Ivor Lewis robotic assisted minimally invasive esophagectomy technique

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Abstract: Esophagectomy is the standard of care for localized esophageal cancer. However, it continues to carry a high rate of morbidity and mortality. Minimally invasive esophagectomy (MIE) has been increasingly adapted as the preferred surgical approach compared to open technique. In a high-volume center, MIE can be performed with faster postoperative recovery and a marked decrease in pulmonary complications while maintaining long-term oncologic outcomes that are equivalent to the open surgery. The preferred technique at the University of Pittsburgh for low to mid esophageal tumors is the Ivor Lewis approach. As the robotic technology has become more prevalent, we have begun to incorporate robotic assisted techniques to our MIE. The robotic assisted MIE (RAMIE) has shown to be feasible with similar rates of morbidity and mortality compared to MIE in retrospective studies. Although the two different approaches share a similar operative principle, there are slight differences in technique that have been identified during our practice. We describe our surgical technique in RAMIE using the Intuitive Surgical DaVinci Xi Robotic platform. We also highlight the importance of a multidisciplinary team approach, patient selection, and postoperative management in addition to the operative techniques.

Keywords: Esophageal cancer; esophagectomy; robotic surgery; minimally invasive

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Introduction

Esophagectomy remains the mainstay of multidisciplinary therapy for localized esophageal cancer. Despite the advances in surgical technique, esophagectomy still carries a high rate of morbidity and mortality. One of the advances has been the application of minimally invasive techniques. Minimally invasive esophagectomy (MIE) has shown faster postoperative recovery and a marked decrease in pulmonary complications while maintaining similar oncologic outcomes compared to an open esophagectomy (1).

More recently, robotic assisted MIE (RAMIE) has been described in institutional series, including ours at the University of Pittsburgh (2,3). There has not been a randomized study comparing MIE and RAMIE but retrospective studies have shown no difference in rates of mortality or morbidity (4). Here we describe our Ivor Lewis approach to RAMIE using the Intuitive Surgical DaVinci Xi Robotic platform.

Patient selection and workup

All patients with diagnosis of esophageal cancer undergo a staging workup which includes computed tomography of the chest abdomen pelvis, positron emission tomography, an esophagogastroduodenoscopy with biopsy, and an endoscopic ultrasound to assess nodal involvement. Patients with upper and mid esophageal tumors will also undergo bronchoscopy to assess the involvement of the airway. Patients with an early stage tumor (T1 and

T2) without nodal involvement are referred for surgery. Patients with locally advanced disease (T3 or any N) will be referred for neoadjuvant chemoradiation. These patients will also undergo diagnostic laparoscopy to assess for metastatic disease and surgical resectability. Often a feeding jejunostomy tube will be placed at the same time as diagnostic laparoscopy if there is a concern for malnutrition or severe malignant obstruction. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.

Pre-operative preparation

Once the patients are considered for esophagectomy, they undergo evaluation of their cardiopulmonary fitness, functional and nutritional status. If the patient had received neoadjuvant chemoradiation, we will wait 4 to 6 weeks prior to proceeding with surgery.

Equipment

The DaVinci Xi Robotic Surgical System with a 30-degree camera is utilized for all RAMIE. The robotic 8 mm instruments used are the fenestrated bipolar grasper, robotic ultrasonic shears, small grasping retractor, large suture cut needle driver, Cadiere forceps, and robotic monopolar shears. The robotic endovascular/endogastrointestinal stapler is also used via a robotic 12 mm trocar. The esophagogastric anastomosis is completed using a 28 mm EEA extra-long circular stapler (DST-XL, Covidien, USA). The Endostitch device with 2-0 permanent braided surgical suture is used for majority of non-robotic suturing. Other instruments that are routinely used are the liver retractor (DiamondFlex, USA) and its stabilization system, 5 mm suction/irrigator system, 5 mm 0-degree and 30-degree standard laparoscope, 12 French percutaneous jejunostomy and introducer, and 10 mm medium/large clip applier (Covidien, USA).

Procedure

Abdominal approach

The patient is placed in supine position towards the right side of the table to facilitate the placement of the liver retractor and its stabilization system. The right arm is positioned in abduction and the left arm is tucked to the side. A footboard is placed since steep reverse Trendelenburg will be used during the hiatal dissection. Prior to starting the case, esophagogastroscopy is performed in all patients to assess the esophagus and viability of the stomach as a conduit. This is especially important in the patient who has undergone neoadjuvant chemoradiation. Care is taken to limit the gas insufflation during esophagogastroscopy to prevent distention of the small bowel.

An 8 mm robotic camera port is place via cut down technique in the paramedian left upper abdomen. Alternatively, the abdomen can be entered with a 5 mm optical separator port under direct vision using a 5 mm 0-degree camera in the left upper abdomen. Standard CO_2 insufflation is achieved to a pressure of 15 mmHg. An 8 mm left subcostal port is placed at the mid clavicular line, and a 12 mm robotic stapling port with an 8 mm reducer in the same position on the right. A standard 5 mm port is placed as lateral as possible under the right costal margin for the liver retractor. Another left lateral 8 mm subcostal port is placed for use by the robotic atraumatic grasper. A standard 12 mm port is placed in the right paraumbilical position, as well as an additional more lateral 5 mm port for the assistant to suction and provide additional retraction, remove small specimens, and introduce suture.

The initial dissection begins by dividing the gastrohepatic ligament and dissecting the esophagus from the right and left crus. During the hiatal dissection, a portion of the crus can be resected *en bloc* with the esophagus for a bulky low esophageal tumor. Excessive mediastinal dissection is avoided at this time to prevent entry into the pleural spaces. Then the left gastric artery is identified and skeletonized. The robotic assistant arm can gently retract the stomach anteriorly to expose the pedicle of the left gastric artery. All lymphatic tissue along the left gastric is swept toward the stomach to be removed later with the specimen. Any bulky adenopathy near the celiac axis, aorta, and pancreas should be noted at this time because it may preclude proceeding with the resection. The left gastric artery is divided with a vascular stapler. If a significant replaced left hepatic artery is encountered, every attempt is made to preserve it during dissection. Keys to preserving the replaced left hepatic artery include skeletonizing the left gastric artery until the origin of the replaced left hepatic artery and then dividing the individual left gastric arteries just distal to the replaced left hepatic artery.

The greater curvature of the stomach is gently retracted medially and superiorly to expose the short gastric vessels. These vessels are divided using ultrasonic shears while fully preserving the gastroepiploic arcade. In patients who have undergone neoadjuvant chemoradiation, a pedicled omental flap is created along the greater curve to be placed between the conduit and the airway and around the anastomosis. Grasping any part of greater curvature of the stomach is avoided to limit the trauma to the later conduit. The dissection is carried cephalad to complete the left crural mobilization. The posterior stomach is mobilized from retroperitoneal structures by entering the lesser sac.

Pyloroplasty is performed in all our esophagectomies. The gastric antrum is retracted superiorly and leftward to expose the pylorus. Retraction sutures are placed at the pylorus superiorly and inferiorly. The pylorus is incised longitudinally using an ultrasound harmonic shears and closed transversely in an interrupted fashion using braided, non-absorbable sutures.

The fundus is grasped with an assistant robotic arm and retracted toward the left upper quadrant. Then the antrum of the stomach is grasped with an additional robotic arm and retracted inferiorly toward the right lower quadrant to reduce any redundancy in the stomach. The nasogastric tube is withdrawn into the esophagus. A 45 or 60 mm robotic endogastrointestinal stapler is used to create a straight, narrow gastric conduit approximately 3–4 cm in width (SureForm or SureFire robotic staplers, Intuitive Surgical, USA). The conduit formation is started at the antrum or 5 cm from the pylorus and carried cephalad once the desired width of the conduit is achieved. The gastric conduit is secured to the specimen in proper orientation to be later pulled up into the chest. A marking stitch is placed approximately at the level of the distal portion of the tubularized stomach to avoid bringing the residual antrum into the chest. Feeding jejunostomy is performed using standard laparoscopic technique and the abdominal approach is completed.

Thoracic approach

The patient is placed in left lateral decubitus position. A Veress needle is inserted and a saline drop test is performed to confirm intrapleural placement. CO_2 insufflation is achieved to 8 mmHg. An 8 mm robotic trocar is placed in the eight intercostal space for the laparoscopic camera. Alternatively, the robotic optical separator port can be used to enter the chest under direct vision with the use of a 5 mm 0-degree standard thoracoscope. Rest of the ports are placed under direct visualization. Two 8 mm ports are placed at the third and fifth intercostal spaces in the mid to posterior axillary line. Another 8 mm port is placed at the ninth intercostal space in line with the tip of the scapula. A 12 mm assistant port is placed right above the diaphragmatic reflection between the camera port and the lateral ninth intercostal space port.

The thoracic portion is started by dividing the pulmonary ligament up to the level of the inferior pulmonary vein. The anterior and posterior pleura to the esophagus is opened using a harmonic shears. All periesophageal lymph nodes are harvested with the specimen. When harvesting the subcarinal lymph nodes with a harmonic shears, attention must be paid to the close proximity of the posterior membrane of the mainstem bronchi and bronchus intermedius. Another approach is using a robotic bipolar Maryland forceps to prevent thermal injuries which may lead to complications of tracheobronchial fistulae. During the posterior esophageal dissection, large lymphatic branches from the thoracic duct and perforating arteries from the aorta are clipped. The circumferential dissection of the esophagus is carried to the level of the azygos vein. Once the esophagus is circumferentially mobilized, a Penrose drain can be placed around the esophagus to assist with retraction and exposure. The azygos vein is divided using an Endovascular robotic stapler. The vagus nerve is divided at the level of the azygos vein to prevent traction injury to the recurrent laryngeal nerve.

The specimen and the conduit are carefully brought up through the hiatus until the previously placed marking stitch is visualized. The conduit is properly oriented so that the staple line is facing posteriorly. The esophagus is sharply divided about 3 to 4 cm above the azygos vein. The posterior port site is extended to a mini access incision 4 cm in length. A wound protector device is used to remove the specimen.

The robotic atraumatic graspers are used to hold the proximal esophagus open while the 28 mm anvil of the end to end anastomotic stapler is introduced. A “baseball-stitch” purse-string suture is placed to secure the anvil in place. A second purse string suture is placed as a reinforcement.

The conduit is brought up to the proximal esophagus without any tension. A gastrostomy is made using an ultrasound shears adjacent to the staple line. The stapler is introduced through the previous mini thoracotomy incision and inserted through the gastrostomy into the proximal conduit. The stapler spike is brought out along the greater curve adjacent to the gastroepiploic arcade. The anvil and the spike are docked and the anastomosis is created. For patients who underwent neoadjuvant chemotherapy, an omental flap is placed between the conduit and the airway. A small drain is placed adjacent to the anastomosis and a right pleural chest tube is also placed.

Role of team members

All patients with esophageal cancer are discussed at multidisciplinary tumor board that includes medical oncology, radiology, pathology, and radiation oncology. Patients are evaluated by the nutritionist who provide a valuable resource pre- and postoperatively. In the operating room, we have a dedicated staff who are familiar with robotic surgery and its instruments. We work closely with the critical care team when the patients are located in the intensive care unit. When the patients are transferred to the step down unit, all the nursing staff are familiar with thoracic and foregut surgical patients. A dedicated bedside assistant familiar with robotic thoracic operations is present in all cases.

Post-operative management

Postoperatively, the patients are transferred to the ICU from the operating room. Every effort is made to extubate the patient at the end of the procedure. Patient is routinely transferred to the step down unit on postoperative day 1. Enteral nutrition is started through the jejunostomy tube on postoperative day 2. The nasogastric tube is removed and an esophagram is obtained on postoperative day 3–4. A liquid diet is initiated if there is no evidence of a leak. The right pleural chest tube is removed after the esophagram and the patients are discharged with the peri-anastomotic drain, which is removed at the first follow up visit in clinic.

Tips, tricks, and pitfalls

❖ A dedicated robotic team should be available for the cases. The team includes a scrub tech, bedside assistant, and circulating nurse who are familiar with the robot and its equipment.

❖ When mobilizing the stomach and creating the conduit, a "no touch" technique should be used. This prevents injury to the any vasculature to the conduit. If necessary, the stomach closer to the lesser curve where it will be resected with the specimen should be grasped.

❖ Maintain correct orientation of the conduit. The conduit is sutured to the specimen to prevent any twisting. The staple line of the conduit should face lateral in the thorax. Any tension as well as redundancy should be avoided after the anastomosis is completed. Redundancy of the conduit in the chest can cause a "shelving" of the conduit and contribute to postoperative dysphagia.

❖ Careful dissection must be performed near the airway to prevent thermal injury. Alternative to an ultrasonic shear, a bipolar Maryland forceps may be used for dissection.

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References

1. Straatman J, van der Wielen N, Cuesta MA, et al. Minimally invasive versus open esophageal resection: three-year follow-up of the previously reported randomized controlled trial: the TIME trial. Ann Surg 2017;266:232-6.
2. Okusanya OT, Hess NR, Luketich JD, et al. Technique of robotic assisted minimally invasive esophagectomy (RAMIE). J Vis Surg 2017;3:116.
3. Okusanya OT, Sarkaria IS, Hess NR, et al. Robotic assisted minimally invasive esophagectomy (RAMIE): the University of Pittsburgh Medical Center initial experience. Ann Cardiothorac Surg 2017;6:179-85.
4. Harbison GJ, Vossler JD, Yim NH, et al. Outcomes of robotic versus non-robotic minimally-invasive esophagectomy for esophageal cancer: an American College of Surgeons NSQIP database analysis. Am J Surg 2019;218:1223-8.

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