Robot-Assisted Thoracolaparoscopic Esophagectomy: The Netherlands

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Abstract

For locally advanced esophageal cancer, radical surgical resection is the mainstay of treatment. Lymph node metastases occur along the entire tract of the esophagus in an early stage. Optimal treatment involves neo-adjuvant chemoradiotherapy followed by a two field thoraco-abdominal en bloc esophagectomy with an extensive mediastinal and truncal lymph node dissection.

Techniques for minimally invasive esophagectomy have been introduced to reduce surgical trauma and morbidity of traditional open esophagectomy. However, conventional endoscopic surgery is limited by 2-dimensional vision, reduced dexterity and limited degrees of freedom. Robotic systems were developed to overcome such limitations, enabling the surgeon to perform complex minimally invasive surgical procedures. Advantages include reduced blood loss and fast postoperative recovery.

This chapter describes the indications and preoperative considerations for robot-assisted thoracolaparoscopic esophagectomy. Furthermore, anesthesiological management is discussed, addressing important intraoperative issues such as single lung ventilation and fluid management.

The three-stage operative procedure is described in detail. The thoracoscopic phase is performed using the robotic DaVinci Si system (Intuitive Surgical Inc., Sunnyvale CA, USA). The laparoscopic phase is performed with conventional laparoscopy. A gastric conduit is created extracorporally and a cervical esophagogastric anastomosis is formed.

Additionally, the clinical care of patients after esophagectomy is discussed with a specific focus on anastomotic leakage and chylous leakage.

Keywords

Esophagectomy • Thoracoscopy • Single lung ventilation • Laparoscopy • Gastric conduit • Lymph node dissection • Thoracic duct • Anastomotic leakage • Chylous leakage

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Esophageal cancer is the eighth most common type of malignancy and the sixth most common cause of cancer mortality in the world [1]. In 2002, approximately 462,000 patients were newly diagnosed with esophageal cancer [1]. The two most common histologic subtypes are esophageal squamous cell carcinoma (ESCC), arising from dysplastic squamous epithelium of the esophagus and esophageal adenocarcinoma

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(EAC), originating from dysplasia in columnar-lined esophagus with intestinal metaplasia (i.e. Barrett's esophagus) [2, 3]. The incidence of esophageal cancer has rapidly increased over the past decades, particularly due to a rise in EAC [4]. Worldwide the incidence of ESCC is highest [1].

Radical surgical resection is the mainstay of treatment for patients diagnosed with locally advanced esophageal cancer, combined with neo-adjuvant chemoradiotherapy, offering the best chance of cure [5]. Symptoms, such as dysphagia and retrosternal discomfort, arise only when the tumor is large enough to obstruct the esophageal lumen. Therefore, patients are frequently diagnosed at an advanced stage of disease. Consequently, less than half of patients are eligible for surgery due to tumor ingrowth into adjacent structures or due to the presence of distant metastases.

As the esophagus has a unique longitudinal lymphatic drainage system in the submucosal layer, lymph node metastases of esophageal cancer can occur along the entire tract of the esophagus from the cervical to the abdominal part. Optimal treatment for esophageal cancer, therefore, consists of transthoracic en bloc esophagectomy (TTE) with an extensive mediastinal lymph node dissection (LND). This approach through thoracotomy is accompanied by significant morbidity, mainly consisting of cardiopulmonary complications.

To reduce surgical trauma and morbidity of open transthoracic esophagectomy, less invasive surgical techniques such as transhiatal esophagectomy (THE) and minimally invasive esophagectomy (MIE) have been introduced. A randomized controlled trial by Hulscher et al. comparing the transthoracic versus transhiatal esophagectomy has shown the latter to have a lower complication rate [6]. However in the transhiatal approach a limited lymph node dissection is performed, with no dissection of the upper mediastinal lymph nodes [7, 8]. Approximately 30% of lymph node metastases in patients with cancer of the distal esophagus or gastro-esophageal junction (GEJ) are located in the upper mediastinum [9]. The transhiatal approach does not include these nodes leading to a trend towards a better survival for transthoracic over transhiatal esophagectomy [10, 11]. Other studies have mixed results, not clearly demonstrating superiority of the transthoracic approach [12–14].

Recent analyses of the MIE to date have shown a decreased operative blood loss, complication rate and hospital stay [15–17]. However, conventional endoscopic surgery has important limitations, such as a 2-dimensional view, a cumbersome hand-eye-coordination and limited degrees of freedom due to the rod-like, inflexible instruments. Robotic systems have been developed to overcome these limitations [18, 19]. During esophagectomy, the robotic platform enables the surgeon to perform an accurate mediastinal dissection. It allows *en bloc* resection of the esophagus with its surrounding mediastinal fat and lymphatic tissue, which often harbour metastatic disease. The available space for this dissection is often limited. In this particular aspect, the robotic approach excels in comparison with open thoracotomy or other MIE techniques. Robot-assisted thoracoscopic esophagectomy (RTE) in conjunction with conventional laparoscopy has shown to be technically feasible [9, 20]. Moreover, it provides sufficient oncological resection and is associated with low blood loss [9, 21].

12.1 Indications

Appropriate patient selection is essential to a successful esophageal surgery program. Depending on tumor stage and extent of comorbidities, 30–40% of esophageal cancer patients is eligible to undergo esophagectomy. The risk of postoperative complications is associated with advanced age and comorbidity. Additionally, prolonged single-lung ventilation during the thoracic phase may further increase the risk of pulmonary complications. Although the minimally invasive approach may offer a potentially curative surgical resection to a greater percentage of patients, careful patient selection remains critical. The presence and degree of comorbidities such as cardiovascular and pulmonary diseases and diabetes must be assessed in each individual case.

Furthermore, for distal tumors (lower third of the esophagus) and cardiac tumors, a laparoscopically-assisted transhiatal may be considered, rather than a robotic transthoracic approach. Other candidates for a laparoscopic transhiatal approach include patients with distal early stage (T1) tumors without evidence of distant adenopathy and absent to minimal local adenopathy on endoscopic ultrasonography (EUS) in whom endoscopic mucosal resection (EMR) did not achieve a complete resection.

12.2 Preoperative Considerations

Routine preoperative diagnostic investigations include esophagogastroscopy with tumor biopsy, endoscopic ultrasound (EUS), computed tomography (CT) of the chest and abdomen, ultrasonography of the neck with fine-needle aspiration of suspicious of cervical nodes, electrocardiography and lung function testing. Bronchoscopy is performed if airway involvement is suspected and [18F]fluorodeoxyglucose (FDG) positron emission tomography (PET) with CT fusion when metastases beyond the surgical field or organ metastases are suspected on CT. Any FDG-avid lesions are biopsied to confirm the presence of metastatic disease.

The proximal and distal borders of the tumor in the esophagus circumferential involvement, degree of obstruction, skip lesions and their location and the health of the remaining mucosa is determined by gastroscopy or EUS. Tumors are considered upper esophageal when they were located between 18 and 24 cm from the incisor teeth, mid oesophageal when located between 24 and 32 cm, and lower esophageal (including tumours of the GEJ) when located between 32 and 40 cm [22].

12.3 Anesthesia Management

Perioperative management involves a multi-specialty team consisting of surgical, anesthetic, critical care, physiotherapy, dietetic and nursing specialists. Standardized perioperative clinical protocols provide a framework for patient management aiming to improve efficiency and outcome. However, there is little evidence from randomized clinical trials to guide management of anaesthesia for esophagectomy. The section below highlights the anaesthesia for robot-assisted thoracoscopic esophagectomy (RTE) conducted in the University Medical Center Utrecht.

12.3.1 Preoperative

All patients planning to undergo RTE are seen by an anaesthesiologist in the Preoperative Clinic. The physical status of the patient is assessed and preoperative testing is guided by institutional guidelines. Patients with comorbidity and increased risk of perioperative complications (e.g. cardiovascular and pulmonary) will be referred for additional specialty care, and treatment as directed by the anaesthesiologist.

12.3.2 Perioperative

Thoracic epidural analgesia (TEA) and its effects during the postoperative period have been studied extensively. TEA most likely decreases the risk of postoperative respiratory failure and results in improved pain control [23, 24]. Furthermore, TEA may increase the blood supply to the esophago-gastric anastomosis area after esophagectomy [25]. Although there are no specific publications on the effects of TEA during minimally invasive esophagectomy, the advantages of TEA in the postoperative course of open esophagectomy is extrapolated to thoracoscopic esophagectomy.

Normally, the epidural catheter is placed between the fifth and the eight thoracic vertebrae. After insertion of the catheter, a test dose of lidocaine with epinephrine is administered to exclude subarachnoid or intravasal placement of the catheter. To avoid the risk of sympathicolysis, no additional boluses of local anaesthetics are given. Epidural sufentanil is used intraoperatively and a continuous infusion of bupivacaine and morphine is applied postoperatively. To enable selective deflation of the right lung during the thoracoscopic phase, patients are intubated with a left-sided double-lumen tube. Patients receive two large-bore peripheral cannulae, a central venous line in the right internal jugular vein, an arterial line, a urinary catheter and a nasogastric tube. Furthermore ASA standards for basic anaesthetic monitoring are applied [26]. Antibiotic prophylaxis is provided by i.v. administration of 2000 mg cefazolin and 500 mg metronidazole. Thirty minutes before incision, 10 mg/kg methylprednisolone is administered to minimize postoperative pulmonary complications [27].

Patients receive either propofol or volatile anaesthesia at the discretion of the attending anaesthesiologist. During the thoracoscopic phase of the operation patients are positioned in the left lateral decubitus position, and selective ventilation of the left lung is instituted. Continuous intravenous muscle relaxation is used to facilitate dissection of the esophagus along the trachea, azygos vein, aorta and pulmonary veins as sudden, unexpected movements of the patient could have detrimental effects. The patient must be protected against inadvertent contact from the motions of the robotic arms. After the instruments are connected to the arms of the robot and are placed inside the patient, the body position cannot be modified unless the instruments are disengaged and removed from the body cavity.

When the robotic system is in place, access to the patient in case of emergency is limited. Therefore, the surgical team should be capable of rapidly removing the robot if required.

12.3.3 Management of One-Lung Ventilation in RTE

The management of one-lung ventilation (OLV) remains challenging. Common problems include hypoxemia, failure to isolate the lungs properly and the potential for causing acute lung injury. To install OLV, a left-sided double-lumen tube (DLT) is used. Positioning of the DLT is most reliably achieved with a fiberoptic bronchoscope. It has been shown that left DLTs, when positioned only by inspection and auscultation, were in fact malpositioned in more than 33% of the cases [28]. After positioning the patient from supine to lateral, the position of the DLT is checked again routinely. Cuff pressure is measured to prevent high intracuff pressures and possible mucosal damage. Patients with a difficult airway present an extra challenge. Airways that are difficult for placement of a single-lumen tube (SLT) are even more difficult for placing a DLT because of its size and shape. Oral fiberoptic intubation with a DLT has been described in both awake and anesthetized patients [29]. Alternatives include the use of a bronchial blocker as well as the use of a tube exchanger. The latter may be used for inserting a DLT or changing a SLT for a DLT. As mentioned earlier, the development of hypoxemia is a problem. During OLV both lungs are perfused. Perfusion of the nonventilated lung inevitably leads to transpulmonary shunting, impairment of oxygenation and possible hypoxemia. Another important problem is the risk of acute lung injury, caused by volume or pressure induced stress of the ventilated lung. To decrease the incidence of hypoxemia and the risk of acute lung injury, a good ventilation strategy is important. In our institution, during OLV a protective lung ventilation (PLV) protocol is applied. This consists of a pressure-controlled ventilation strategy with a maximum pressure of 20 cm H_2O. Tidal volume is reduced to 6 ml/kg predicted body weight. Furthermore, 5 cm H_2O PEEP is routinely used. Although hypoxemia is a constant threat, the lowest possible fraction of inspired oxygen (FiO_2) is delivered to prevent oxidative damage and postoperative ALI [30].

In case of hypoxemia, the first treatment is an increase in FiO_2. If no improvement occurs, the surgeon is informed and the nonventilated lung is expanded with 100% oxygen. Our clinical experience suggests that dislocation of the DLT, atelectasis or bronchial occlusion of the ventilated lung with blood or secretions are the most occurring causes of hypoxemia. Therefore, immediate fiberoptic bronchoscopy is performed to rule out or even correct dislocation of the DLT and occluded bronchi. Once these are ruled out, a recruitment manoeuvre is performed to open possible atelectasis.

When hypoxemia persists, the administration of oxygen with or without CPAP to the nonventilated lung is a valuable option. Clear communication with the surgeon is necessary in these circumstances as both manoeuvres may have a negative impact on the surgical exposure during thoracoscopy. When applying CPAP, the nonventilated lung is first reinflated as CPAP alone does not inflate an atelectatic lung. At the end of the thoracoscopic phase, the nonventilated lung is reinflated under direct vision and extensive recruitment manoeuvres are performed after which two-lung ventilation is restarted and 10 cm H_2O PEEP is added. There is no more need for lung separation during the rest of the operation and usually the DLT is exchanged for a SLT. The risks and benefits of changing the DLT should be carefully considered. After large fluids shifts and an extended surgical procedure, swelling in the upper airways occurs relatively often. Exchanging the DLT for an SLT should be done under direct vision if possible. If adequate exposure is not possible, an airway exchanger may be used.

12.3.4 Fluid Management

Much has been written about intraoperative fluid administration. Several publications suggest that a restrictive fluid management reduces length of hospital stay, cost and complication rates. In our institution fluid strategy during RTE is aimed at a mildly positive fluid balance of approximately 500–1000 ml at the end of the procedure. Additional information is obtained from the use of FloTrac/Vigileo which calculates continuous cardiac output and stroke volume variation from arterial pressure waveform characteristics. These values can be used to predict the effect of extra boluses of fluid. Although not validated for thoracoscopic procedures, it has been validated for laparoscopic operations in pigs [31]. Therefore, FloTrac/Vigileo can be of assistance in the laparoscopic phase of the operation especially to predict fluid responsiveness and distinguish those patients with low cardiac output from hypovolemia and the patients that are in need of inotropic support. The use of central venous oxygen saturation may have additional value in particular in patients with decreased cardiac function. However, at the moment no large scale randomized trials are available.

12.3.5 Perioperative Complications

The most common complications encountered perioperatively include arrhythmias, most often seen as the result of manipulation of the heart during the thoracoscopic phase of the operation. Usually these arrhythmias are self-limited after interruption of the surgical manipulation. Another complication regularly seen is the development of a pneumomediastinum as a result of the opening of the hiatus during the laparoscopic phase of the operation. Hemodynamics may show the characteristics of a tension pneumothorax. Again the surgeon should be informed immediately and asked to lower the pressure of the pneumoperitoneum. If indicated, thoracic drains are inserted to relieve the pneumomediastinum.

12.3.6 Postoperative Care

Postoperatively all patients remain under general anaesthesia and are intubated until they are transferred to the intensive care unit. Extubation is aimed for the same day. Although immediate extubation in the operating room has been described and considered safe [32], we consider it appropriate to ventilate patients postoperatively until chest X-ray is obtained. When the X-ray shows no significant atelectasis, weaning from ventilation is started. As stated earlier, thoracic epidural analgesia improves pain control and decreases pulmonary complications. In order to ensure analgesia is satisfactory enough to enable mobilization and physiotherapy, each patient is visited on a daily basis by a pain service as long as the epidural catheter remains in place.

12.4 Procedures

12.4.1 Robot-Assisted Thoracoscopic Dissection

12.4.1.1 Instruments

- Hook
- Cadiere
- Needle driver
- Long tip forceps
- optional: Large Hem-o-lok® Clip Applier

12.4.1.2 Positioning

The patient is positioned in the left lateral decubitus position, tilted 45° towards the prone position. The operating table is flexed, lowering the legs and upper thorax (the patient is positioned with the xyphoid above the pivoting point of the table). This extends the thorax and widens intercostal space for introducing trocars. The bedside cart of the robotic system (DaVinci Si system, Intuitive Surgical Inc., Sunnyvale CA, USA) is brought into the operative field from the dorsocranial side of the patient (Fig. 12.1). Before incision, the right lung is desufflated. A 10-mm camera port is placed at the sixth intercostal space, posterior to the posterior axillary line. Two 8-mm ports are placed just anterior to the scapular rim in the fourth intercostal space and more posterior in the eighth intercostal space. Two thoracoscopic ports are used in the fifth and seventh intercostal spaces just posterior to the posterior axillary line. These ports are used for conventional thoracoscopic assistance such as suction, traction, and clipping. CO_2 insufflation of the thoracic cavity permits excellent vision, without the need for retracting the lung from the operative field. In case of a none-compliant lung, a retractor can be used.

12.4.1.3 Operative Steps

After division of any pulmonary adhesions and a proper overview of the operating field is achieved, the pulmonary ligament is divided. The parietal pleura is dissected at the anterior side of the esophagus from the diaphragm up to the azygos arch (Fig. 12.2). The azygos arch is carefully dissected and ligated using Hem-o-lok® clips (size Large, Teleflex Medical, Limerick PA, USA) applied with the robot. Then dissection of the parietal pleura is continued above the arch for a right paratracheal lymph node dissection. The right vagal nerve is dissected below the level of the carina. Subsequently, the parietal pleura is dissected at the posterior side of the esophagus cranially to caudally along the azygos

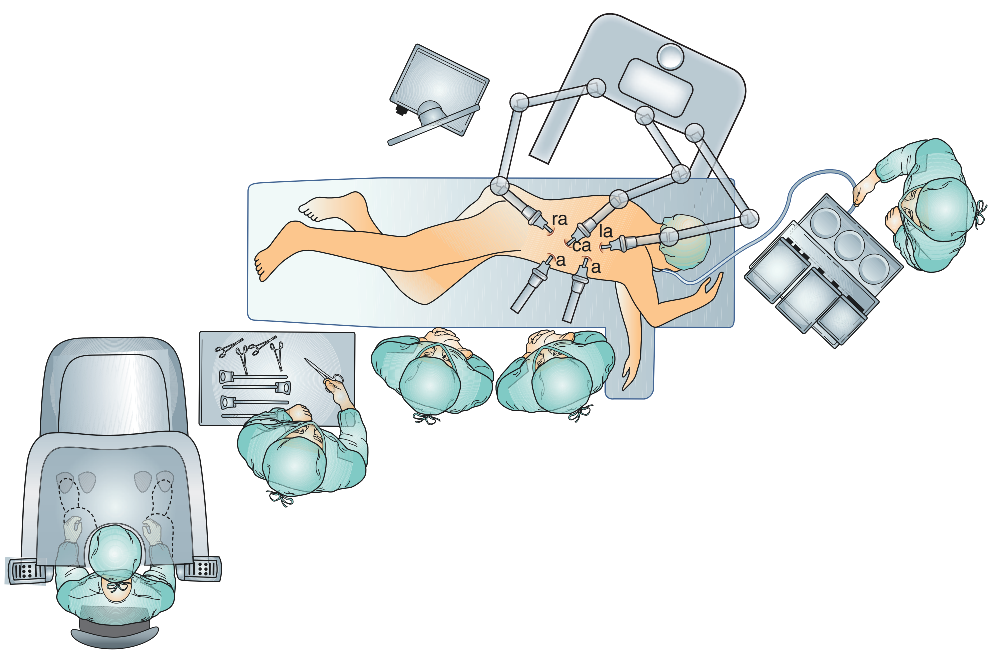

Fig. 12.1 Room organization and port site locations for the chest portion. Patient is positioned in the left lateral decubitus position, tilted 45° towards the prone position. The operating table is flexed, lowering the legs and upper thorax (the patient is positioned with the xyphoid above the pivoting point of the table). The bedside cart of the robotic system is brought from the dorsocranial side of the patient. Five chest ports are placed in the following manner: a 10-mm camera port (ca) is placed at the sixth intercostal space, posterior to the posterior axillary line. Two 8-mm ports are placed just anterior to the scapular rim in the fourth intercostal space and more posterior in the eighth intercostal space (ra and la). Two thoracoscopic ports (a) are used in the fifth and seventh intercostal spaces just posterior to the posterior axillary line. These ports are used for conventional thoracoscopic assistance such as suction, traction, and clipping

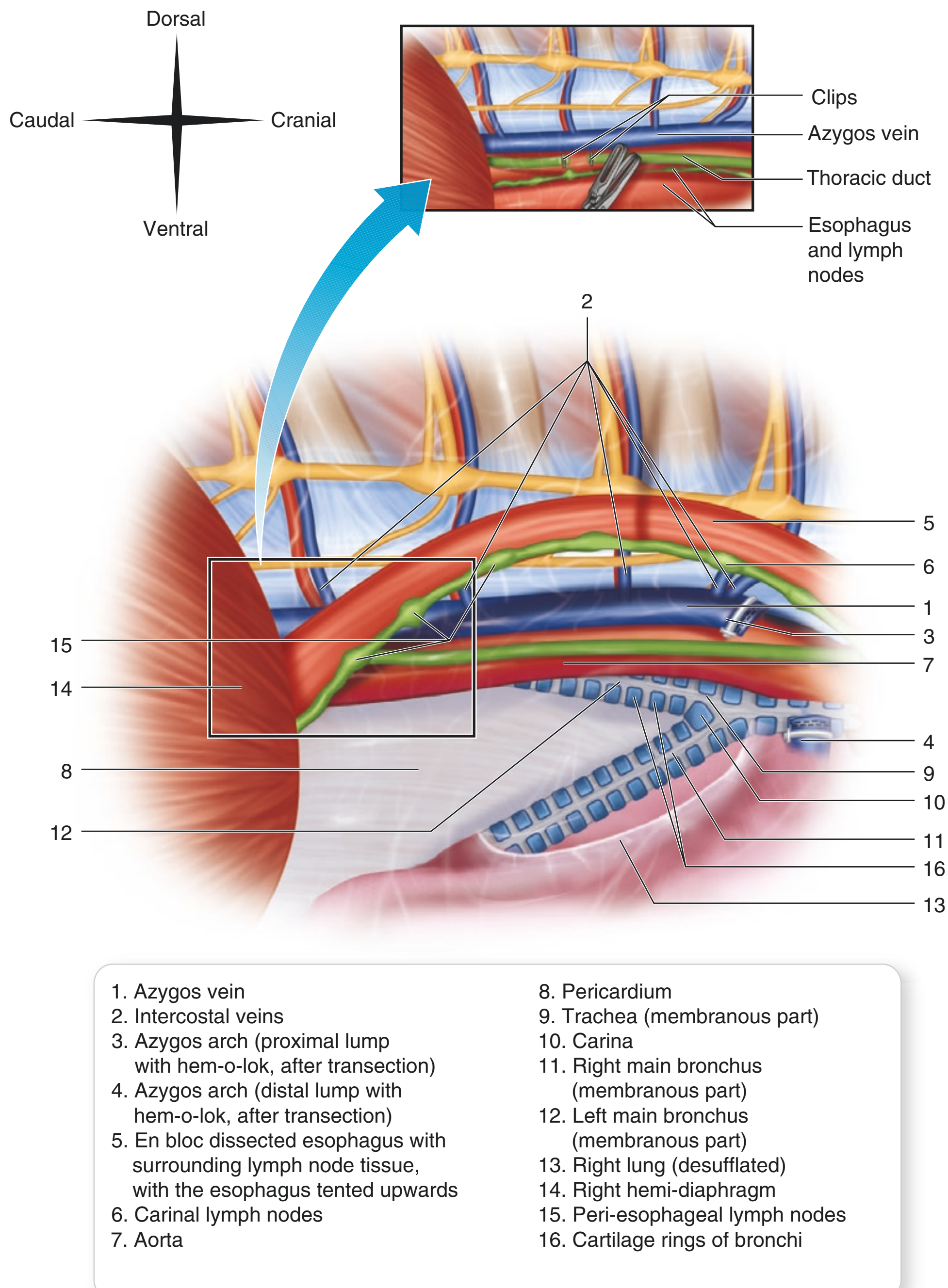

Fig. 12.2 Initiation of the thoracic esophagectomy. The pulmonary ligament is divided. The parietal pleura is dissected at the anterior side of the esophagus from the diaphragm up to the azygos arch

vein, including the thoracic duct. At the level of the diaphragm, the thoracic duct is clipped with a 10-mm endoscopic clipping device (EndoclipTM II; Covidien, Mansfield, Massachusetts, USA) to prevent postoperative chylous leakage (Fig. 12.3).

At the level of the diaphragm, a Penrose drain is placed around the esophagus to provide traction, which facilitates esophageal mobilization. The esophagus is then resected en bloc with the surrounding mediastinal lymph nodes and the thoracic duct from the diaphragm up to the thoracic inlet. Aortoesophageal vessels are identified and clipped by the assisting surgeon. The extensive lymphadenectomy includes the right-sided paratracheal (lymph node station 2R), tracheobronchial (lymph node station 4), aortopulmonary window (station 5), carinal (station 7) and peri-esophageal (station 8) lymph nodes. A 24-Fr chest tube is placed, and the lung is insufflated under direct vision.

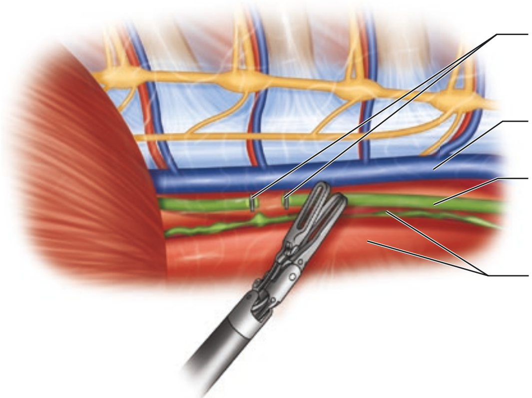

Fig. 12.3 Dissection of the mid-thoracic esophagus. The azygos arch is ligated. The parietal pleura is dissected at the posterior side of the esophagus cranially to caudally along the azygos vein, including the thoracic duct. At the level of the diaphragm, the thoracic duct (TD) is clipped with a 10-mm endoscopic clipping device to prevent postoperative chylous leakage

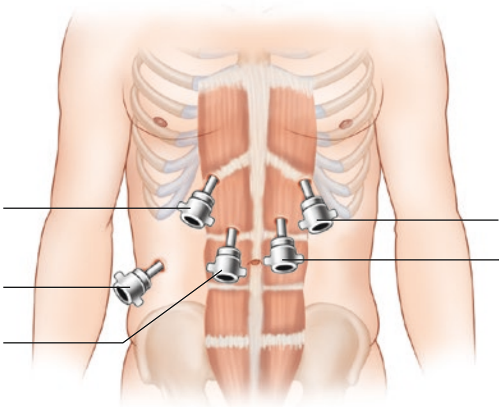

Fig. 12.4 Port placement for the abdominal laparoscopic portion. The patient is put in supine position. An 11-mm camera port is introduced left paraumbilically, and an 11-mm working port is placed at the left midclavicular line at the umbilical level. A 5-mm working port is placed more cranially at the right midclavicular line. A 5-mm assisting port is placed in the left subcostal area, and a 12-mm port is placed to the right of the rectus for the liver retractor. Using a matt retractor, the stomach and adjacent omentum is lifted anteriorly, exposing the retroperitoneum and celiac axis. Dissection and lymphadenectomy then continues around the celiac axis. The left gastric artery and vein then are transected at their origin. Abdominal lymphadenectomy includes lymph nodes surrounding the left gastric artery and the lesser omental lymph nodes

12.4.2 Laparoscopic Dissection

12.4.2.1 Instruments

- Harmonic scalpel
- 2× fenestrated bowel clamps
- Endopaddle
- Clipper

12.4.2.2 Positioning

After completion of the robot-assisted thoracoscopic esophageal mobilization, the patient is put in supine position. An 11-mm camera port is introduced left paraumbilically, and an 11-mm working port is placed at the left midclavicular line at the umbilical level. A 5-mm working port is placed more cranially at the right midclavicular line. A 5-mm assisting port is placed in the left subcostal area, and a 12-mm port is placed pararectally right for the liver retractor (Fig. 12.4). The abdomen is insufflated to a carbon dioxide pressure level of 15 mmHg.

12.4.2.3 Operative Steps

The hepatogastric ligament is opened. The greater and lesser curvatures are dissected with ultrasonic harmonic scalpel. The hiatus is opened, and the distal esophagus is dissected from the right and left crus. The carbon dioxide pressure level is reduced to 6 mmHg to avoid excessive intrathoracic pressure and a chest tube is placed in the left pleural sinus. Dissection and lymphadenectomy then continues around the celiac trunk (Fig. 12.5). The left gastric artery and vein then are transected at their origin. Abdominal lymphadenectomy includes lymph nodes surrounding the left gastric artery and the lesser omental lymph nodes.

The cervical esophagus is mobilized through a left-side longitudinal neck incision along the sternocleidoid muscle. No formal cervical lymph node dissection is carried out, but cervical lymph nodes are dissected if lymph node metastases are suspected macroscopically during the cervical phase of esophagectomy. The esophagus is dissected and a cord is attached to the proximal part of the specimen to enable pull-up of the gastric conduit along the anatomical tract of the esophagus.

The esophagus and surrounding lymph nodes are pulled into the abdomen under laparoscopic vision. A 7-cm transverse incision is made at the level of the left paraumbilical port for extraction of the specimen and stomach using a wound protector.

Outside the abdomen, a 5-cm-wide gastric tube is constructed with staplers (GIATM 80, 3·8 mm; Covidien, Dublin, Ireland), and the stapled line is oversewn with 3–0 polydioxanone. Routine extracorporal oversewing was reintroduced as two serious complications occurred when the staple line was not oversewn [20, 33]. The specimen consisting of the esophagus and cardia of the stomach is sent for pathological examination. After the gastric tube has been

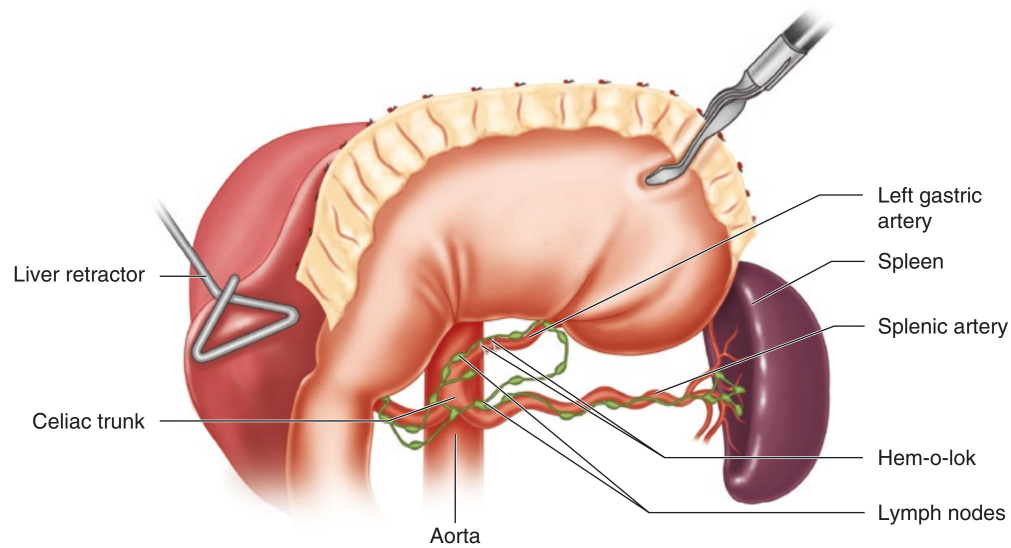

Fig. 12.5 Laparoscopic ligation of the left gastric artery and celiac axis lymphadenectomy. Using a matt retractor, the stomach and adjacent omentum is lifted anteriorly, exposing the retroperitoneum and celiac axis. Dissection and lymphadenectomy then continues around the celiac axis. The left gastric artery and vein then are transected at their origin. Abdominal lymphadenectomy includes lymph nodes surrounding the left gastric artery and the lesser omental lymph nodes

pulled to the neck, a hand-sewn end-to-side esophagogastrostomy is performed in the neck using 3–0 polydioxanone single-layer running sutures. Excess gastric tubing is removed using a GIA stapler.

A feeding jejunostomy is placed at the level of the transverse incision (Freka® FCJ-Set, Fresenius Kabi AG, Bad Homburg vd H., Germany).

12.5 Postoperative Care

12.5.1 Clinical Care

Postoperatively, patients are transferred to the intensive care unit (ICU). After leaving the operating room, mechanical ventilation is continued briefly usually extubating later that evening. After 1 day in the ICU patients are transferred to a medium care (MC) ward.

Important for postoperative care are a nasogastric tube, feeding jejunostomy and an epidural catheter. The nasogastric tube is used for gastric decompression and to provide a splinting in case of anastomotic dehiscence. Fixation of the tube is imperative, as re-introduction can cause damage to the anastomosis.

No oral intake is allowed for 7 days minimum. During that first week, feeding is provided by the feeding jejunostomy. After 7 days without any indication of anastomotic dehiscence sips of water are initiated. If there is no evidence of anastomotic leak, oral intake is gradually supplemented to solid foods under close supervision of a clinical nutritionist. The feeding jejunostomy is left *in situ* up to 6 weeks after discharge from the hospital. Only after sufficient intake is maintained, the jejunostomy is removed at the outpatient clinic.

Pain medication through the epidural catheter is required to improve postoperative ventilation and coughing. Other strategies to prevent postoperative pulmonary complications include elevation of the bed by 15°–30°, physical respiratory therapy and early mobilization.

12.5.2 Points of Interest

12.5.2.1 Anastomotic Leakage

Leakage of the esophago-gastrostomy can present itself in various ways. Possible clinical signs are fever, swelling, erythema or fluctuations in the neck, subcutaneous emphysema and pneumothorax. In case of anastomotic leakage, the neck wound is re-opened to enable drainage. Frequent cleaning and flushing of the wound is required. Leakage can occasionally drain to the mediastinum. This causes fever and mostly pleural effusion and atelectasis. The pleural cavity should be drained. The mediastinum is drained through the neck.

12.5.2.2 Chylous Leakage

The diagnosis of chylous leakage is based on excessive drainage of milk-like fluid from a thoracic drain containing an elevated level of triglycerides and increased concentration of chylomicrons. Long chain triglycerides (LCT) are drained through the thoracic duct. By eliminating LCTs from the diet less triglycerides will be drained, reducing chylous production. To sustain energy intake, medium chain triglycerides which are absorbed directly through the portal system, can be added to the patient's diet.

When a clinical suspicion of chylous leakage arises, concentrations of triglycerides and cholesterol in both serum and drain fluids need to be examined. A triglyceride drainfluid-serum ratio of more than 10 and a cholesterol drainfluid-serum ratio of less than 1 is typical for chylous leakage.

Mild chylous leakage (<500 cm^3/24 h) is conservatively treated with adapted enteral feeding (MCT) and ceasing oral intake. Mild to serious leakage (500–1000 cm^3/24 h) requires MCT feeding or total parenteral feeding (TPF). Serious leakage of more than 1000 cm^3/24 h is treated with TPF without any enteral or oral type of feeding.

12.5.3 Outpatient Care

After discharge from hospital, patients are seen frequently every 2–4 weeks to make sure their weight is stable and eating is tolerated. In case of weight loss of more than 2 kg, tube feeding is started through the jejunostomy. After the initial visits, patients are seen every 3–4 months in the first year, at 6-month intervals in the second year, and annually thereafter. At each visit, a medical interview and physical examination are carried out. Diagnostic modalities such as gastroscopy with biopsy, CT, FDG-PET or magnetic resonance imaging are only performed if tumour recurrence is suspected, in accordance with the 2006 National Comprehensive Cancer Network Esophageal Cancer Clinical Practice Guidelines [34].

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