16 Ivor Lewis Esophagectomy

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In August 1944, the Welsh surgeon Ivor Lewis (1895–1982) described a two-staged esophagectomy, including a laparotomy followed by a right-sided thoracotomy, and an immediate intrathoracic gastroesophageal anastomosis. Because this approach advocated immediate rather than delayed reconstruction and also involved two standardized incisions, the Ivor Lewis procedure gained immediate popularity and is now the most commonly utilized approach for esophageal resection worldwide. The evolution of surgical technology has led to the description of hybrid, total, minimally invasive, and robotic approaches.

Selecting an operative approach for esophageal resection must be preceded by a complete preoperative evaluation that includes accurate tumor staging, an assessment of the patient's comorbidities and past medical history (with particular attention to prior history of surgery), and a patient-specific physiologic assessment. Pulmonary function testing should be performed routinely, in preparation for single-lung ventilation. In patients with documented coronary artery disease, congestive heart failure, or atrial or ventricular dysrhythmia, selected objective cardiac testing is recommended.

Surgical treatment for esophageal cancer is indicated in patients with loco-regional disease and may be accompanied by neoadjuvant therapy, if appropriate. Patients with distant metastases or lymph node metastases not included in the surgical resection field should undergo definitive chemotherapy, radiation, or palliation.

With the variety of different surgical approaches currently available for esophagectomy, the choice of resectional approach should take into account individual patient and tumor characteristics. No single approach to esophageal resection is appropriate for all patients. The Ivor Lewis esophagectomy has advantages in cancers of the mid and distal esophagus, as it provides optimal visualization during dissection of the esophagogastric junction and thoracic esophagus, and it allows a complete two-field thoracoabdominal lymphadenectomy. With mid-level tumors abutting the tracheobronchial tree, the aorta, or the spine, a three-stage approach with initial right thoracotomy should be considered. We believe that the Ivor Lewis procedure also should be the approach of choice in patients with documented significant cardiac comorbidity, as the right thoracic approach minimizes intraoperative cardiac manipulation. Our unit's experience over the past 4 years shows that 43 % of patients (60 of 137) underwent Ivor Lewis resections, and even though 70 % of these patients had significant cardiac comorbidities, operative mortality in the group having Ivor Lewis resections was 1 %.

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16.1 Case Description

The patient is a 61-year-old woman with a long history of gastroesophageal reflux disease, which led to a combined hiatal hernia repair and cholecystectomy. After several years of relief, her heartburn symptoms recurred, and she has been back on antacid medication for many years.

She has a history of smoking and carries a diagnosis of COPD. Her past medical history is also significant for deep venous thrombosis at the ages of 22 and 35 and for atrial fibrillation, which led to the placement of a pacemaker. After a recent emergency coronary bypass operation for her second myocardial infarction, she experienced progressive dysphagia for solids.

A diagnostic work-up produced the following findings:

- Conventional chest x-ray: history of sternotomy for coronary bypass surgery as well as previous placement of cardiac pacemaker (Fig. 16.1a)
- Endoscopy: 3 cm–long ulcerated mass at the gastroesophageal junction (Fig. 16.1b). Targeted biopsies confirmed a moderately differentiated invasive adenocarcinoma
- Endoscopic ultrasound: transmural extension of the tumor into the adventitia without invasion into adjacent organs; paraesophageal nodes suspicious for malignancy (Fig. 16.1b). (These nodes were not assessed by fine needle biopsy, as the needle would have had to traverse the tumor.) Endoscopic staging classified her stage as cT3 N1 because of transmural extension in the area of the ulcerated mass (cT3) and multiple enlarged paraesophageal lymph nodes (cN1).
- CT scans: esophageal thickening in the distal esophagus and esophagogastric junction without evidence of metastatic disease (Fig. 16.2a). PET/CT scans showed focal hypermetabolic activity in the distal esophagus. Mildly prominent lymph nodes in the posterior mediastinum and supraceliac region showed no definitive uptake.

Her case was presented and discussed at the multidisciplinary Thoracic Tumor Board. The treatment decision for her clinical T3 N0-1 MX tumor included neoadjuvant radiochemotherapy followed by surgery. She received carboplatin and paclitaxel (Taxol) along with 5040 cGy of radiation, which she tolerated well. Restaging with CT and endoscopy demonstrated a good macroscopic response, and review in the Tumor Board agreed that proceeding to surgical resection was appropriate.

This patient was taking a beta blocker, which was continued. On the day of surgery, a thoracic epidural was placed. Following induction of general anesthesia, the patient was intubated with a double-lumen endotracheal tube. A Foley catheter and arterial line were placed. No central venous catheter is routinely used. Bilateral compression stockings and a lower-body heating blanket are both utilized.

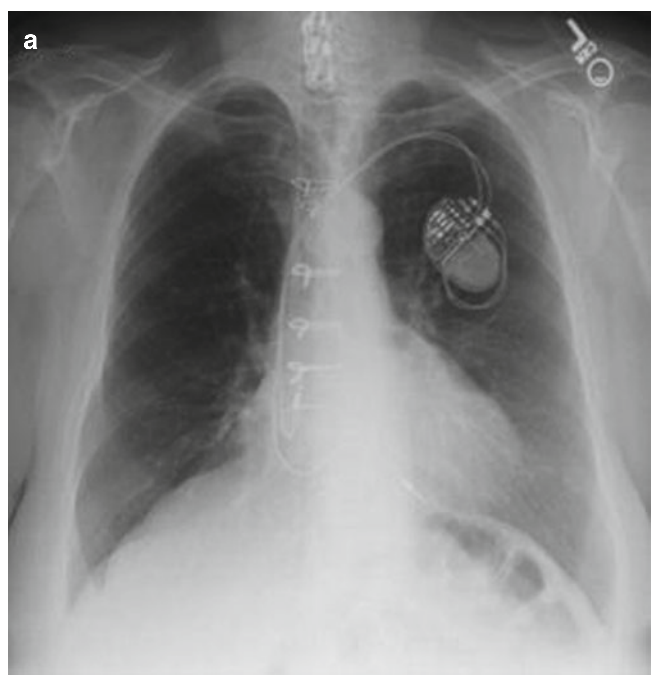

Fig. 16.1 (**a**) Conventional chest x-ray demonstrating a history of sternotomy for coronary bypass surgery, as well as previous placement of a cardiac pacemaker. (**b**) Endoscopy (*upper left*) showing ulcerated mass in the distal esophagus, and endoscopic ultrasound showing transmural extension of the tumor into the adventitia in the area of the ulcerated mass (cT3) (*two-headed arrow*) and multiple enlarged paraesophageal lymph nodes (cN1) (*arrow*)

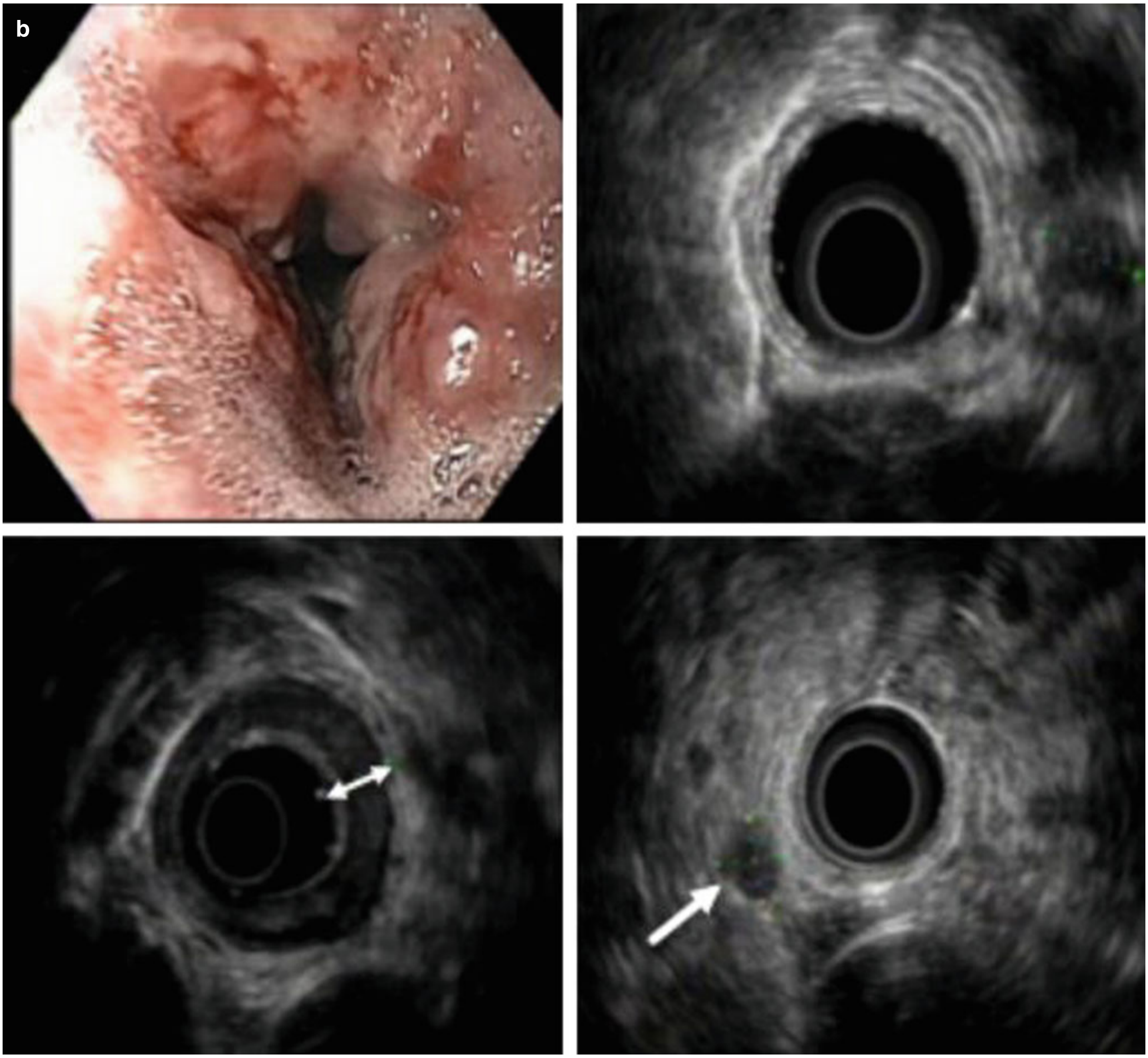

Fig. 16.1 (continued)

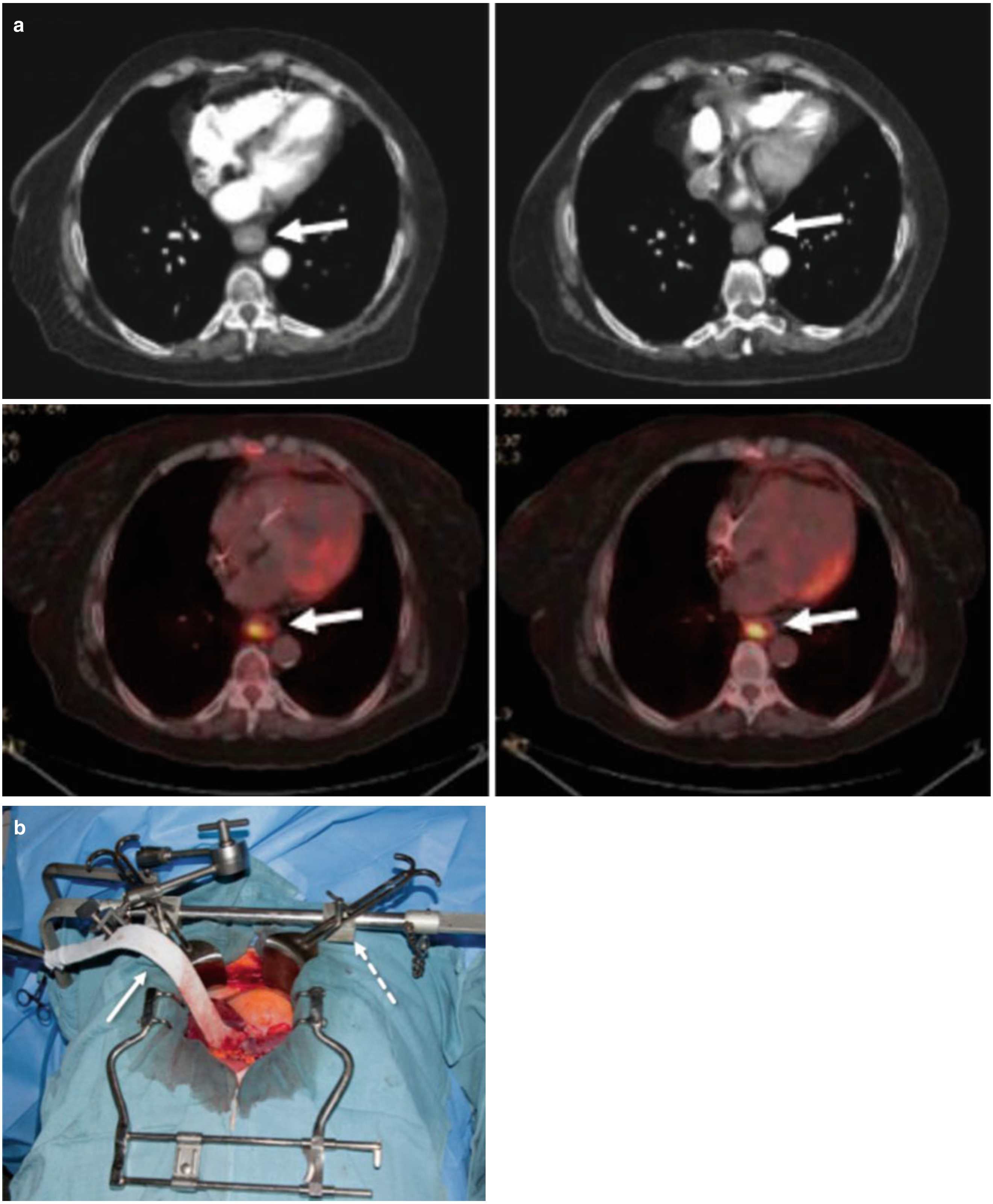

Fig. 16.2 (**a**) CT scans at initial staging (*top*) showing the distal esophageal tumor (*arrows*); PET/CT scans (*bottom*) with increased standardized uptake value (SUV 14) (*arrows*). (**b**) Limited midline incision from the xiphoid to 3–4 cm above the umbilicus. Mobilize liver by taking down the triangular ligament, and retract the liver to the patient's right with a fixed retractor (*solid arrow*). Ideally, a fixed retraction system (*dashed arrow*) lifts the costal margin to verticalize the diaphragm and provide an unobstructed view of the proximal stomach and esophagogastric (EG) junction

16.2 Procedure

Make a limited midline incision from the xiphoid to 3–4 cm above the umbilicus (Fig. 16.2b). Mobilize the liver by taking down the triangular ligament, and retract the liver to the patient's right with a fixed retractor. Ideally, the fixed retraction system will provide an unobstructed view of the proximal stomach and esophagogastric (EG) junction.

Figure 16.3a shows the completed dissection of the EG junction, encircled by a Penrose drain. Transhiatal dissection mobilizes the esophagus, mediastinal fat, and level 8 lymph nodes. Dissection should be completed over 8–10 cm. Any attachment or invasion of crura or diaphragm should be resected en bloc. Following Kocherization of the duodenum, assess for pyloric stenosis (Fig. 16.3b). Whether a pyloric procedure is done remains controversial. We do not do a pyloroplasty unless pyloric stenosis is noted at preoperative esophagogastroduodenoscopy (EGD) or intraoperatively. Ideally, the duodenum should be mobilized sufficiently to place the pylorus 3–4 cm below the hiatus.

Figure 16.4a shows the dissection of the greater curvature, ensuring preservation of the right gastroepiploic arcade. Omental attachments are taken down, starting at the watershed area between the left and right gastroepiploic arcades. The right gastroepiploic arcade is preserved (Fig. 16.4b). When the greater curve is completely mobilized (Fig. 16.4c), ideally the omentum is preserved along the upper body and cardia of the stomach to cover the anastomosis (see Fig. 16.16c). The mobilized stomach shown in Fig. 16.4d demonstrates posterior access to the left gastric pedicle. Lymph node dissection includes supraceliac, suprapancreatic, and paragastric nodes. Figure 16.5a shows dissection of the left gastric vein. The left gastric artery is ligated immediately above the celiac axis (Fig. 16.5b).

The lesser curvature is dissected 7–10 cm distal to the EG junction (Fig. 16.6a), at a location guided by pretreatment endoscopy and endoscopic ultrasound to provide a minimum of 5–7 cm of distal resection margin. The conduit is then fashioned with sequential firing of a linear stapler (Fig. 16.6b–d). It is important to keep the stapled margin oriented and parallel to the greater curve.

The extent of gastric resection can vary. It should be based on findings at endoscopy and endoscopic ultrasound. The resection in Fig. 16.7a provides a margin of 10–12 cm from the EG junction. The width of the conduit remains controversial; we aim to fashion a gastric conduit 3–4 cm in width (Fig. 16.7b), preserving the right gastroepiploic arcade and the proximal right gastric arcade.

To decrease the risk of bleeding, we recommend oversewing the staple line with interrupted 3.0 silk sutures (Fig. 16.8a). The last imbricating stitches at the tip of the conduit are left long, with the needle attached (Fig. 16.8b). These sutures are used to attach the tip of the conduit to the gastric portion of the specimen (Fig. 16.8c) so it can be drawn up into the chest following esophageal mobilization.

A 14 Fr feeding jejunostomy is placed 60–80 cm from the ligament of Treitz (Fig. 16.9a). The tube is imbricated into the antimesenteric jejunum over a 2-cm distance and suspended to the peritoneal surface circumferentially. To avoid torsion, it is then tacked proximally and distally to the peritoneal surface over 3–4 cm.

The second stage of the procedure is initiated with a limited thoracotomy, typically performed at the fourth or fifth interspace (Fig. 16.9b). The visceral pleura is incised and the azygous vein is ligated (Fig. 16.10a). The esophagus is mobilized just distal to the azygous vein (Fig. 16.10b). Esophageal mobilization proceeds distally, mobilizing all paraesophageal nodes en bloc. Subcarinal nodes can be mobilized en bloc or separately.

Dissection is continued distally following mobilization of the inferior pulmonary ligament (Fig. 16.11a). This dissection can include resection and ligation of the thoracic duct if desired. The mobilized esophagus and the gastric component of the specimen with the gastric conduit are brought up into the chest prior to initiating anastomosis (Fig. 16.11b).

The esophagus is mobilized up to the thoracic inlet (Fig. 16.12a). Level 4 (paratracheal) and Level 10 (tracheobronchial) lymph nodes can be mobilized in mid-level tumors.

The gastric conduit is placed in the apex of the chest beside the proximal esophagus and above the ligated azygous vein (Fig. 16.12b). The conduit should lie in this location without tension. Sutures are placed between the conduit and the esophagus to create a common wall (Fig. 16.13a). We recommend placing two or three of these sutures on each side. The proximal esophagus is transected with a linear stapler at or above the ligated azygous vein (Fig. 16.13b). Figure 16.13c shows the transected esophagus lying adjacent to the proximal gastric conduit. The staple line is cut away prior to anastomosis (see Fig. 16.14a).

The proximal resection margin is checked by pathology for Barrett's and cancer. A gastrostomy in the conduit is then created immediately adjacent to the end of the esophageal stump (Fig. 16.14a). Full-thickness sutures are placed between the adjacent free walls of the esophagus and gastrostomy to create a common wall prior to the anastomosis (Fig. 16.14b).

To create the anastomosis, a 30-mm linear stapler is placed with one limb in the esophagus and the other in the apex of the conduit (Fig. 16.15a). Firing the stapler creates most of the anastomosis in the common walls of the esophagus and gastric conduit (Fig. 16.15b). After the nasogastric tube is advanced down into the conduit, the esophagogastric anastomosis is completed (Fig. 16.16a) with full-thickness absorbable sutures and a second layer of imbricating 3.0 silk sutures. The conduit should be positioned vertically in the chest without redundancy above the diaphragm (Fig. 16.16b).

The anastomosis optimally is covered with adjacent omental fat and pleura (Fig. 16.16c, d).

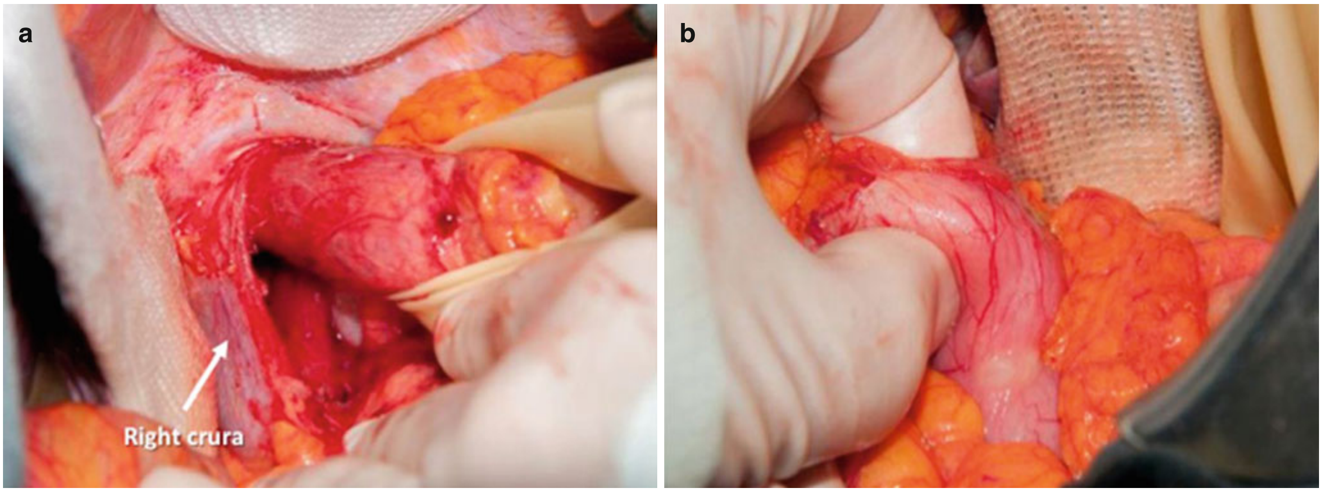

Fig. 16.3 (**a**) Completed dissection of the EG junction, encircled by a Penrose drain. (**b**) Assessing for pyloric stenosis following Kocherization of the duodenum

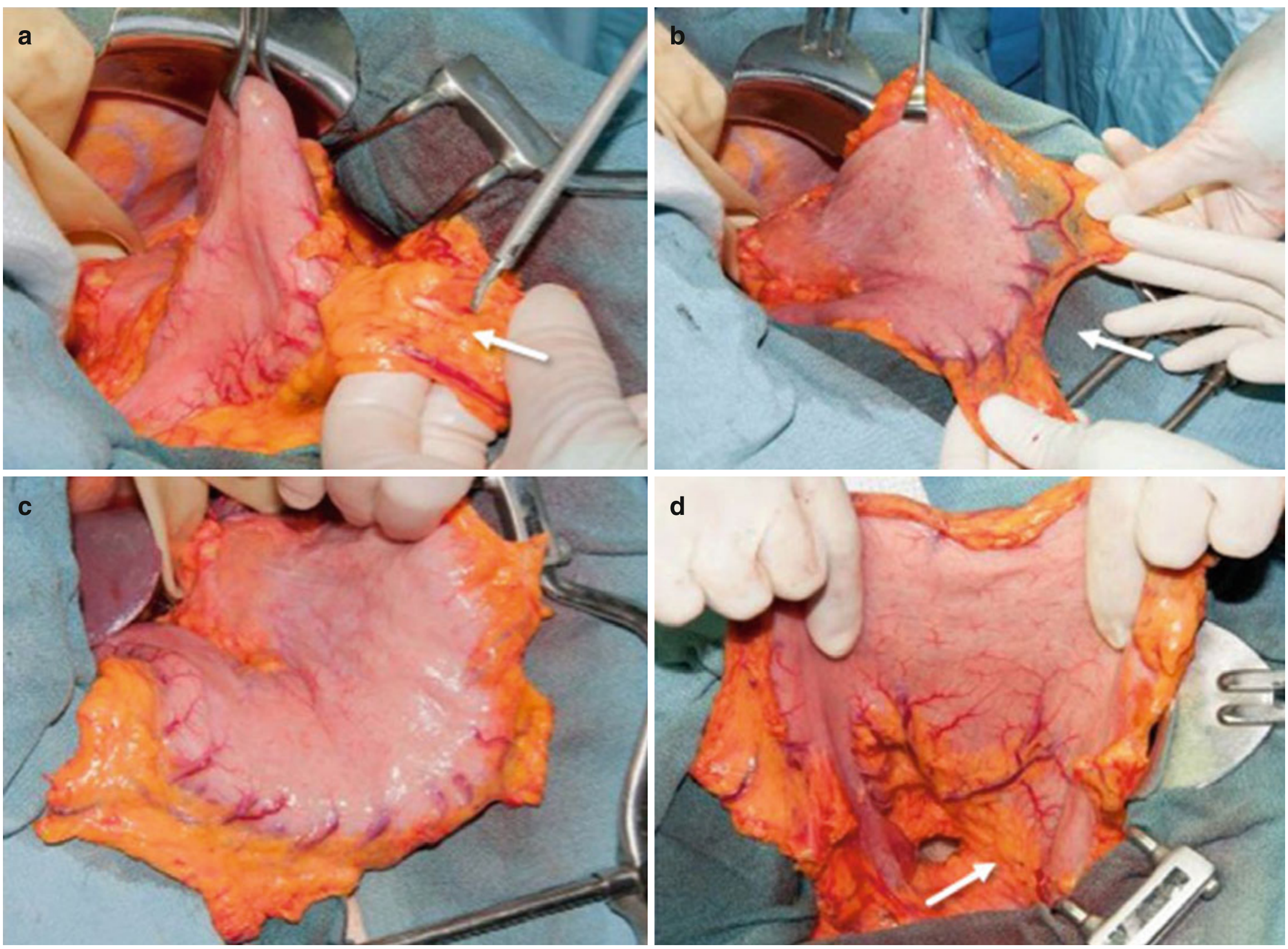

Fig. 16.4 (**a**) Dissection of greater curvature, ensuring preservation of the right gastroepiploic arcade. Starting at the watershed area (*arrow*) between the left and right gastroepiploic arcades, omental attachments are taken down. (**b**) Right gastroepiploic arcade is preserved (*arrow*). (**c**) Greater curve completely mobilized. (**d**) Mobilized stomach demonstrating posterior access to left gastric pedicle (*arrow*). Lymph node dissection includes supraceliac, suprapancreatic, and paragastric nodes

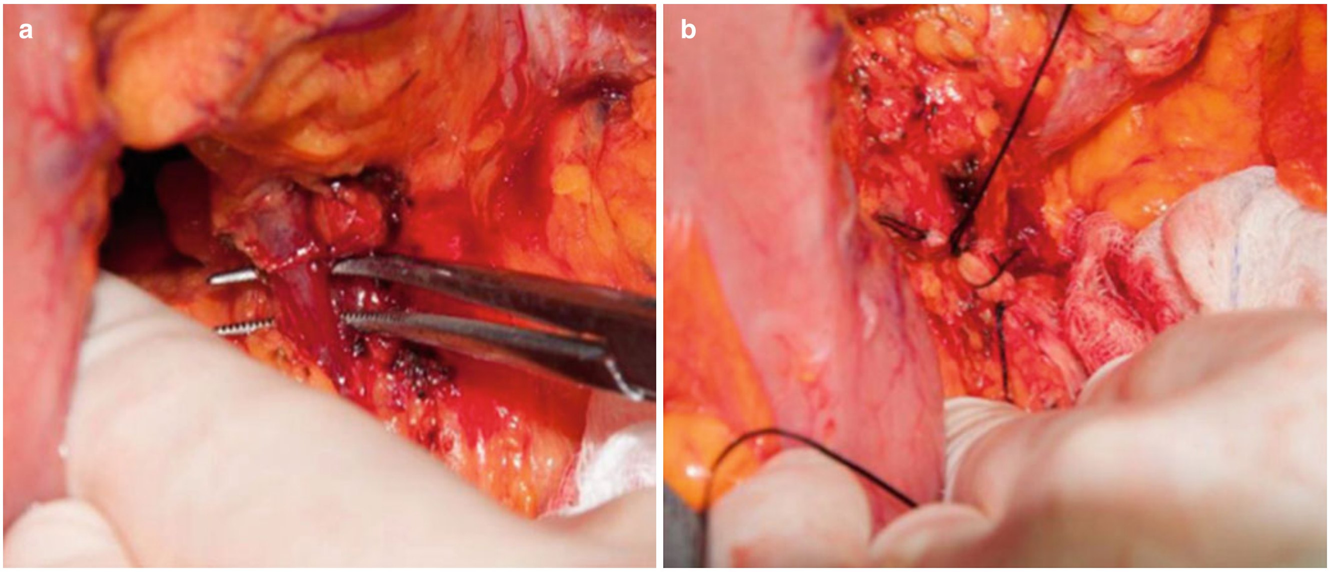

Fig. 16.5 (**a**) The entire suprapancreatic and supraceliac lymph node fields are dissected. This image shows dissection of the left gastric vein. (**b**) The left gastric artery is ligated immediately above the celiac axis

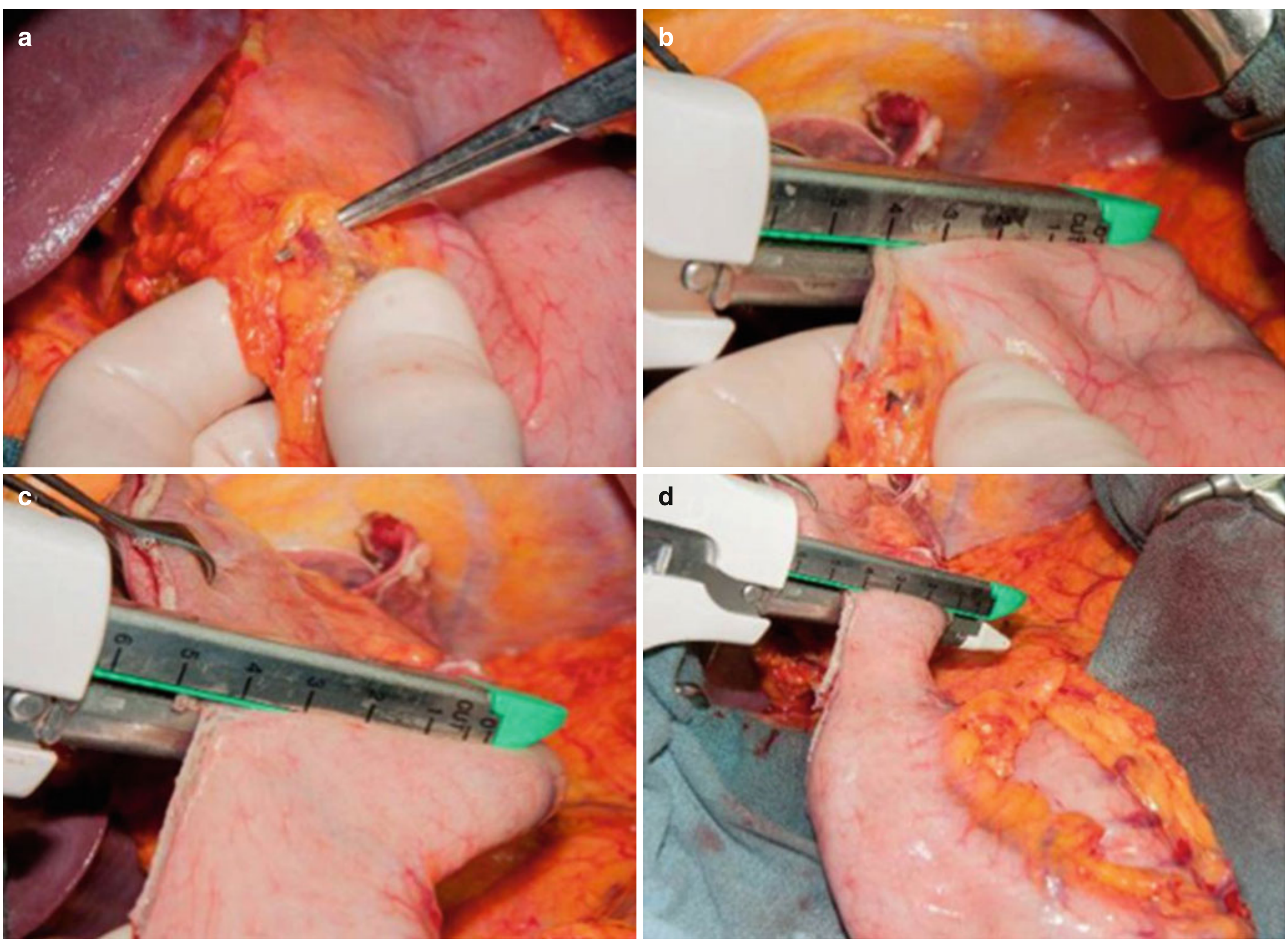

Fig. 16.6 (**a**) The lesser curvature is dissected 7–10 cm distal to the EG junction, providing a minimum of 5–7 cm of distal resection margin. (**b**–**d**) The conduit is then fashioned with sequential firing of a linear stapler

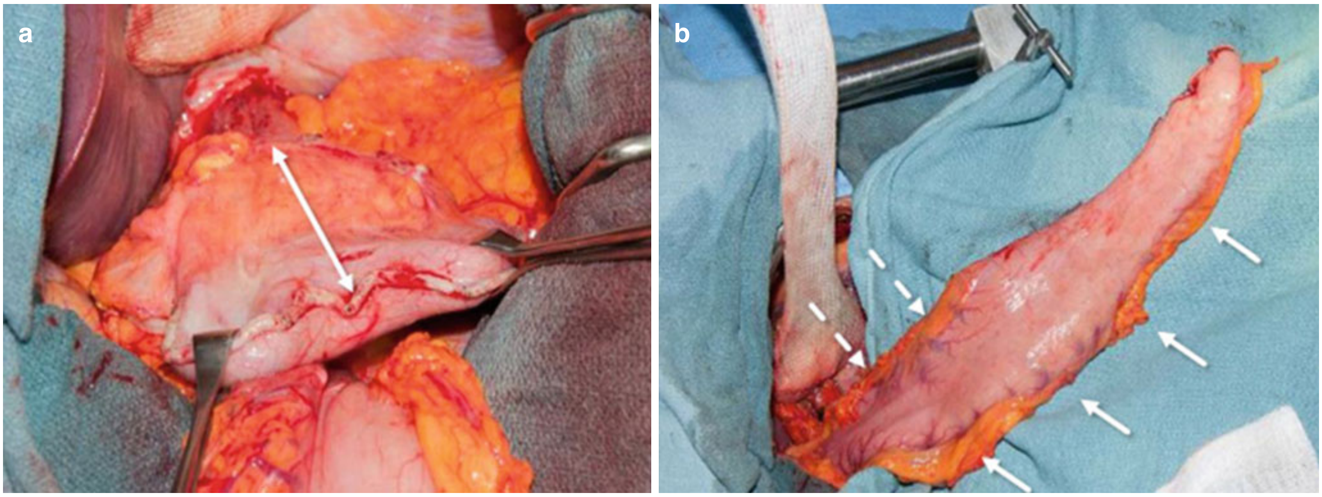

Fig. 16.7 (**a**) This gastric resection provided a 10- to 12-cm resection margin from the esophagogastric junction (*arrow*). (**b**) We aim to fashion a gastric conduit 3–4 cm wide, with preservation of the right gastroepiploic arcade (*arrows*) and proximal right gastric arcade (*dashed arrows*)

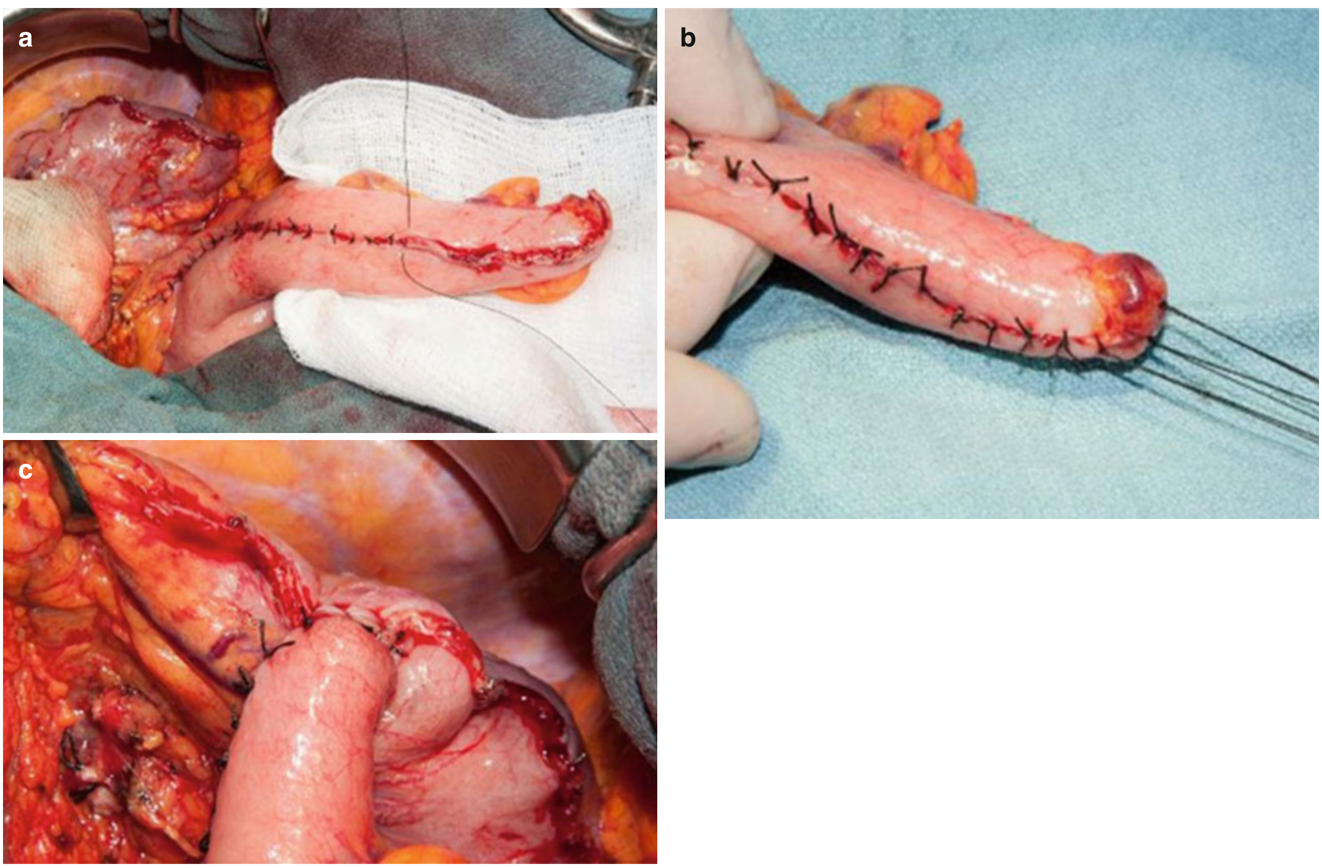

Fig. 16.8 (**a**) The staple line is oversewn with interrupted 3.0 silk sutures. (**b**) The last imbricating stitches at the tip of the conduit are left long, with the needle attached. (**c**) These sutures are used to attach the tip of conduit to the gastric portion of the specimen

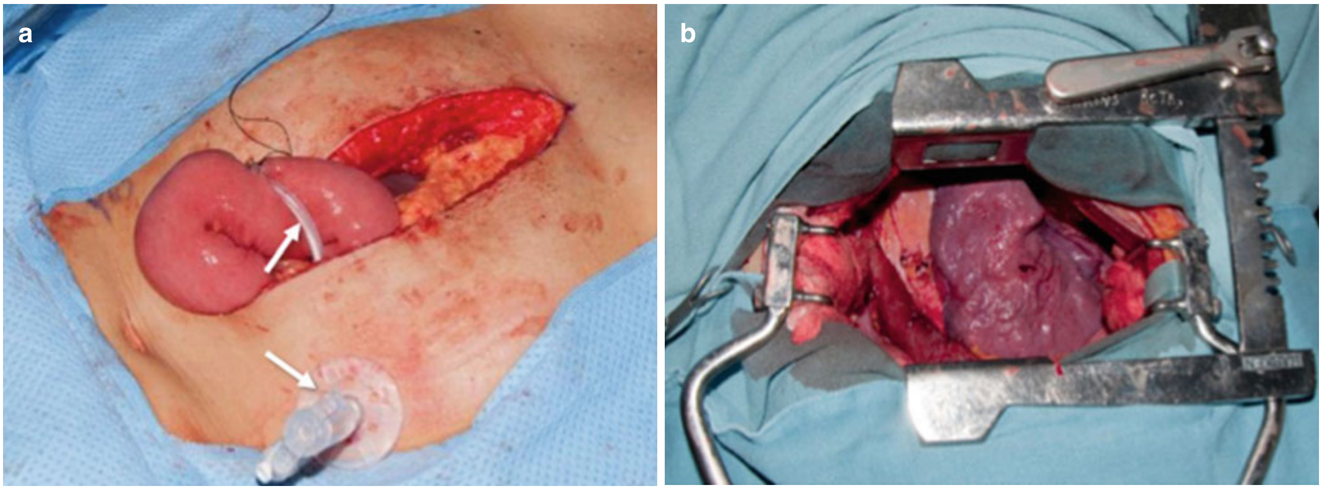

Fig. 16.9 (**a**) A 14 Fr feeding jejunostomy (*arrow*) is placed 60–80 cm from the ligament of Treitz. The tube is imbricated into the antimesenteric jejunum over a 2 cm distance and suspended to the peritoneal surface circumferentially with 3.0 silk sutures. To avoid torsion, it is then tacked proximally and distally to the peritoneal surface over 3–4 cm. (**b**) The second stage of the procedure is initiated with a limited thoracotomy, typically performed at the fourth or fifth interspace

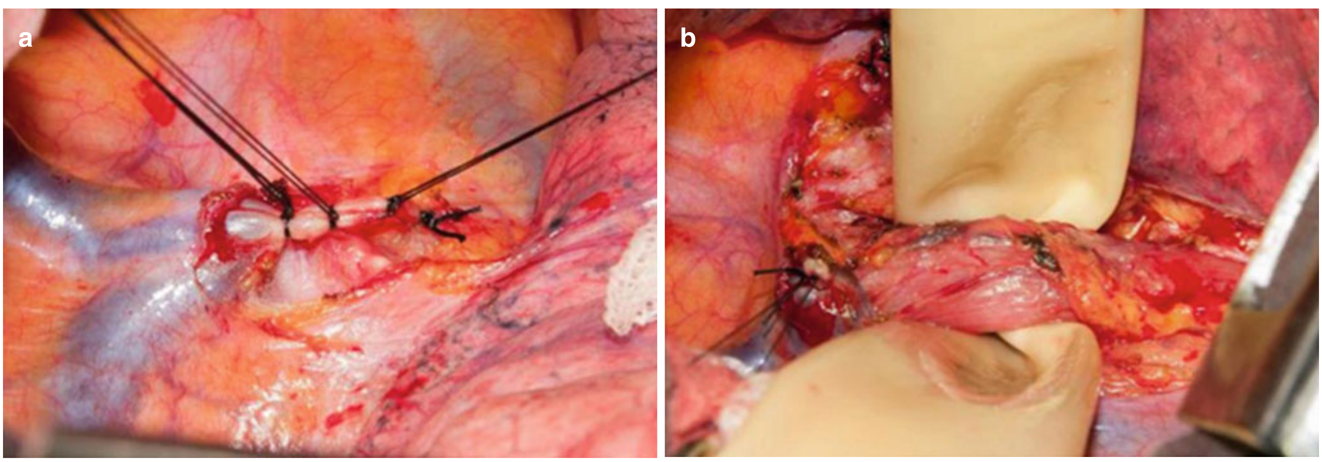

Fig. 16.10 (**a**) Incision of visceral pleura and ligation of azygous vein. (**b**) Mobilized esophagus just distal to the azygous vein

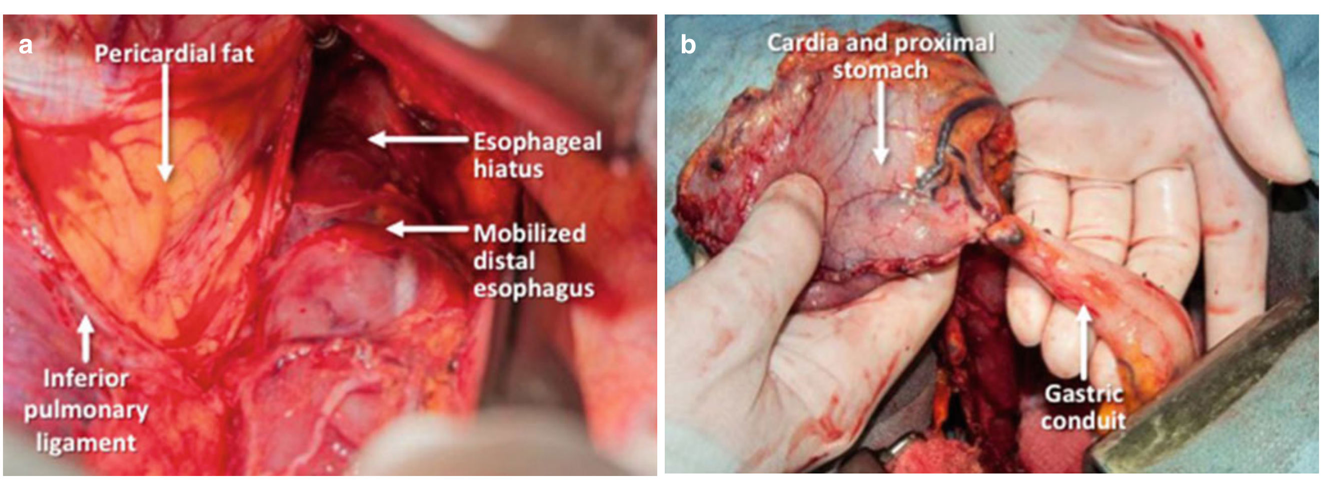

Fig. 16.11 (**a**) Dissection is continued distally following mobilization of the inferior pulmonary ligament. (**b**) The mobilized esophagus and the gastric component of the specimen with the gastric conduit are brought up into the chest prior to initiating anastomosis

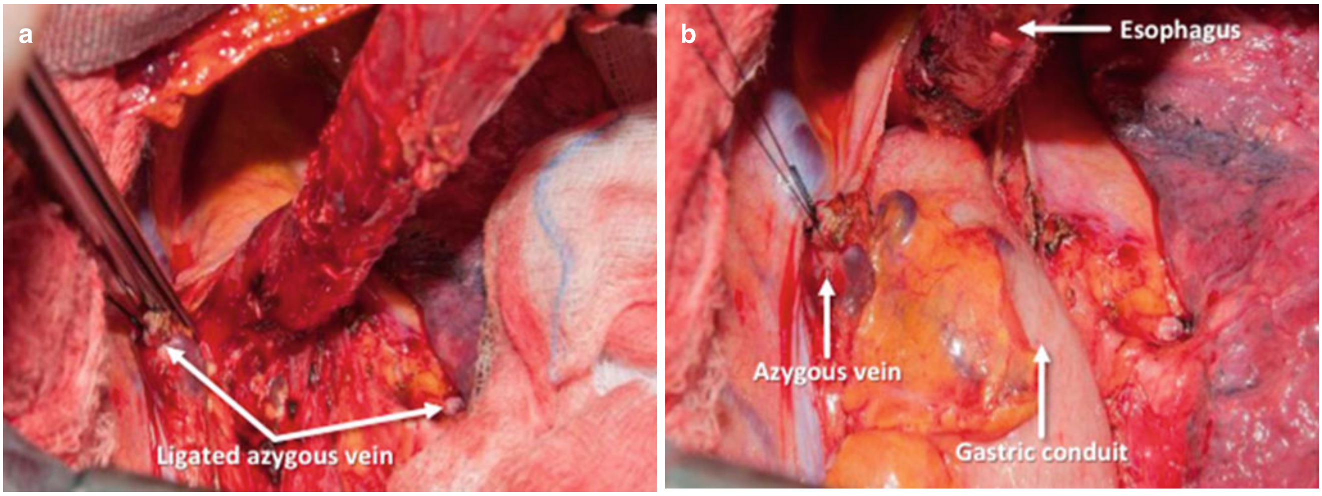

Fig. 16.12 (**a**) Esophagus mobilized up to the thoracic inlet. (**b**) Gastric conduit placed in the apex of the chest beside the proximal esophagus and above the ligated azygous vein. The conduit should lie in this location without tension

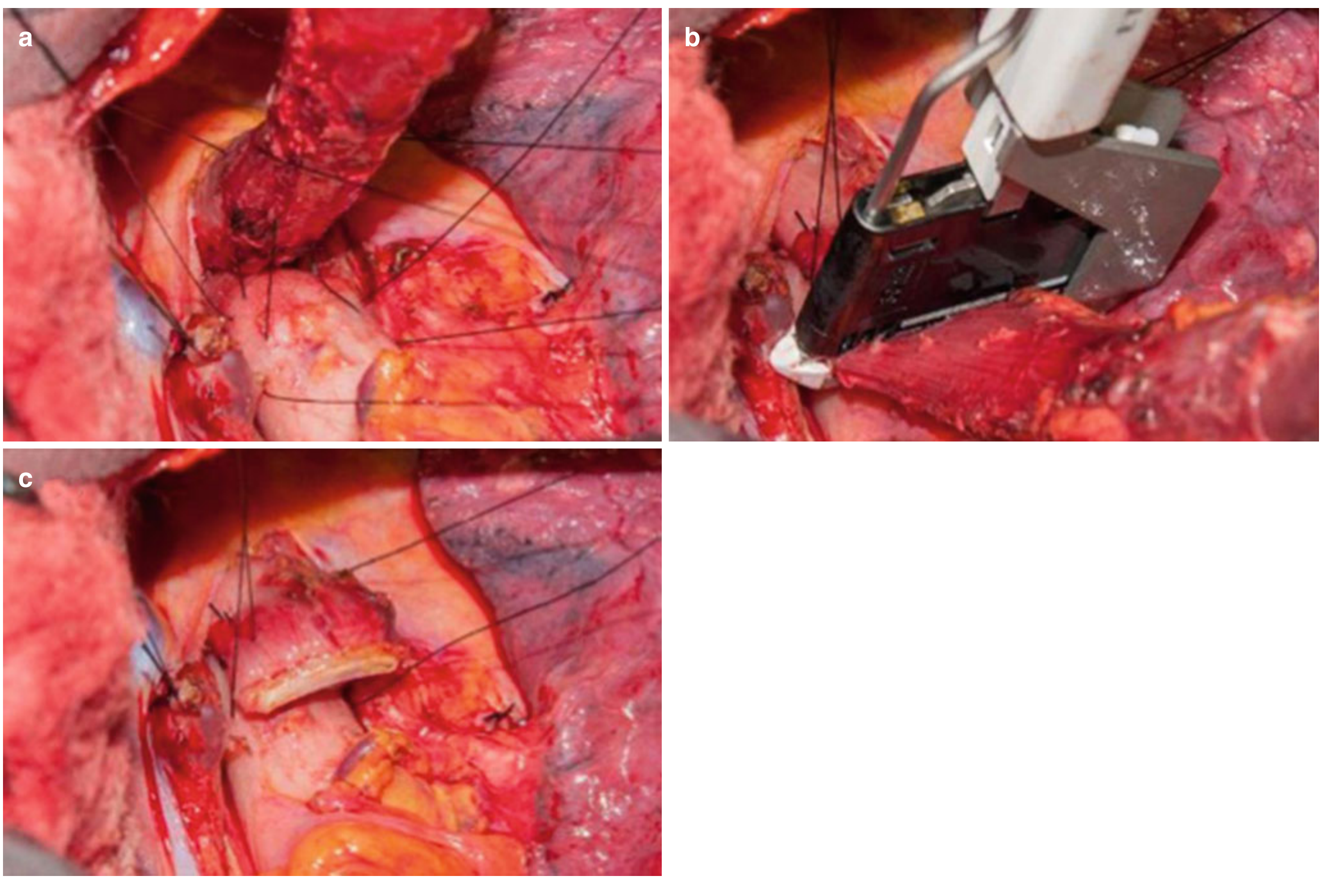

Fig. 16.13 (**a**) Sutures are placed between the conduit and esophagus to create a common wall. (We recommend two or three sutures on each side.) (**b**) Transection of the proximal esophagus with a linear stapler at or above the ligated azygous vein. (**c**) Transected esophagus lying adjacent to the proximal gastric conduit. The staple line is cut away prior to anastomosis

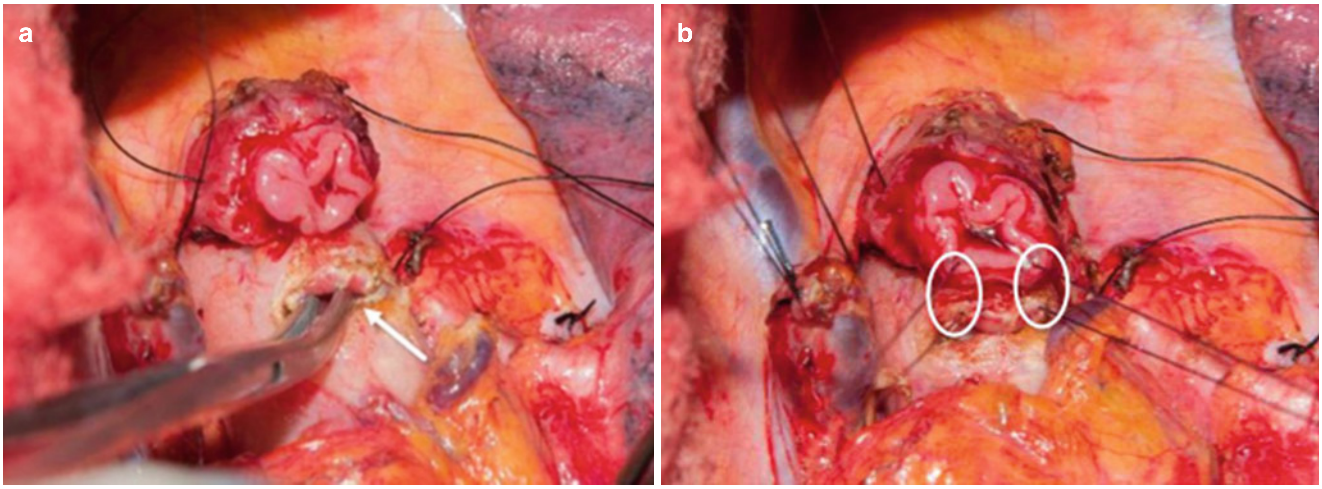

Fig. 16.14 (**a**) Following pathologic checking of proximal resection margin for Barrett's and cancer, a gastrostomy (*arrow*) in the conduit is created immediately adjacent to the end of the esophageal stump. (**b**) Full-thickness sutures are placed between the adjacent free walls of the esophagus and gastrostomy to create a common wall prior to the anastomosis (*circles*)

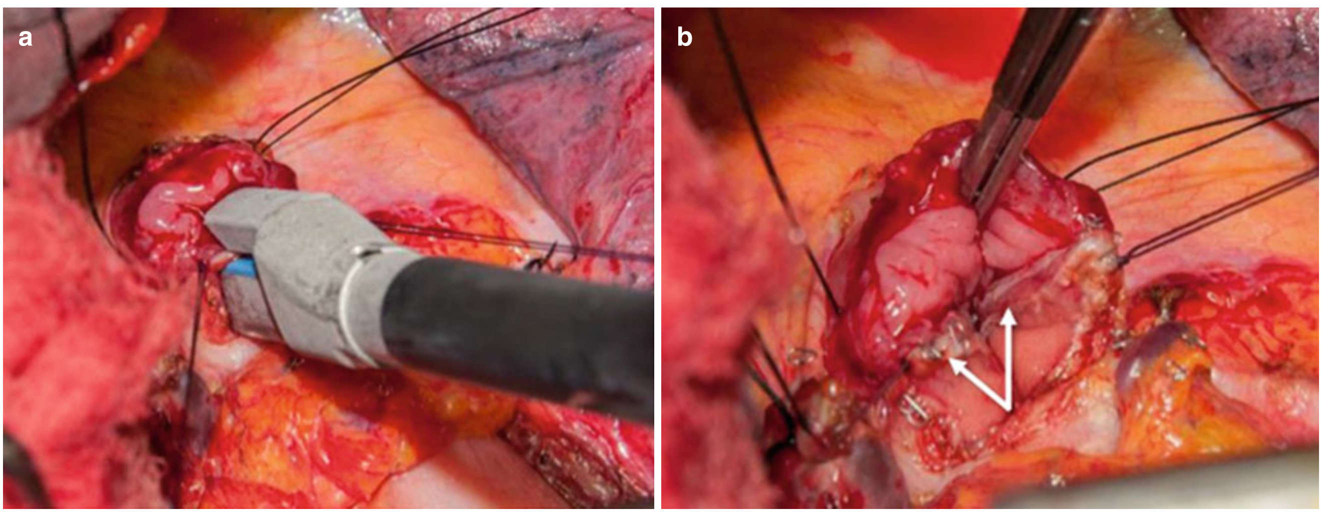

Fig. 16.15 (**a**) 30-mm linear stapler placed with one limb in the esophagus and other limb in the apex of the conduit. (**b**) Firing the stapler creates the majority of the anastomosis in the common walls of the esophagus and gastric conduit (*arrows*)

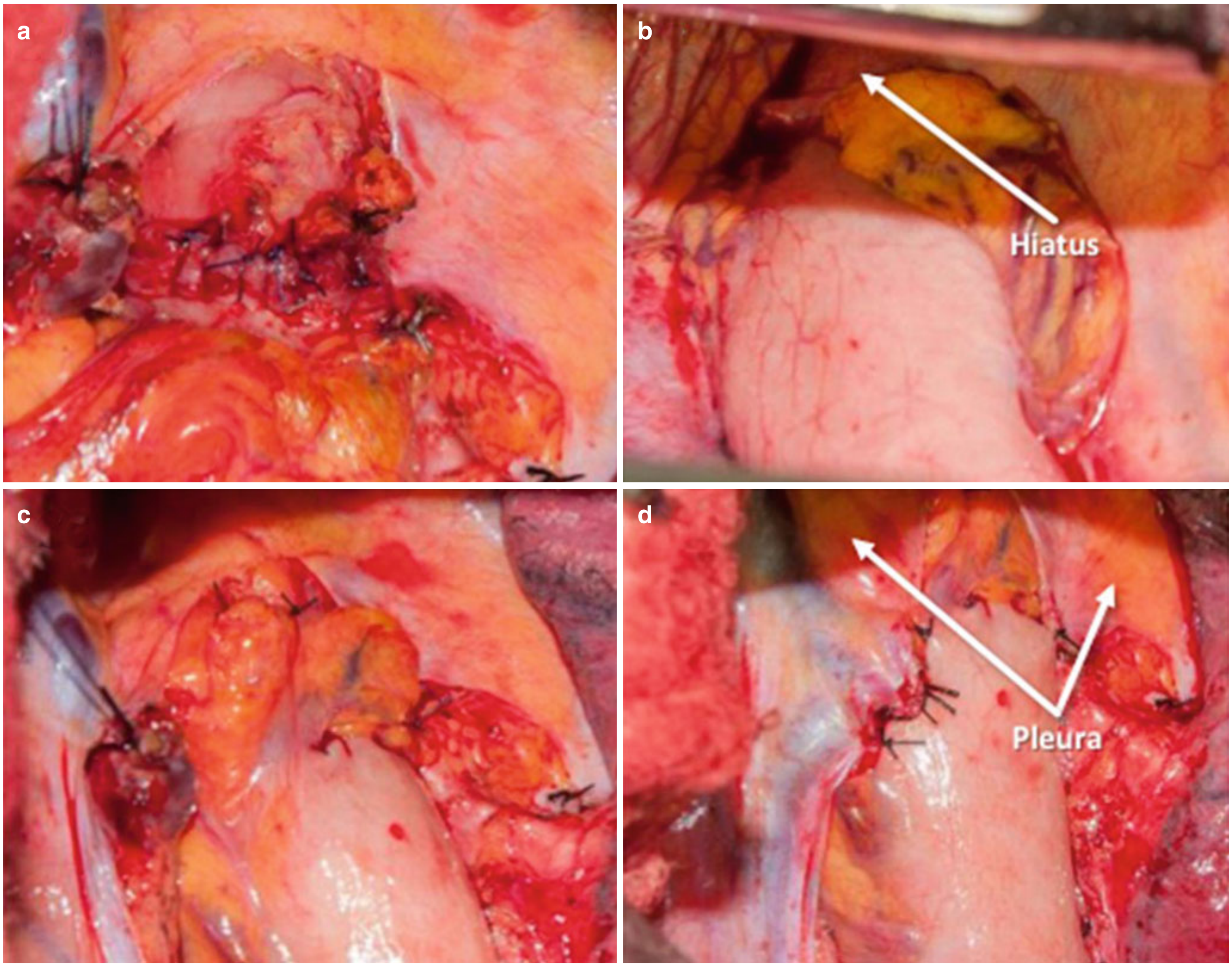

Fig. 16.16 (**a**) The esophagogastric anastomosis is completed with full-thickness absorbable sutures and a second layer of imbricating 3.0 silk sutures. (**b**) Conduit should be positioned vertically in the chest without redundancy above the diaphragm. (**c**, **d**) Anastomosis optimally covered with adjacent omental fat and pleura

16.3 Postoperative Course

Estimated operative blood loss was 150 mL. Intraoperative fluid administration was 3 L of crystalloid; no transfusions were required. The patient was extubated in the operating room and taken to the postoperative stepdown unit. The patient was managed according to a standardized care pathway defining specific goals for each day of her recovery (Markar et al. 2014). She was mobilized into the chair on the same night as surgery, and hemodynamic management (IV fluids, pressors, and epidural adjustments) were aimed at maintenance of a mean arterial pressure greater than 70 mmHg. On postoperative day 1, the patient was transferred to the regular ward, her jejunostomy tube feeds were initiated, and her mobilization plan progressed to include 3–4 walks in the hall. On day 3, she underwent an upper GI contrast study, which showed no evidence of an anastomotic leak and rapid emptying of the stomach into the duodenum (Fig. 16.17). Her nasogastric tube was then removed.

The patient was transitioned off her epidural on day 4, and oral intake was initiated on the same day. The patient was able to independently mobilize on day 5 and was tolerating full jejunostomy feeds. She was sent home on day 6 following resection. Patient followed up in Clinic 3 weeks and 3 and 6 months postoperatively.

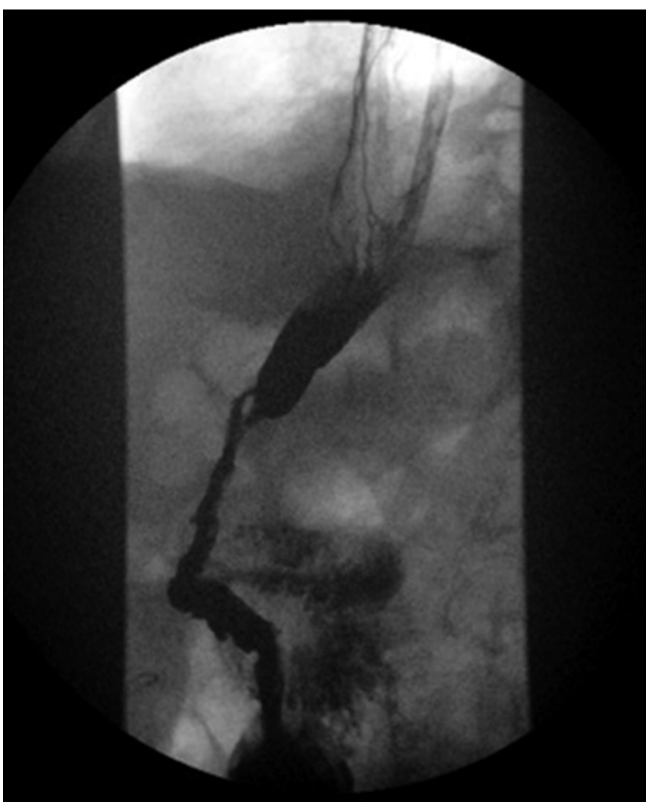

Fig. 16.17 Upper GI contrast study at postoperative day 3. Anastomosis is assessed, but more importantly, gastric emptying is assessed. This study shows immediate gastric emptying in a patient who did not have pyloroplasty

16.4 Pearls and Pitfalls

- The laparotomy and thoracotomy are standard incisions and therefore are easy to teach.
- The Ivor Lewis approach allows for esophageal dissection and complete two-field thoracoabdominal lymphadenectomy, all under direct visualization.
- Depending on the preoperative or operative findings regarding the extent of required gastric resection, the anastomosis can be placed at a variety of levels within the chest, depending on the length of the gastric conduit. It should be recognized, however, that the best results are obtained by placing the anastomosis above the azygous vein and by ensuring that the conduit has a straight pathway through the hiatus without any redundancy above the diaphragm.
- Stapling the conduit further down the lesser curvature and stapling smaller lengths along the greater curvature will provide a longer conduit.
- Patients with significant cardiac comorbidities such as congestive heart failure, ischemic heart disease, or atrial dysrhythmia will benefit from the Ivor Lewis approach because there is minimal need for cardiac manipulation or intraoperative hypotension, which is more common in other types of resections.
- By performing an intrathoracic anastomosis, the risk of vocal cord injury is less than with cervical anastomoses. Intrathoracic anastomotic leaks have historically been associated with higher levels of mortality compared with cervical anastomosis, however.
- Extra omentum, left at the mid and proximal conduit, can be used to cover the intrathoracic anastomosis; doing so may decrease the incidence and severity of leaks.
- The linear stapled esophagogastric anastomosis is a good option in an esophagus with a small luminal diameter, as it may decrease anastomotic stricture formation.
- Surgeons should focus on ensuring that the conduit is well oriented and in a vertical position in the thorax, without supradiaphragmatic redundancy. This position will provide good gastric emptying regardless of whether a pyloric drainage procedure is performed.
- Placing the posterior chest tube in the costovertebral groove in proximity to (but not adjacent to) the anastomosis will be sufficient to provide good drainage and monitor the anastomosis.
- In patients undergoing an open Ivor Lewis esophagectomy, a thoracic epidural should be placed for pain control. This will also facilitate early mobilization, which will potentially decrease pulmonary complications that are more commonly associated with thoracotomies.

Suggested Reading

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