laryngeal nerves and confirm that they were anatomically intact in all cases. The incidence rate of postoperative recurrent nerve palsy was found to be 16.1% (5 patients), which seems relatively high compared with the results from previous reports. However, all cases of vocal cord palsy were presented as unilateral paramedian fixation and were managed by thyroplasty ($n = 2$) or by swallowing practice alone ($n = 3$). Furthermore, as shown in Table 1, most of the unexpected lymphatic metastases were found in these recurrent laryngeal nerve nodes. The mean number of harvested lymph nodes and lymphatic stations seemed comparable to those reported for open surgery, although a statistical comparison was not conducted. When we first started using VATS esophageal cancer surgery, we strictly limited the indication to early-stage disease. However, we adapted rapidly because we were able to use almost the same approach and the VATS lobectomy technique for pulmonary disease, and we were confident that lymph node dissection under VATS for esophageal cancer was also feasible. Therefore, the indication for VATS in esophageal cancer can be extended to more advanced disease.

The outcomes of VATS esophagectomy and esophagogastrostomy were quite favorable. No patients experienced severe postoperative pulmonary complications, anastomotic leak, or other life-threatening morbidities. We also did not observe anastomotic stricture with VATS intrathoracic anastomosis. However, we could not estimate whether our VATS procedure contributed to shortening the hospital stay because all our esophageal cancer patients stayed in the hospital for 2 to 3 weeks under the aid of national health-care insurance until they could eat soft food. There was no delay in discharge due to problems related to surgery.

The quality of life of the patient is evidently superior with the Ivor Lewis procedure compared with open thoracotomy. Postoperative pain after the Ivor Lewis operation was mostly attributed to the open thoracotomy rather than the laparotomy. Patients frequently complain of chronic pain, even years after surgery, and they require oral opioid analgesics after discharge for at least 4 weeks. However, in this series, only 1 patient required the administration of intermittent oral analgesics for pain control, and the patient improved soon after that. In addition, the interval between surgery and initiation of adjuvant treatment might be shortened by virtue of rapid recovery.

The limitations of this study included: (a) lack of comparison with conventional open thoracotomy; (b) incomplete long-term survival data; and (c) insufficient objective measurement of quality of life. Much of these might be overcome by conducting a controlled comparative study of larger population, which we are currently getting into.

In conclusion, our VATS technique for esophagectomy and intrathoracic esophagogastrostomy can be performed safely and effectively in the lateral decubitus position with a utility incision by segmental rib cutting. The use of the latest ultrasonic devices and endosurgical staplers can facilitate the dissection and anastomosis of the intrathoracic esophagus. The early outcomes were comparable to those achieved with open surgery, and there was a significant decrease in postoperative pulmonary complications.

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