Operative Techniques in Thoracic and Cardiovascular Surgery

General Thoracic Surgery

Radical En Bloc Esophagectomy for Carcinoma of the Esophagus

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Despite the rising interest in preoperative chemo-radiation in the treatment of patients with esophageal cancer, the results of nearly all randomized trials offer little if any support for this strategy.[1-12] It is, therefore, my view that in the absence of a clinical trial, primary surgical resection remains the standard of surgical care for eligible patients with this disease. However, there is ongoing controversy among both thoracic and general surgeons as to the extent of surgical resection. Most would agree that patients with intramucosal carcinoma, or even perhaps submucosal carcinoma, can be treated by standard resection techniques such as transhiatal esophagectomy or conventional transthoracic resection, with a reasonable expectation of prolonged survival and perhaps cure. The controversy centers on those patients with malignant mural penetration beyond the submucosa (T2/T3) and those with clinically evident (N1 by endosonography or CT scan) or pathologically confirmed nodal disease (N1 by transesophageal fine needle aspiration). Advocates of conventional resection argue that, in such instances, cure with surgical resection is a chance phenomena, since the disease is likely systemic in nature. Advocates of extended or radical resection, myself included, believe that a meaningful prolongation of survival and perhaps cure may yet be possible in a small, but significant number of patients within this group. The results of the only randomized trial comparing radical en bloc esophagectomy with transhiatal esophagectomy showed a trend toward a survival benefit after radical en bloc esophagectomy.[13] Patients who underwent radical resection had a 10% improvement in both overall and disease free survival; however, the difference in survival between the two groups did not achieve statistical significance. The survival results reported from our institution and others advocating a similar surgical strategy have shown that 5-year survival after radical en bloc esophagectomy exceeds that reported in the literature after transhiatal esophagectomy.[14] This survival benefit is especially evident in patients with T3N0 tumors where 5-year survival exceeds 50%.

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Preoperative Evaluation

A full staging workup is always performed to determine the clinical TNM stage. In my practice, a positron emission scan has largely replaced computed tomography (CT) scan of the chest and abdomen to exclude radiographic evidence of distant metastases. The value of CT scanning in determining malignant mural penetration is suboptimal. Blurring of the outer margin of the esophagus in the area of the tumor is suggestive of transmural disease; however, lesser degrees of penetration are less easily identified. Similarly, the CT scan is of limited value in predicting the presence of nodal disease, with an overall diagnostic accuracy of 50%. Endoscopic ultrasonography (EUS) is frequently used to define the T and N factors more accurately. The diagnostic accuracy of EUS in determining transmural disease (T-3) is almost 80%, whereas nodal metastases are predicted with a 60% to 70% accuracy. Occasionally a transesophageal needle aspiration of suspected nodal areas can be done under EUS guidance. Although some have suggested that minimally invasive techniques, such as a laparoscopy or thoracoscopy, can be used for staging purposes, we have generally found such procedures time-consuming and of little added benefit, and possibly harmful when the curative en bloc resection field is violated.

The principle causes of nontechnical morbidity and mortality are pulmonary and cardiovascular complications. Age alone is not a determining factor. Accordingly, detailed pulmonary function testing is performed, as is a cardiologic evaluation, including stress testing. To evaluate choices for reconstruction, an upper gastrointestinal endoscopy or barium study determines the normality of the stomach or duodenum, and a colonoscopy or barium enema establishes the colon as an alternative organ for reconstruction.

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doi:10.1053/j.optechstcvs.2005.02.004

Operative Procedure

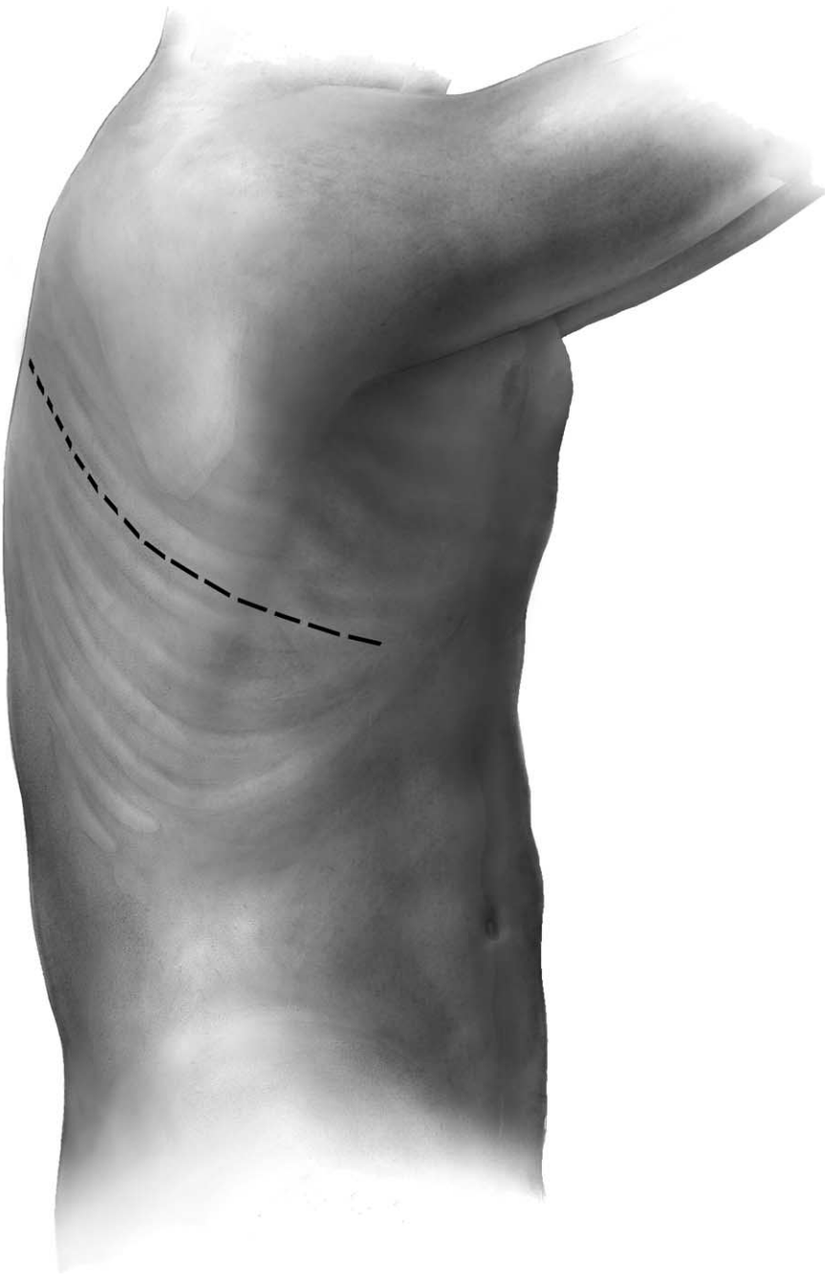

Figure 1 After successful placement of an epidural catheter for postoperative analgesia, the patient is placed in the left lateral position. A straight right lateral thoracotomy is performed and access to the hemithorax is obtained through the fifth interspace. The sixth rib is not resected; however, a one centimeter segment of rib undercover of the paraspinal fascia is excised to facilitate retraction of the rib cage. Occasionally, tumors at the gastroesophageal junction and tumors within the hiatal tunnel are approached through a left sixth interspace thoracotomy—abdominal access in such cases is achieved through a peripheral semilunar diaphragmatic incision.

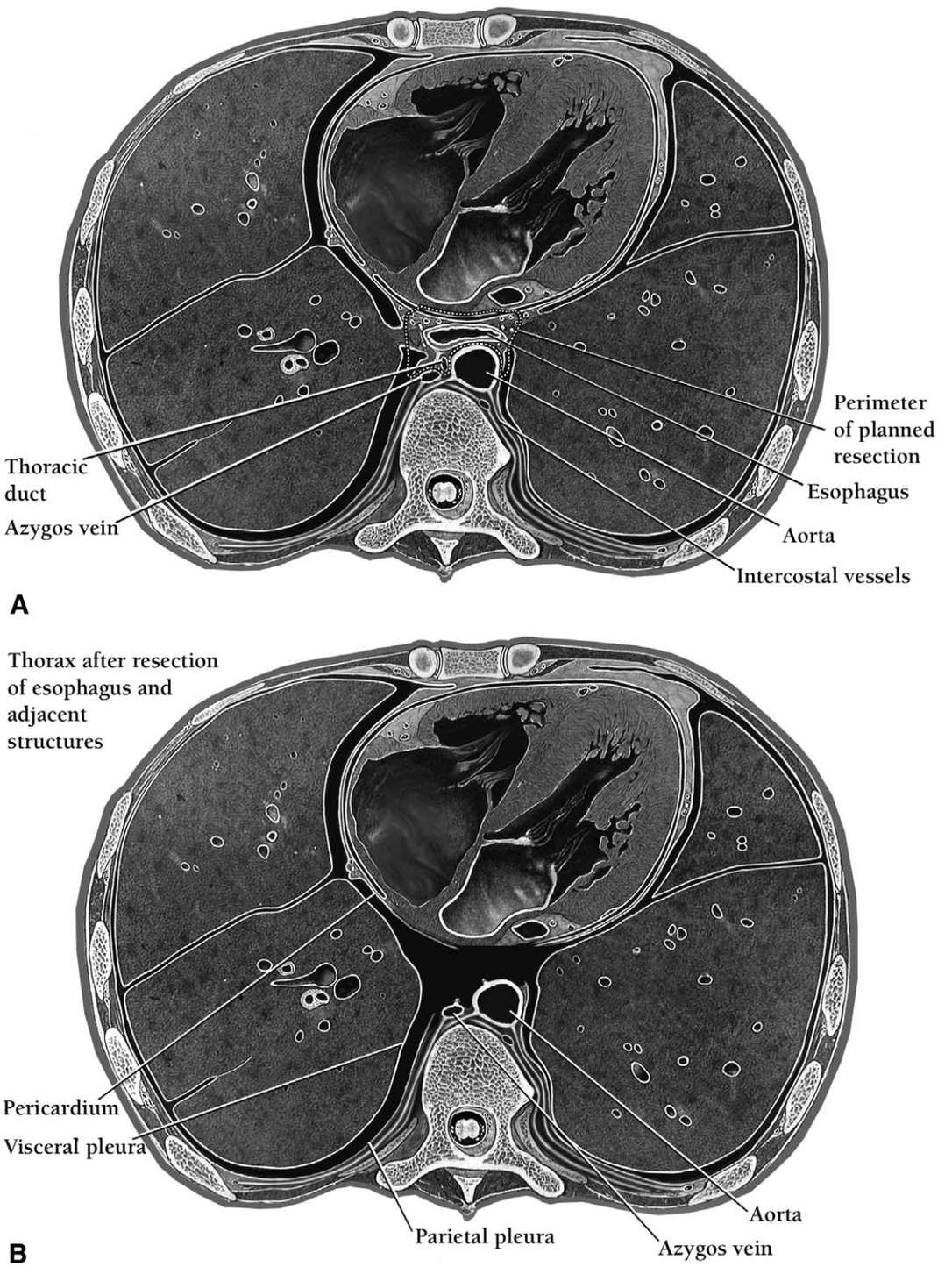

Figure 2 (A and B) The basic concept of an en bloc resection is extirpation of the tumor-bearing esophagus within a bloc of surrounding tissues including both pleural surfaces abutting the esophagus laterally, the dorsal lymphovascular tissue wedged between the esophagus and the descending thoracic aorta, including the thoracic duct and a patch of pericardium where the latter abuts the tumor bearing segment of the esophagus.

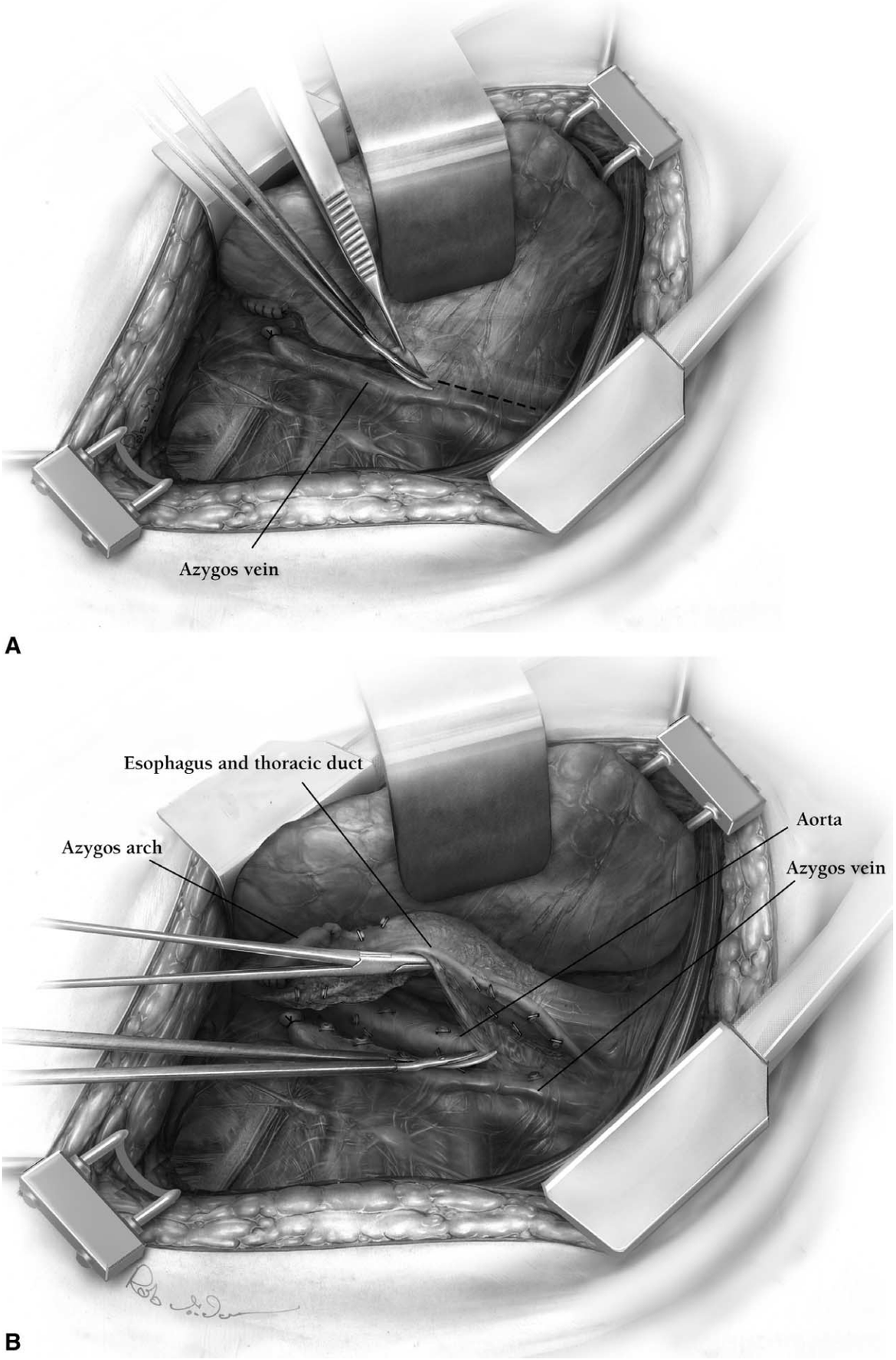

Figure 3 (A and B) The dissection begins by incising the mediastinal pleura directly overlying the trunk of the azygous vein from the level of the azygous arch superiorly to the aortic hiatus inferiorly. Dissection continues dorsally and to the left until the descending thoracic aorta is encountered mobilizing the thoracic duct anteriorly toward the en bloc specimen. All lymphatic tributaries of the duct are either clipped or ligated.

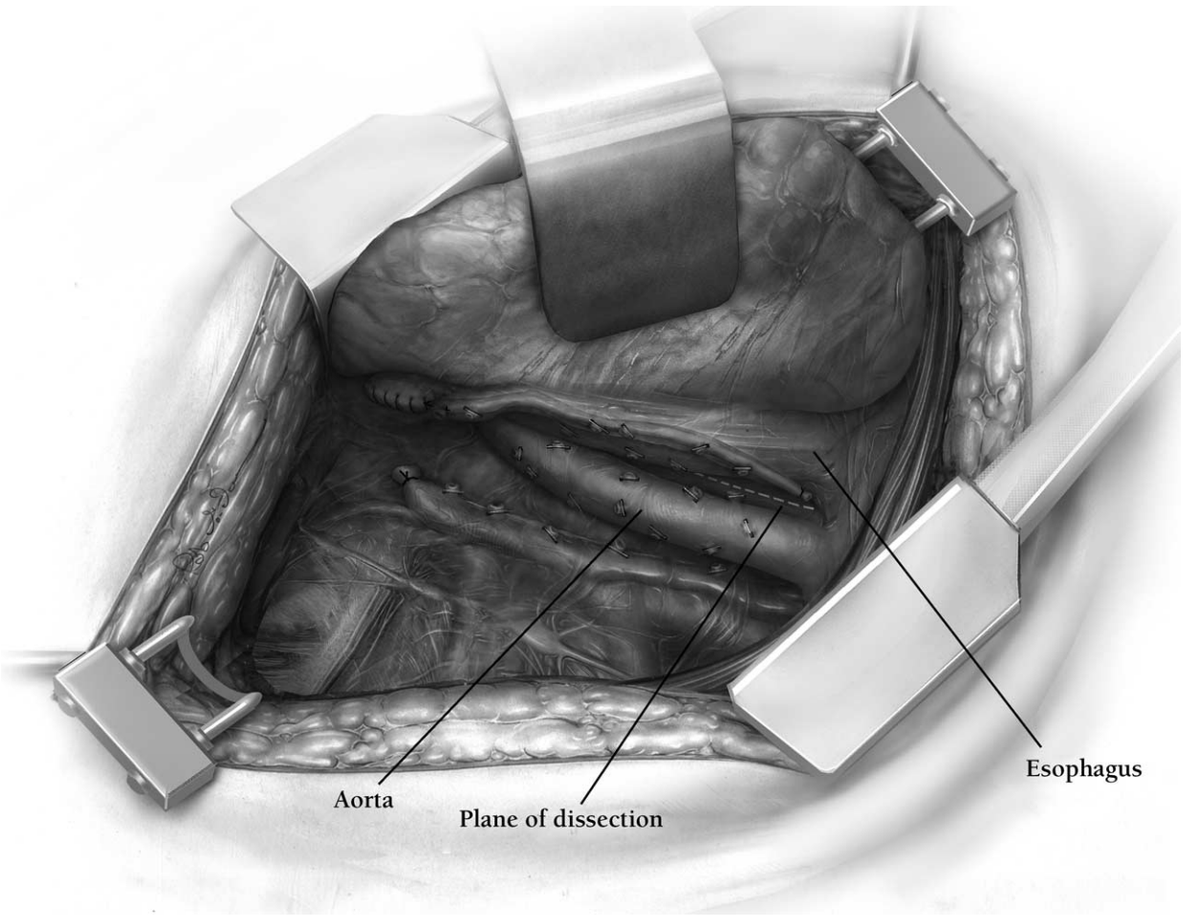

Figure 4 Once the aorta is encountered, dissection proceeds anterior to the aorta ligating all esophageal and bronchial vessels. Finally, with strong forward retraction, the contralateral pleura is seen and incised from the level of the left main bronchus to the diaphragm. Ligation and division of the thoracic duct inferiorly at the aortic hiatus and superiorly at the azygous arch concludes the posterior dissection.

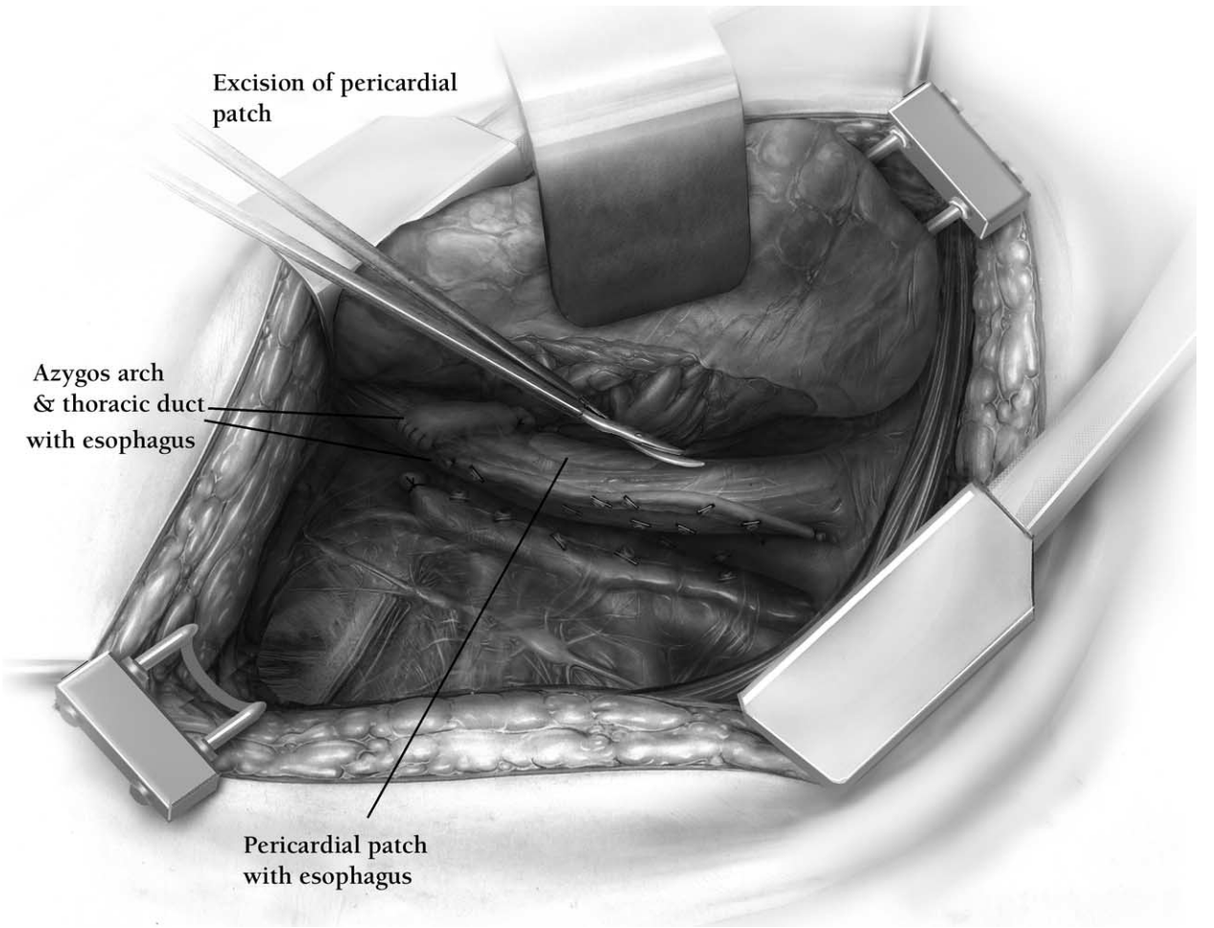

Figure 5 The anterior dissection begins by division of the azygous arch at its caval junction anteriorly. Further dissection proceeds along the right main bronchus with dissection of the subcarinal space and along the medial border of the left main bronchus. The dissection then proceeds inferiorly where the pericardium is incised just anterior to the tumor bearing segment of the esophagus. Working from within the pericardial cavity, a quadrangular patch of pericardium is excised en-bloc with the tumor bearing segment of the esophagus.

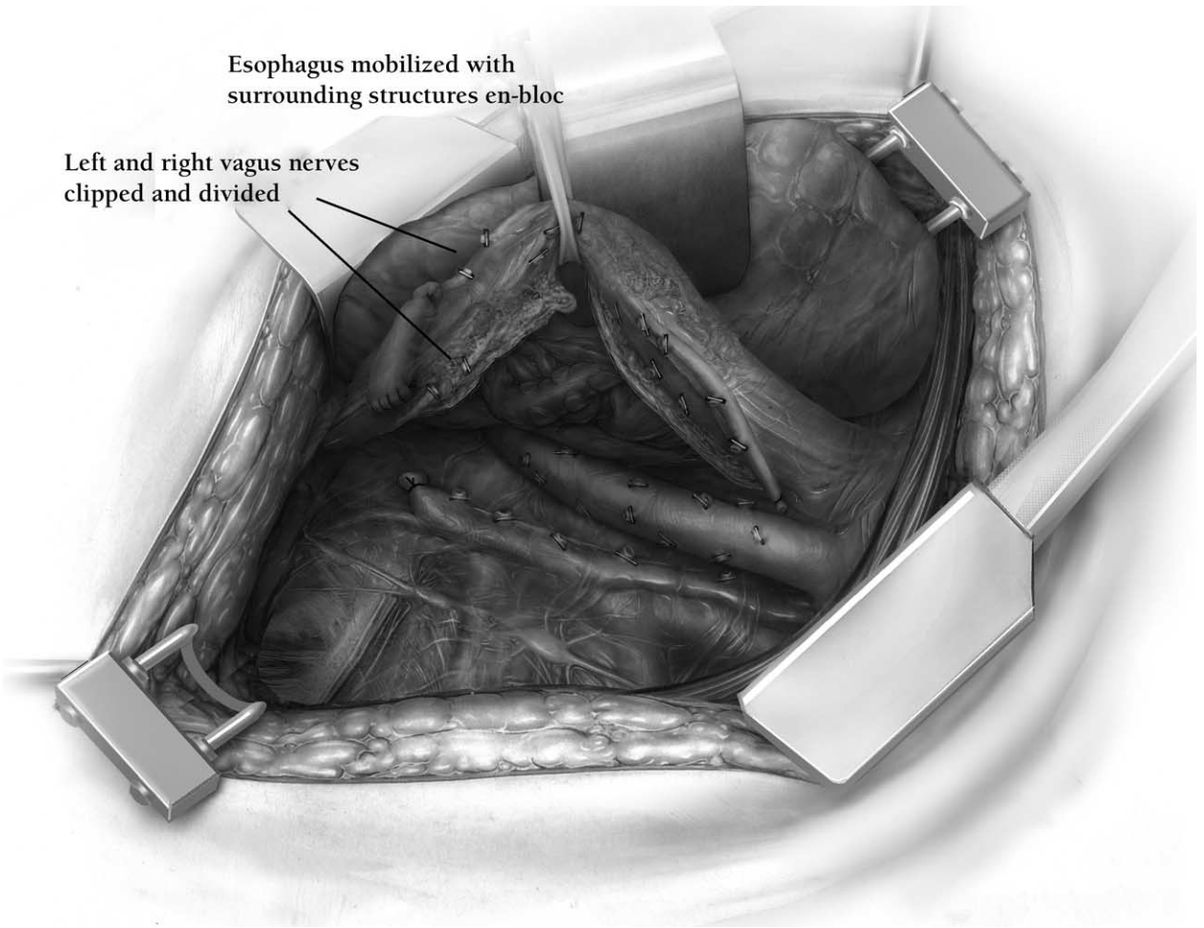

Figure 6 Once the pericardial patch is excised, a plane is developed medial to the left main bronchus and the en bloc specimen is encircled in an umbilical tape or penrose drain. Both vagus nerves are identified and divided at this point. The diagram illustrates the completed dissection of the subcarinal space, the periarotic tissue with the ligated thoracic duct, and the exposed left lung and myocardium.

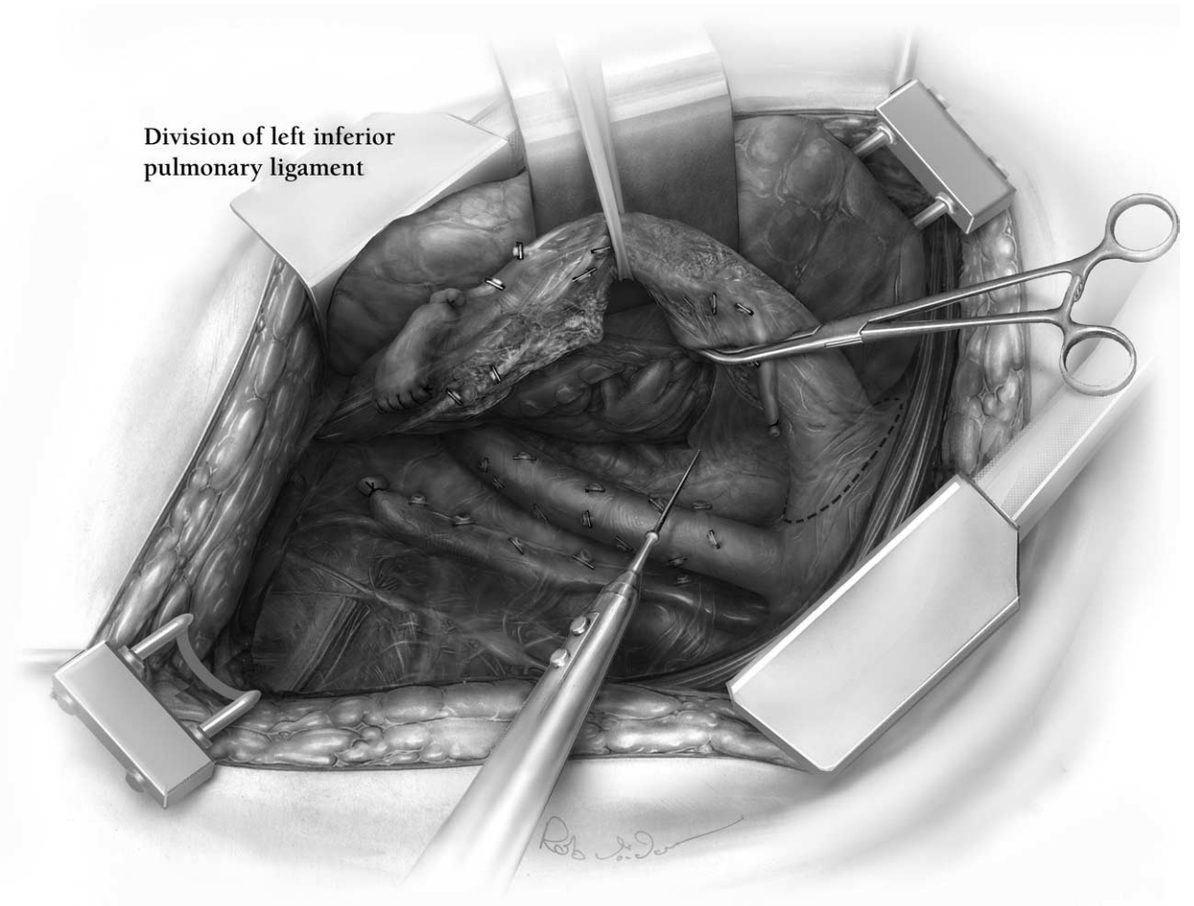

Figure 7 Dissection of the distal third of the esophagus proceeds by division of the right inferior pulmonary ligament and dissection along the pleuro-pericardial reflection. The specimen is then lifted from within the mediastinum and the contralateral inferior pulmonary ligament is divided, avoiding injury to the left inferior pulmonary vein. With strong traction on the specimen, the cautery is used to resect a circumferential one inch ring of diaphragm around the esophagus at the hiatus.

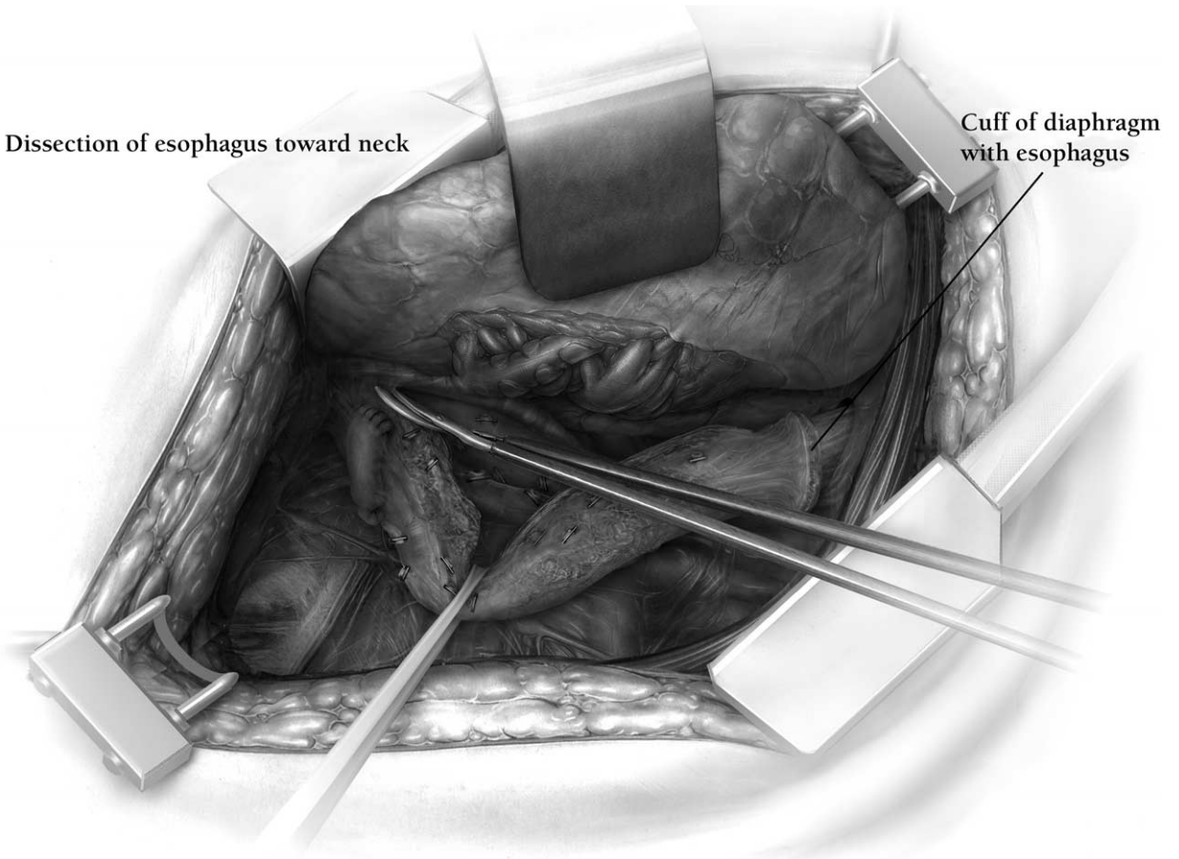

Figure 8 Superiorly, the esophagus is mobilized by blunt and sharp dissection from the prevetebral tissue and the membranous trachea to the neck. This dissection is carried bluntly and sharply all the way to the prevertebral space in the neck. This maneuver will greatly facilitate retrieval of the mobilized esophagus through the cervical incision. This completes the intrathoracic portion of the procedure. The right hemithorax is drained and closed. The patient is repositioned for the cervical and abdominal portions of the operation.

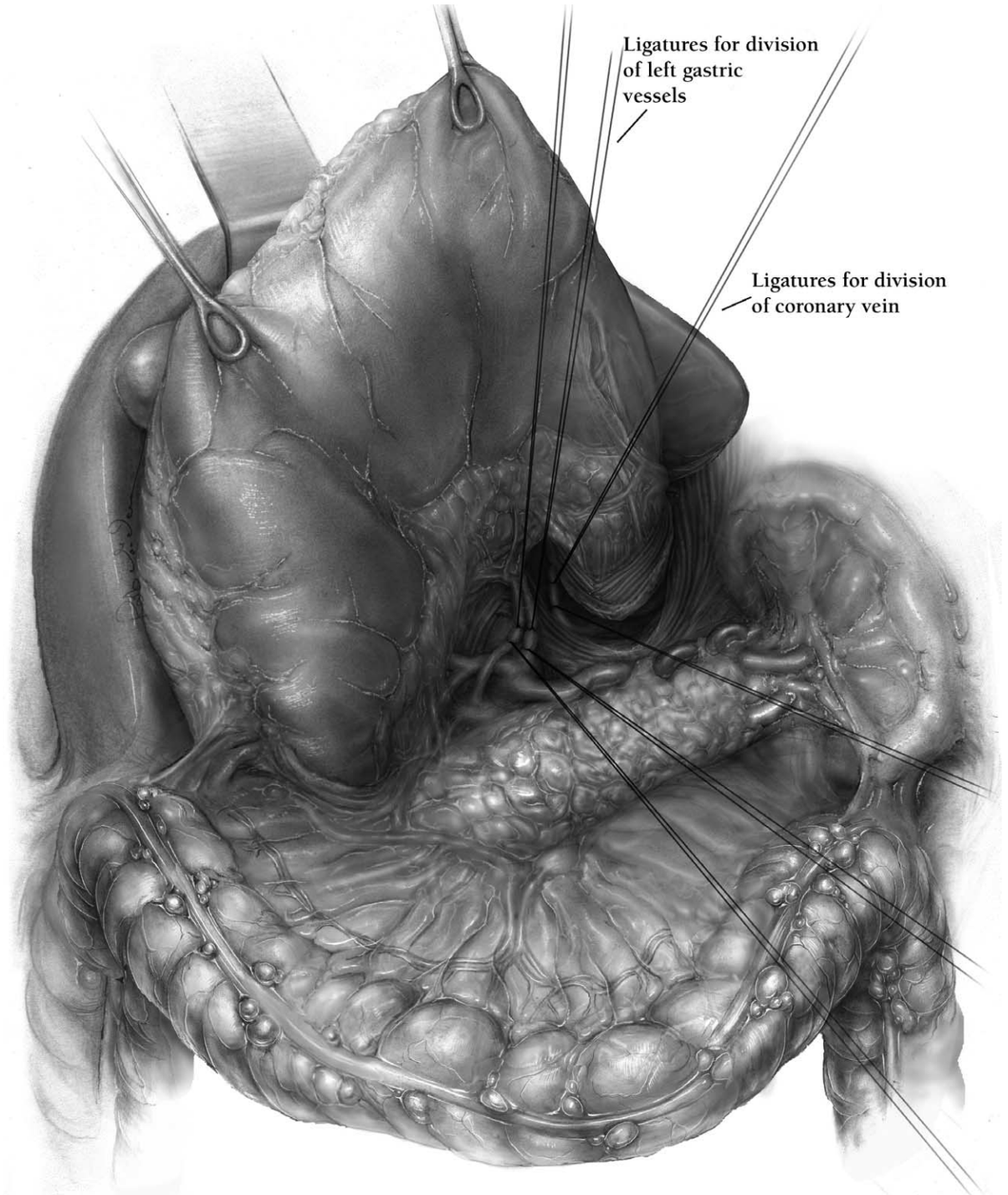

Figure 9 The abdomen is entered through an upper midline incision. Division of the left triangular ligament and retraction of the left lobe of the liver greatly facilitates exposure of the upper abdomen. The omentum is separated from the mesocolon in the avascular plane and the short gastric vessels are ligated and divided. The lesser sac is entered and the stomach is retracted cephalad. The retroperitoreum is incised along the splenic artery to the celiac access. All lymphatics superior to the pancreas are swept toward the hiatus. The left gastric artery and coronary vein are ligated and transected. The lymph nodes along the common hepatic artery are also resected.

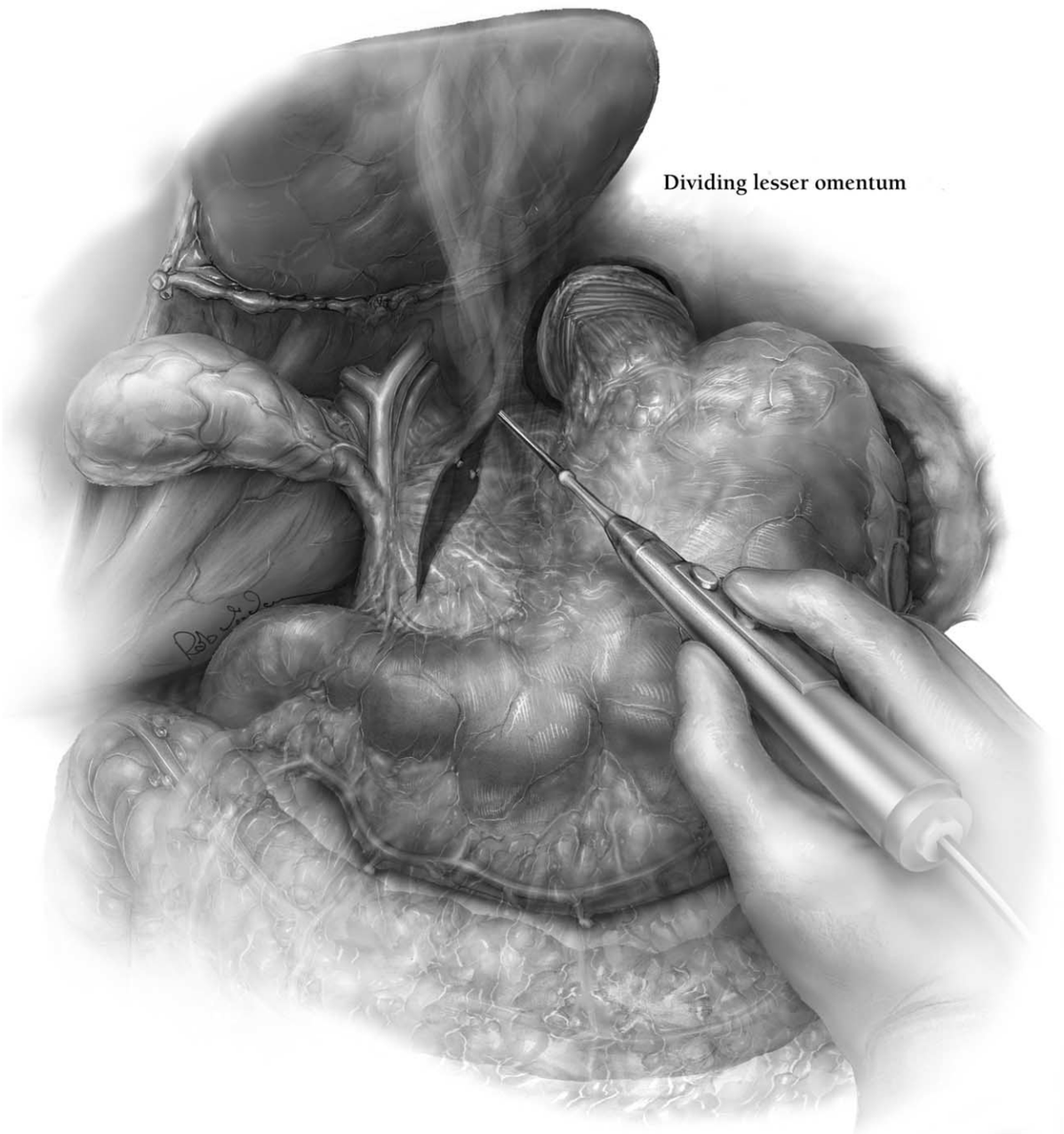

Figure 10 The electrocautery is used to complete division of the diaphragm if necessary, and to divide the gastrohepatic ligament. A Kocher maneuver is usually performed and a pyloromyotomy is always done.

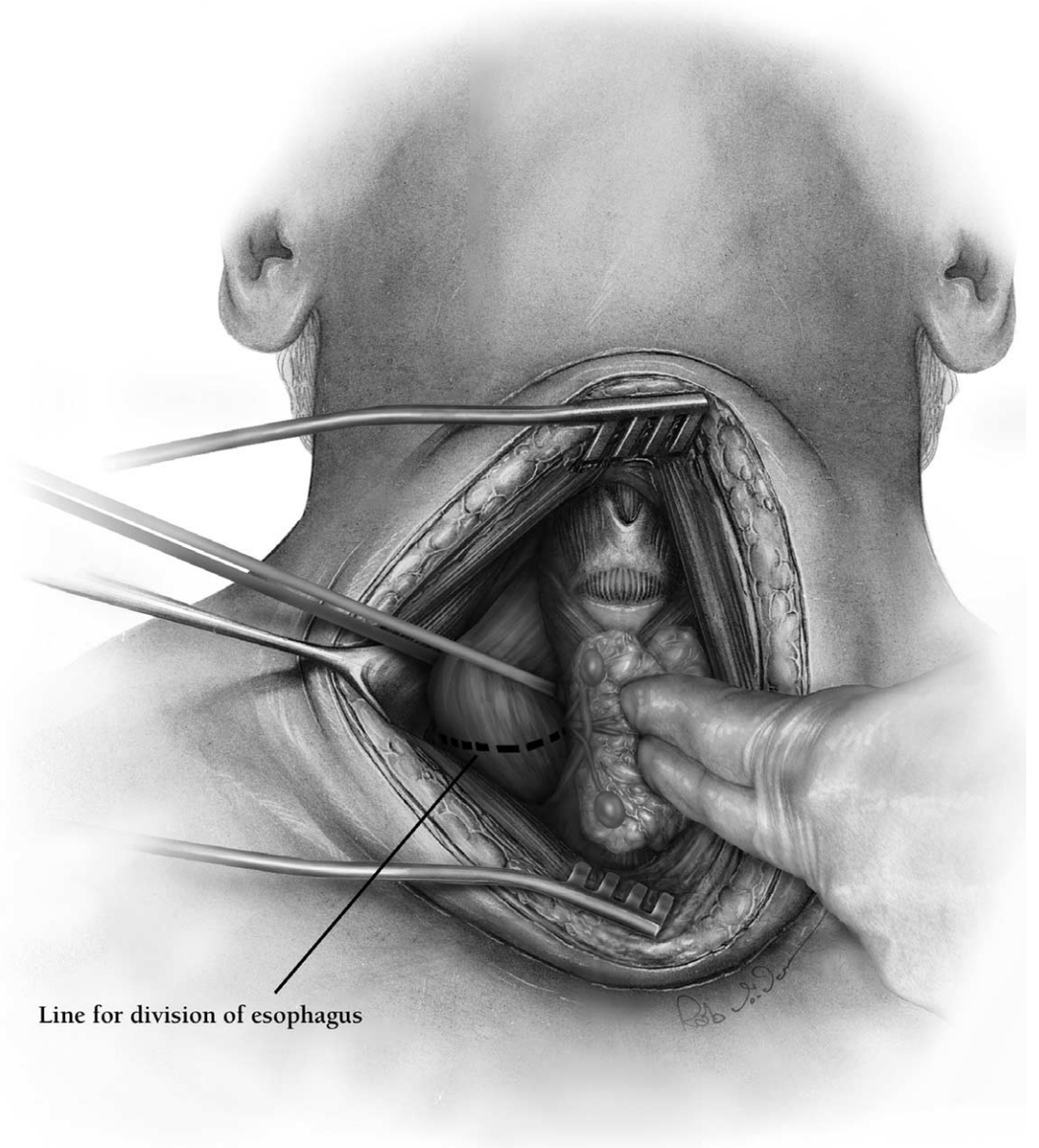

Figure 11 Through a transverse cervical incision the prevetebral space is entered, and the previously mobilized cervical esophagus is easily retrieved and transected.

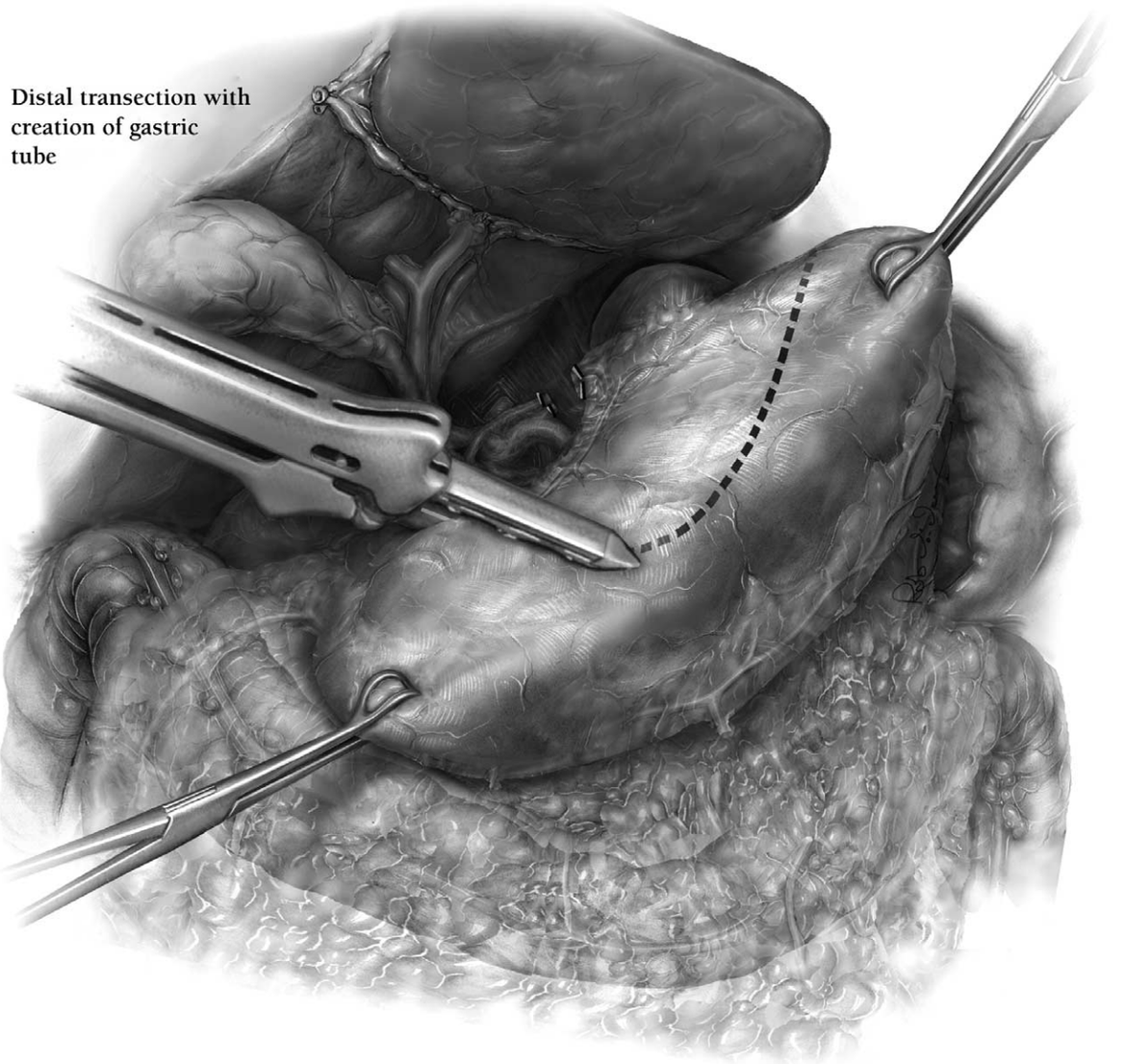

Figure 12 The en bloc specimen is pulled into the abdominal cavity and transected distally using a stapling device, thus simultaneously creating a greater curvature gastric tube.

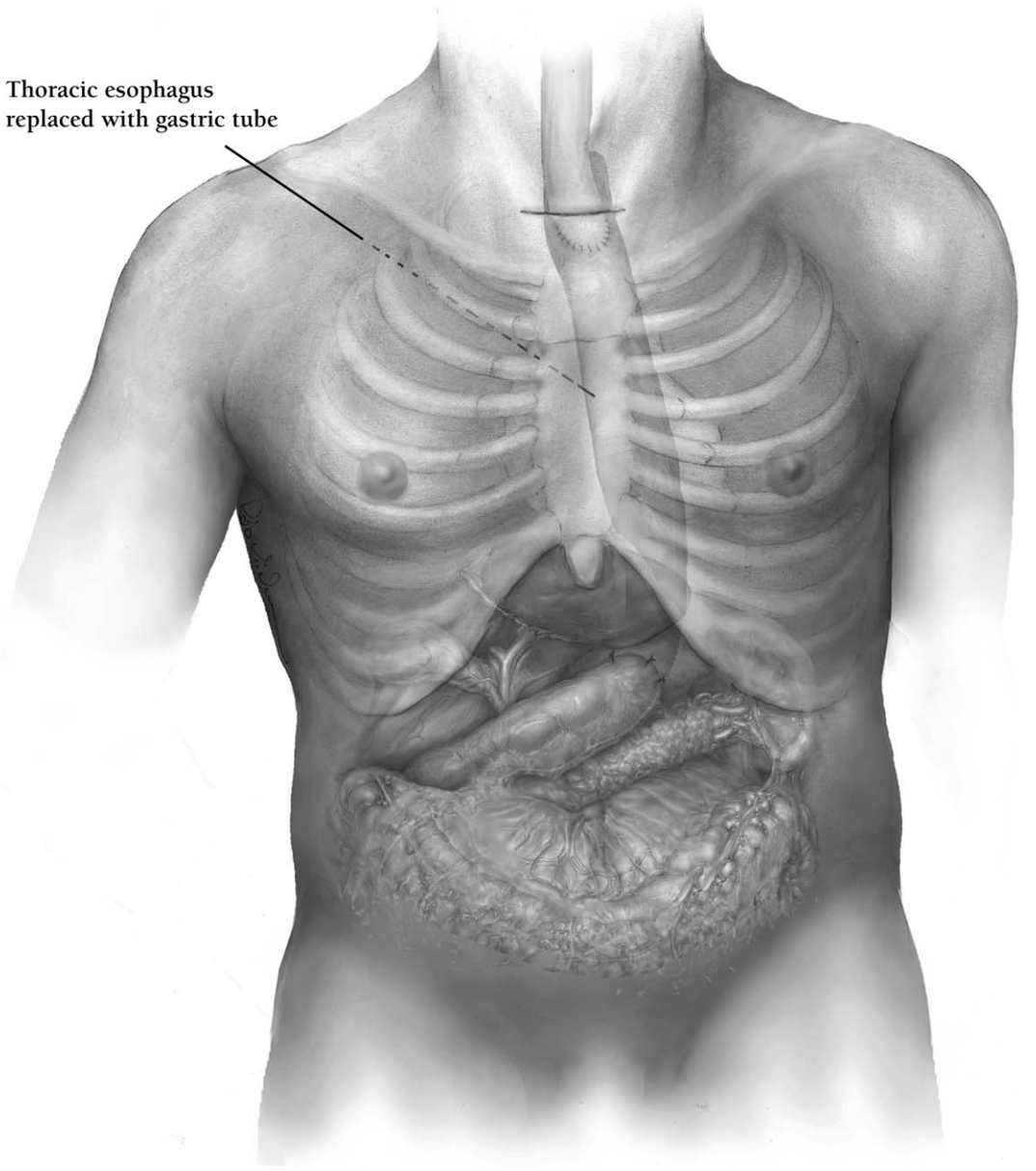

Figure 13 The gastric tube is passed across the posterior mediastinum where an end-to-side esophagogastrostomy is performed. After completion of the anastomosis, all redundancy in the gastric tube is reduced into the abdomen and the tube is secured to the edges of the neo-hiatus with sutures to prevent herniation of the bowel into the negative pressure environment in the chest.

Postoperative Care and Results

Patients undergoing en bloc esophagectomy are routinely admitted to the intensive care unit for respiratory support for 24 to 48 hours. The removal of the thoracic duct and the mediastinal lymphatics leads to sequestration of extracellular fluid and must be treated by aggressive fluid replacement during the first 48 hours after surgery. Pulmonary-lymphatic congestion is expected. Following congestion, a spontaneous diuresis heralds the mobilization of the extracellular fluid and intravenous fluid replacement must be cut back to maintenance levels to avoid the possibility of circulatory overload. After 2 to 3 days, the hemodynamic and fluid shifts are stabilized. The chest tubes should be left in place until the drainage is less than 200 mL/d.

Following en bloc resection and reconstruction, the patient is maintained without oral intake for 4 to 5 days. Clear liquids are started by mouth and, if tolerated for 24 hours, a barium swallow study is performed to confirm healing of the digestive tract anastomoses. The diet may then be advanced.

In addition to the possibility of an anastomotic leak, which occurs in approximately 10% of patients, other technical concerns exist, including ischemia or necrosis of the esophageal substitute. Lymphatic leak, or chylothorax, occurs in fewer than 1% of patients. Because the thoracic duct is ligated at the time of the initial procedure, there is almost never a need for reoperation, and most leaks cease with conservative management. Clinically evident cardiac arrhythmias occur in approximately 10% of patients following mediastinal dissection and are treated medically. Subcutaneous heparin is given preoperatively and during the recovery period to reduce the

risks of venous thrombosis and pulmonary embolism. In an uncomplicated case, the patient spends 2 days in an intensive care unit and will be discharged from the hospital on a soft diet in 7 to 10 days.

Results

Over the past decade, approximately 250 patients underwent en bloc resection for cancer of the thoracic esophagus at the Weill-Cornell Medical College.[15] In hospital mortality was 2%, whereas nonfatal complications occurred in 49% of patients. The principal morbidity was pulmonary and occurred in 27% of patients. Clinically detectable cardiac arrhythmias developed in 11% of patients, none of which were hemodynamically important. Anastomotic leaks developed in 12% of patients, and all healed with simple drainage.

Overall survival, including operative mortality and noncancer-related deaths, was 40% at 5 years. Five-year survival for node-negative patients was 75%, and was reduced to 25% in patients with nodal metastases. Tumor recurrence within the dissected fields (mediastinum or upper abdomen) or at the anastomosis was found in only 8% of patients. This local recurrence rate compares favorably with the reported 25% to 40% local recurrence rate following less extensive resections.[4,5,10]

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