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Thoracoscopic Esophageal Resection for Cancer in Prone Decubitus Position: Operative Technique

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Minimally invasive approach for esophageal resection for cancer is increasingly used in many centers because it can resect the esophageal cancer along the same planes as in the conventional way, and perform the same type of one- or two-field lymphadenectomy (obtaining the same number of lymph nodes (LN)), but avoiding a thoracotomy and/or laparotomy. Consequences of this are less postoperative pain and possibly less respiratory complications.

Initial reports used the right lateral thoracoscopic approach with total lung block in order to visualize and dissect the esophagus [1–3]. The goal of this minimally invasive procedure was to resect the esophageal cancer, according to established oncological principles, with all postoperative advantages of the minimally invasive surgery.

However, the reports of the initial pioneers were followed by others who were critical about the procedure and others who were especially disappointed [4, 5] because the outcome (conversions to open approach in 10–17%, morbidity, especially respiratory, between 17 and 42% and mortality between 3 and 12%) were not better than the conventional approach.

They conclude that this approach was feasible but these initial results did not show a real benefit.

As a consequence of this, Cuschieri et al., attempted to change the thoracoscopic approach from a lateral to a prone position, without total collapse of the lung, in order to diminish the postoperative respiratory complications [6].

Prone decubitus position for conventional lung resection was initially described by Overholt in 1949 [7].

The advantages of this approach, in comparison with the standard lateral decubitus position were: (a) the attainable range of thoracic cage and diaphragmatic excursion is greater than in the side position; (b) the amplitude of mediastinal swing or displacement is less; (c) exposure of the posterior aspect of the hilum and esophageal area is facilitated; (d) the weight of the lung itself allows it to fall forward; and (e) in the event of hemorrhage the blood flows away from its source, thus permitting its control with greater ease.

The approach was not commonly used again until the introduction of the esophageal approach by prone decubitus right thoracoscopy.

Indication

All patients with esophageal squamous cancer or adenocarcinoma of the esophagus, with exception of the gastro-esophageal junction cancers Siewert type I, were considered for thoracoscopic-prone position (and laparoscopy plus cervical approach) resection.

Exclusion and Conversion

Patients operated on previously by right thoracotomy were excluded for this approach.

Extensive adhesions in the thoracic cavity, precluding an adequate partial collapse of the right lung were quickly converted to conventional right thoracotomy.

Operative Technique

1. After induction of general anesthesia, standard intratracheal single lumen intubation follows.

Patient is then positioned in prone decubitus position on a standard apparatus in order to support on the head, thorax and pelvis. Abdomen is maintained free for breathing excursions. Position of the arms is very important in order to get abduction of the scapula. The arms are positioned on a support device in flexion of the shoulders and elbows (Fig. 6.1a, b).

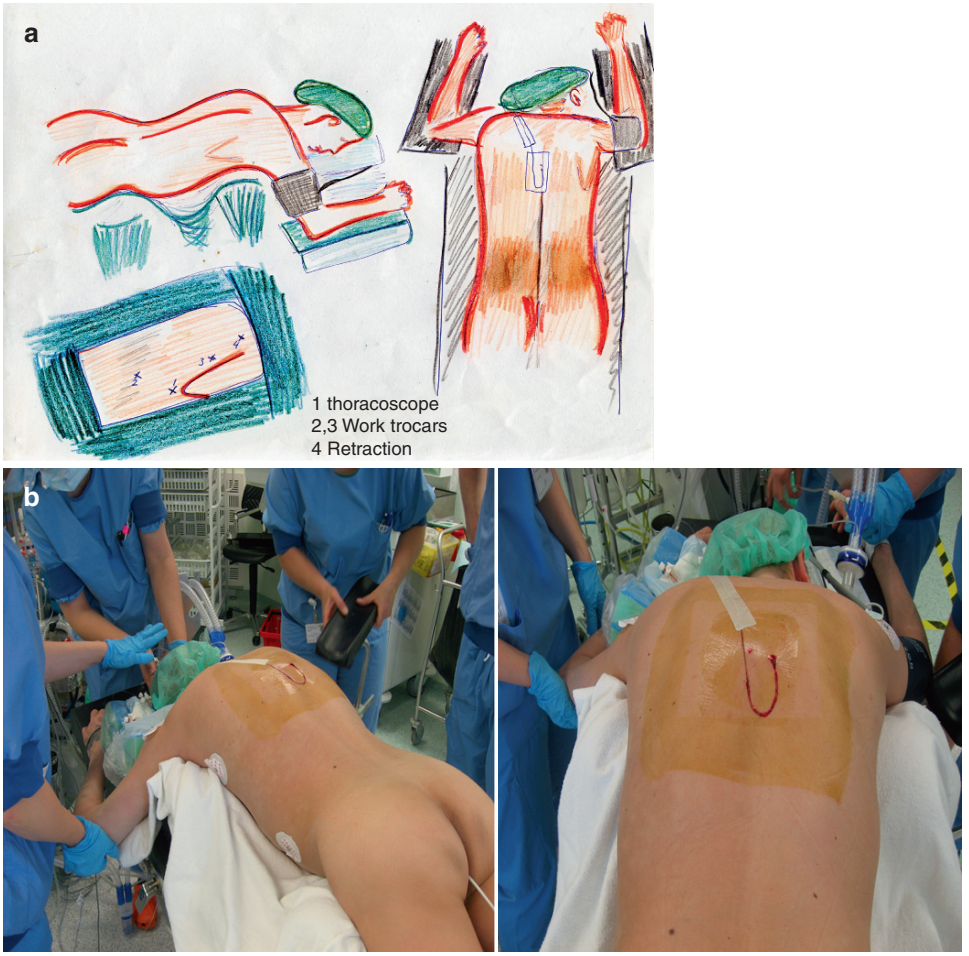

Fig. 6.1 (**a–d**) Placement of patient in the prone position. Operating room set-up during operation. Surgeon (and the first assistant) stand at the right side of the patient, looking at the monitor in front of them. Position of trocars along the medial border of the scapula

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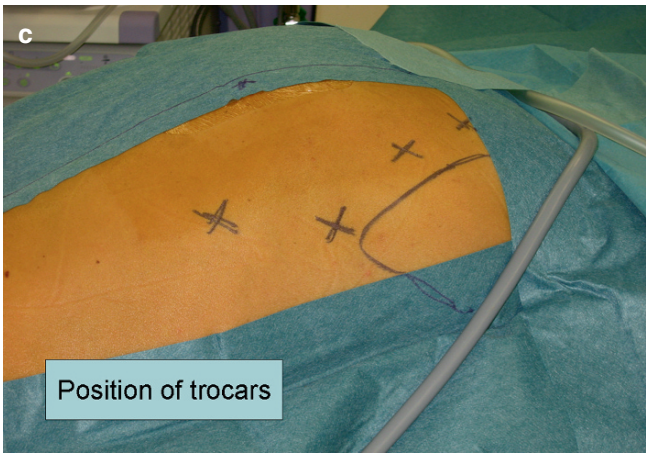
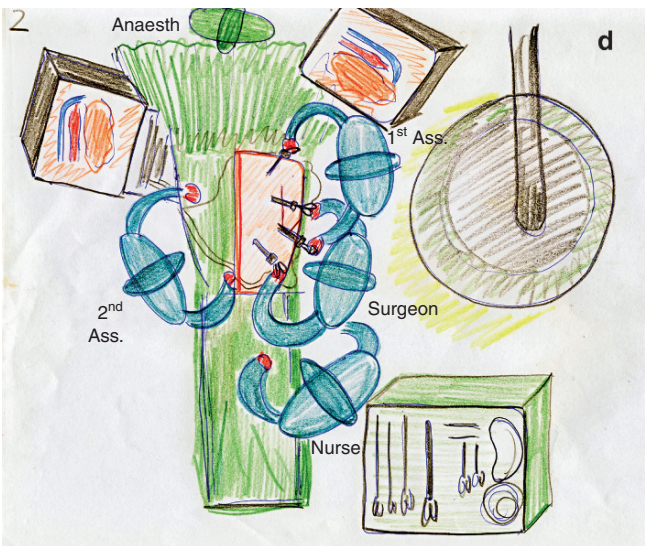


In this way the area between the spine and the inner edge of the scapula is broadened.

2. Surgeon stands on the right side of patient with the first assistant on his/her right side looking to the monitor in front of them. Scrub nurse stands on the left side of the surgeon (Fig. 6.1d).

3. Four trocars are placed along the inner edge of the right scapula (Fig. 6.1c). The first at the level of the lowest point of the scapula, a 10 mm, (can be 5 mm) for the thoracoscope. The second, at the level of 4th intercostal space, 5 mm; the third, at the level of 8th intercostal space, 12 mm and the last, at the level of 2th intercostal space as work trocar for assistant (suction, lung retraction etc). The first trocar is introduced open in the thoracic cavity after control by finger palpation that the space is free of adhesions. After introduction of the first trocar a positive insufflation of 5–8 mmHg is initiated in order to retract enough the right lung for an adequate visualization of the posterior mediastinum. A thoracoscope of 30° is used.



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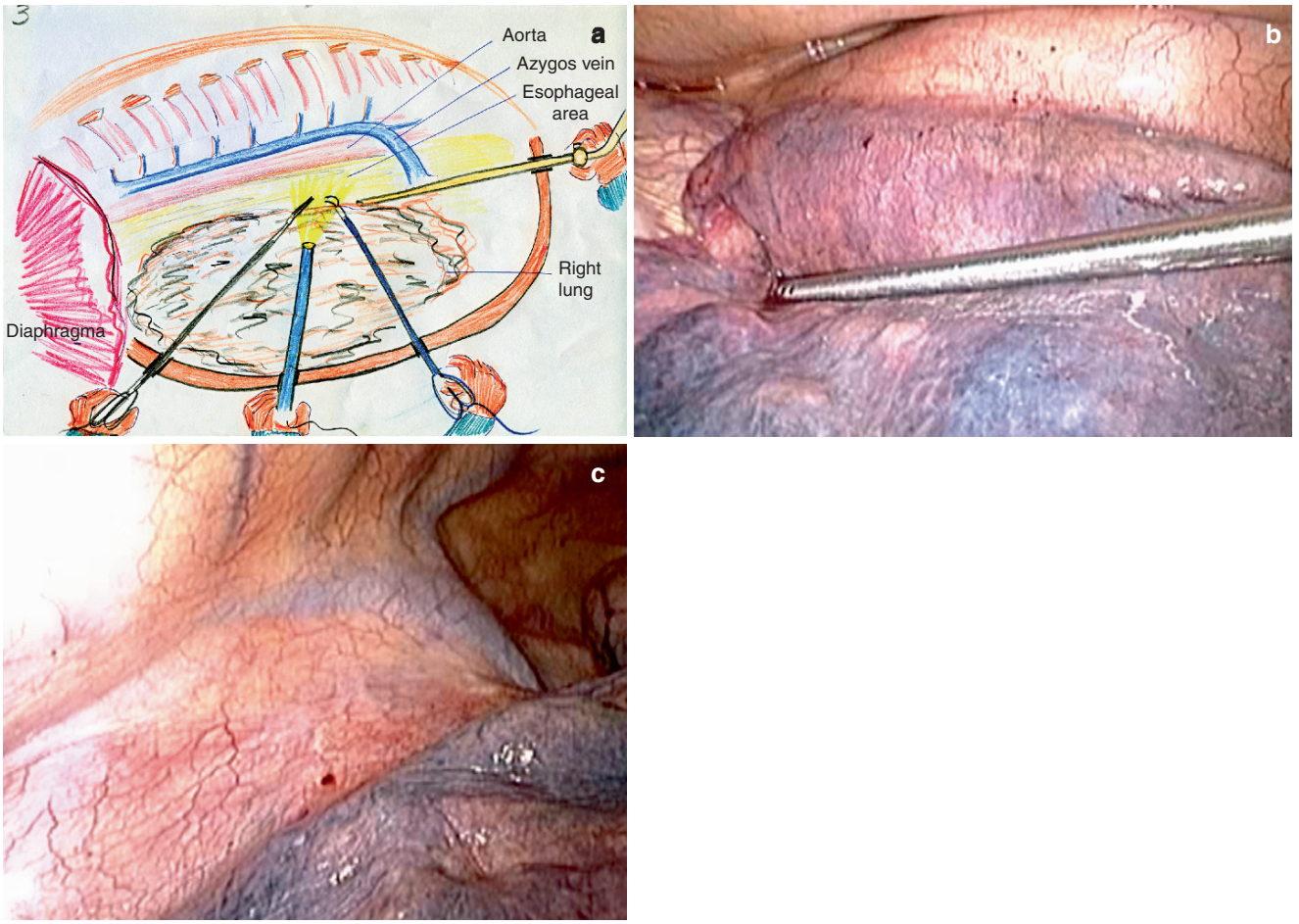


Fig. 6.2 General inspection of the thoracic cavity, distal part and aspects of esophageal area, at the level of the carina and azygos vein (**a**–**c**). The right lung falls due to the insufflation of the cavity (pressure between 5 and 8 mm) and the position of the patient. (**d**–**h**)

4. Inspection is performed of the thoracic cavity and the esophageal area in order to assess if resection is possible As in conventional surgery, presence of metastases, in the pleura or lung, and local ingrowth of the tumor and fixation will preclude a thoracoscopic resection (Fig. 6.2a–c).

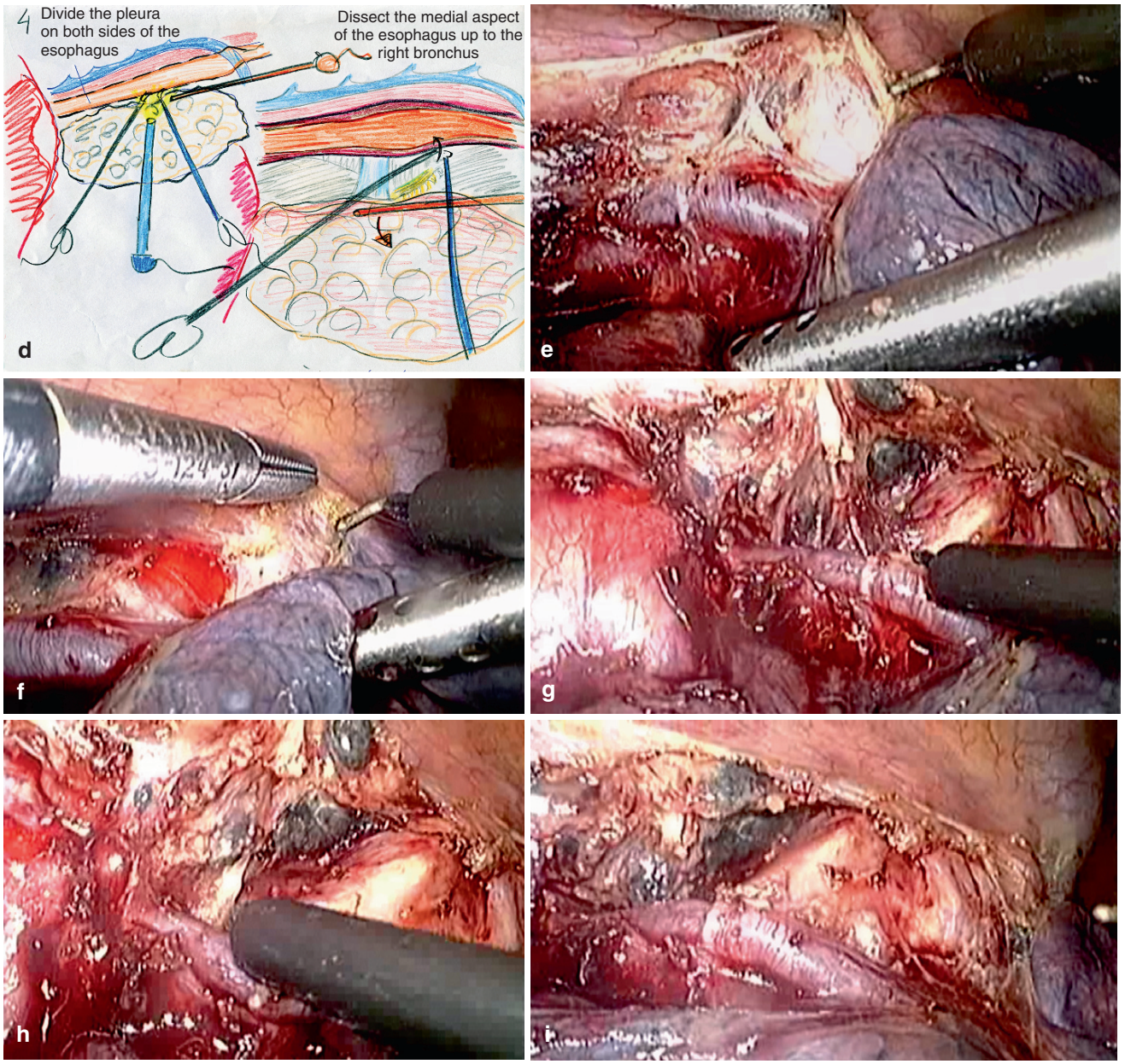


Fig. 6.2 (Continued)

Dissection starts anteriorly by cutting the pulmonary ligament, and the anterior pleura along the lung, from the pericard sac to the hilum of the right lung (right pulmonary vein and right bronchus) up to the azygos vein (Fig. 6.2d–i).

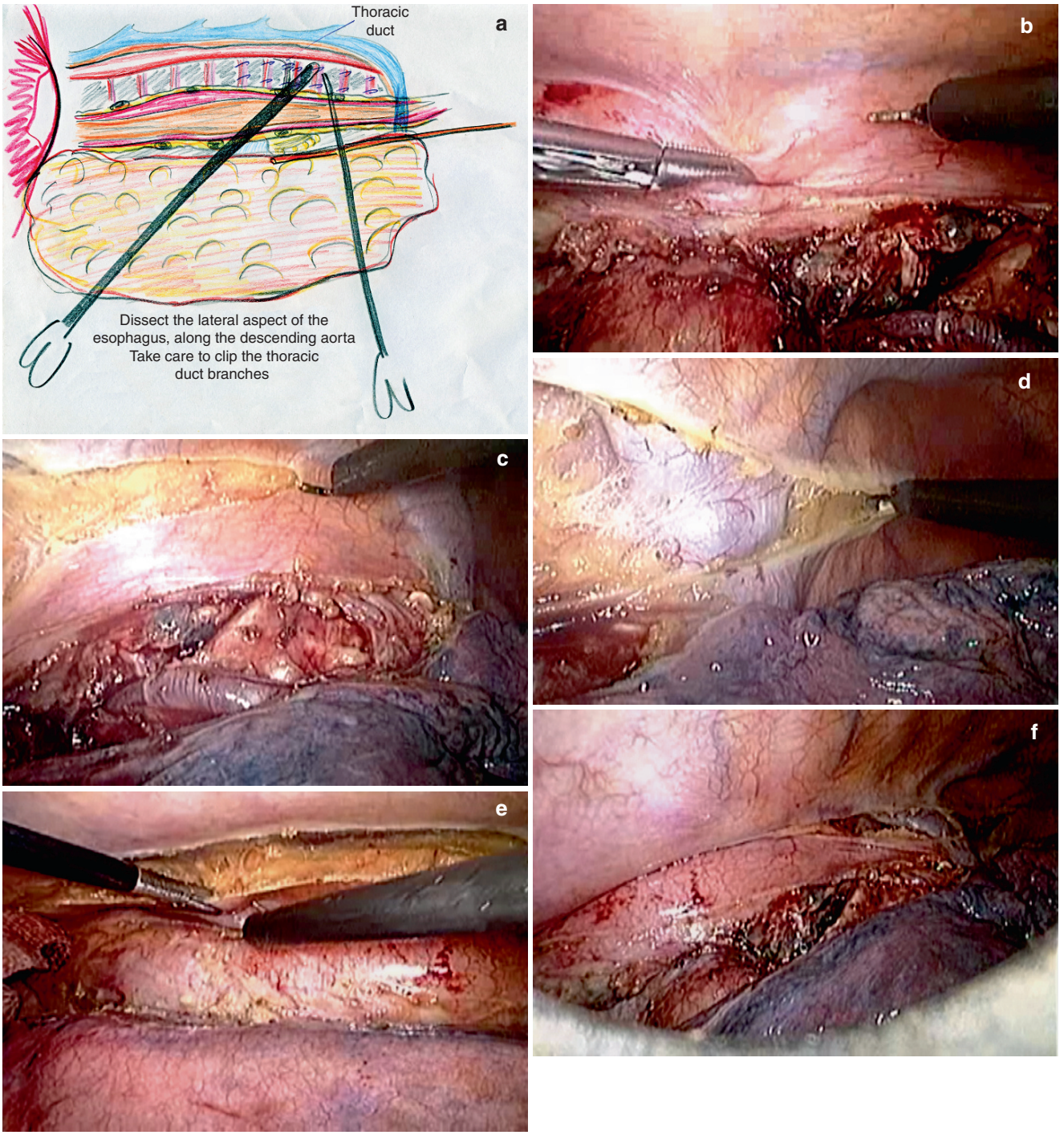


Fig. 6.3 The mediastinal pleura is open at the posterior aspect of the esophagus along the medial aspect of the azygos vein. Dissection takes place along the aorta plane, taking care to localize the thoracic duct, dividing all its branches at the level of the carina between clips (**a**–**h**). The posterior aspect of the dissection is reached (pericard sac, pulmonal veins and contralateral pleura), after dividing several esophageal vessels (**i**)

5. Posteriorly the mediastinal pleura is cut longitudinally at the posterior edge of the esophagus, anterior of the azygos vein from the costo-phrenic angle to the arch of the azygos vein (Fig. 6.3a–f). In this way a broad piece of pleura is resected with the specimen.

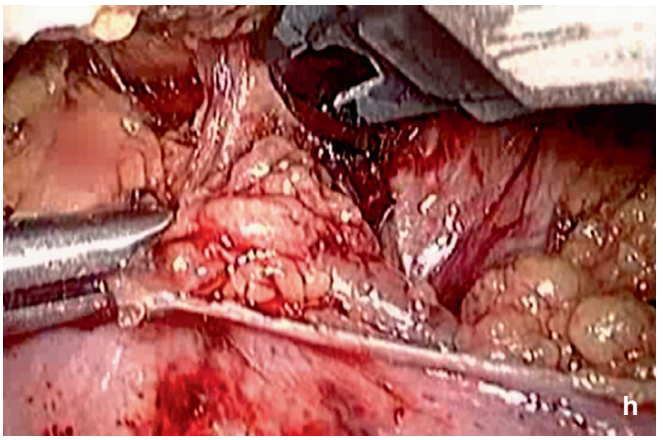
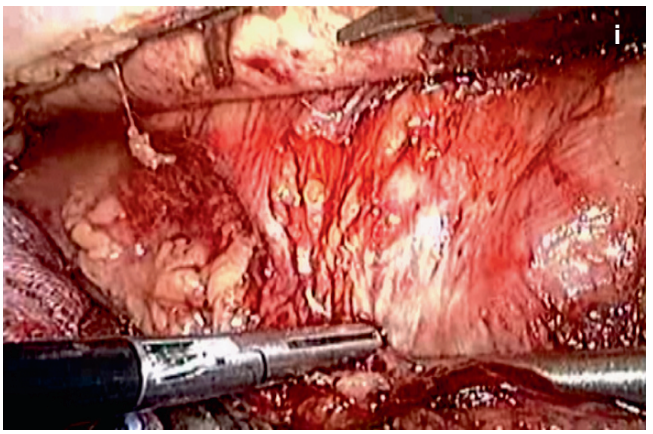


Fig. 6.3 (Continued)

6. Along the plane of the descending aorta, the esophagus with periesophageal lymphnodes and fat is dissected free, taking care with the control of the thoracic duct, and crossing branches from right to left at the carina level. Vascular branches from the aorta to the esophagus at this level have to be clipped in order to avoid lymph leakage (Fig. 6.3g–h). The rest of branches are divided by means of a Ligasure device®. In this way the posterior plane of the pericard, right atrium and contralateral pleura is reached (Fig. 6.3i).



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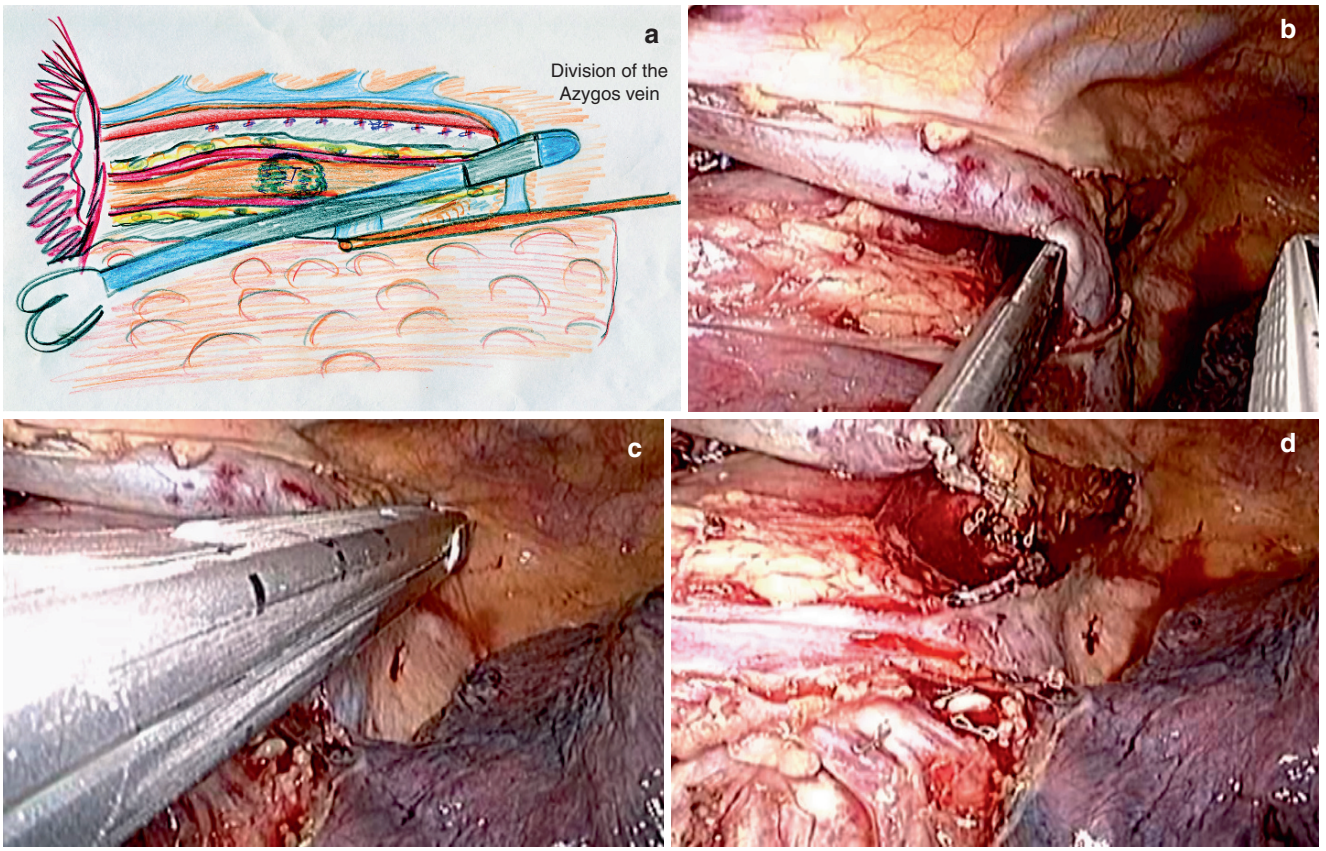


Fig. 6.4 (**a**–**d**) The azygos vein is dissected free and divided by means of vascular (white) endostapler

7. Furthermore the azygos vein is dissected free and cut by means of a vascular endostapler (Fig. 6.4a–d).

8. Dissection proceeds with extensive lymphadenectomy of the right bronchus, carina and left bronchus resection (Fig. 6.5a–f). Lymphadenectomy is not picking one but "en bloc," The LN remain attached to the specimen.

9. Dissection continues between esophagus and trachea (pars membranacea) in proximal direction, to stop 3 cm from the apex of the thoracic cavity, leaving a small cuff of pleura intact (Fig. 6.5g, h).

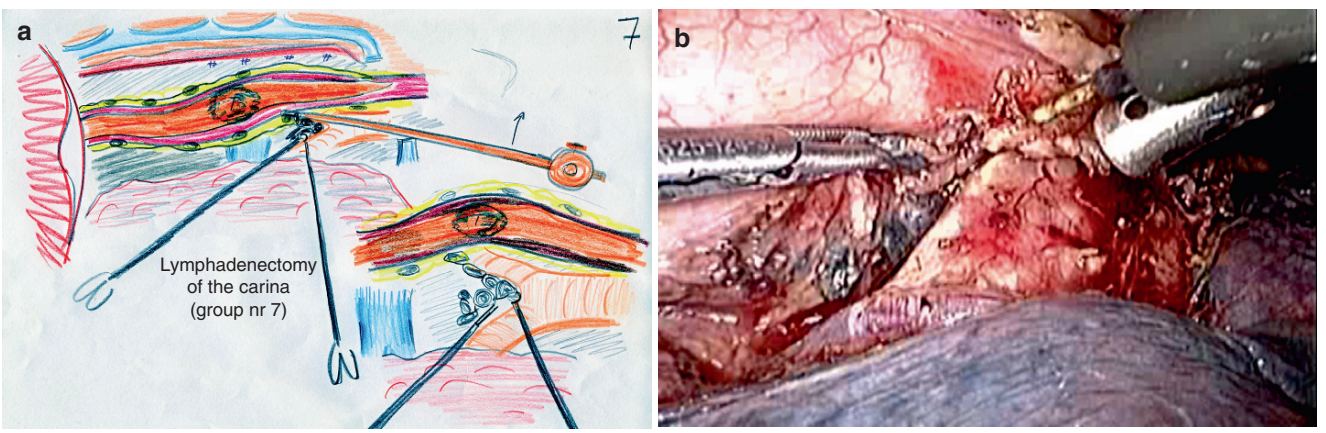
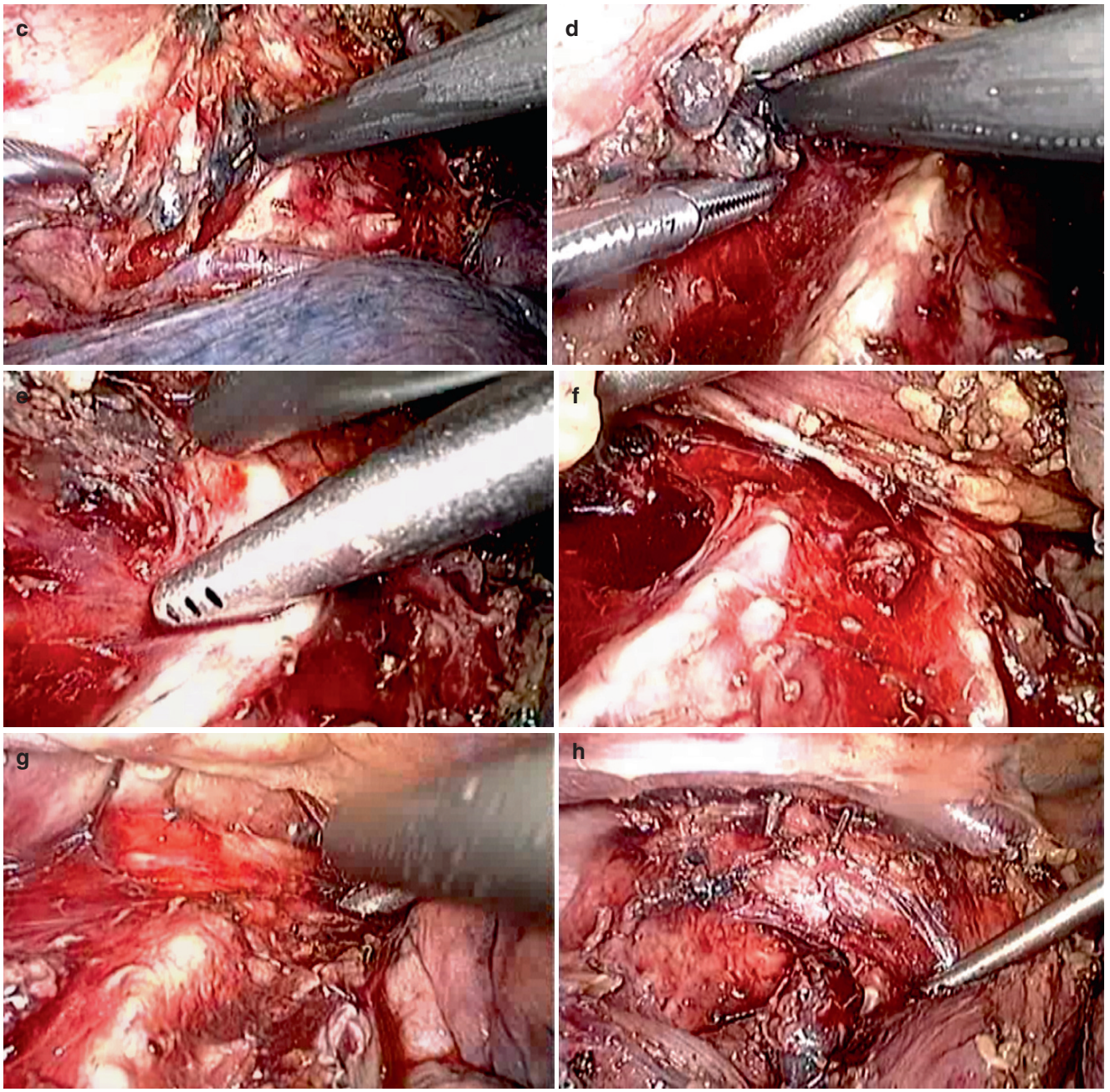


Fig. 6.5 (**a**–**h**) Lymphadenectomy of the carina is now performed, starting at the right bronchus, the carina and thereafter the left bronchus. The hook is used for this dissection. It is important to complete the dissection of the left bronchus not only behind the esophagus but also from the other side (posterior). In this way the lymphadenectomy of the carina is completed and the lymph nodes remain attached to the esophagus. The trachea is freed from the esophagus. In proximal tumors dissection must be very precise and careful in order to preserve the pars membranacea of the trachea



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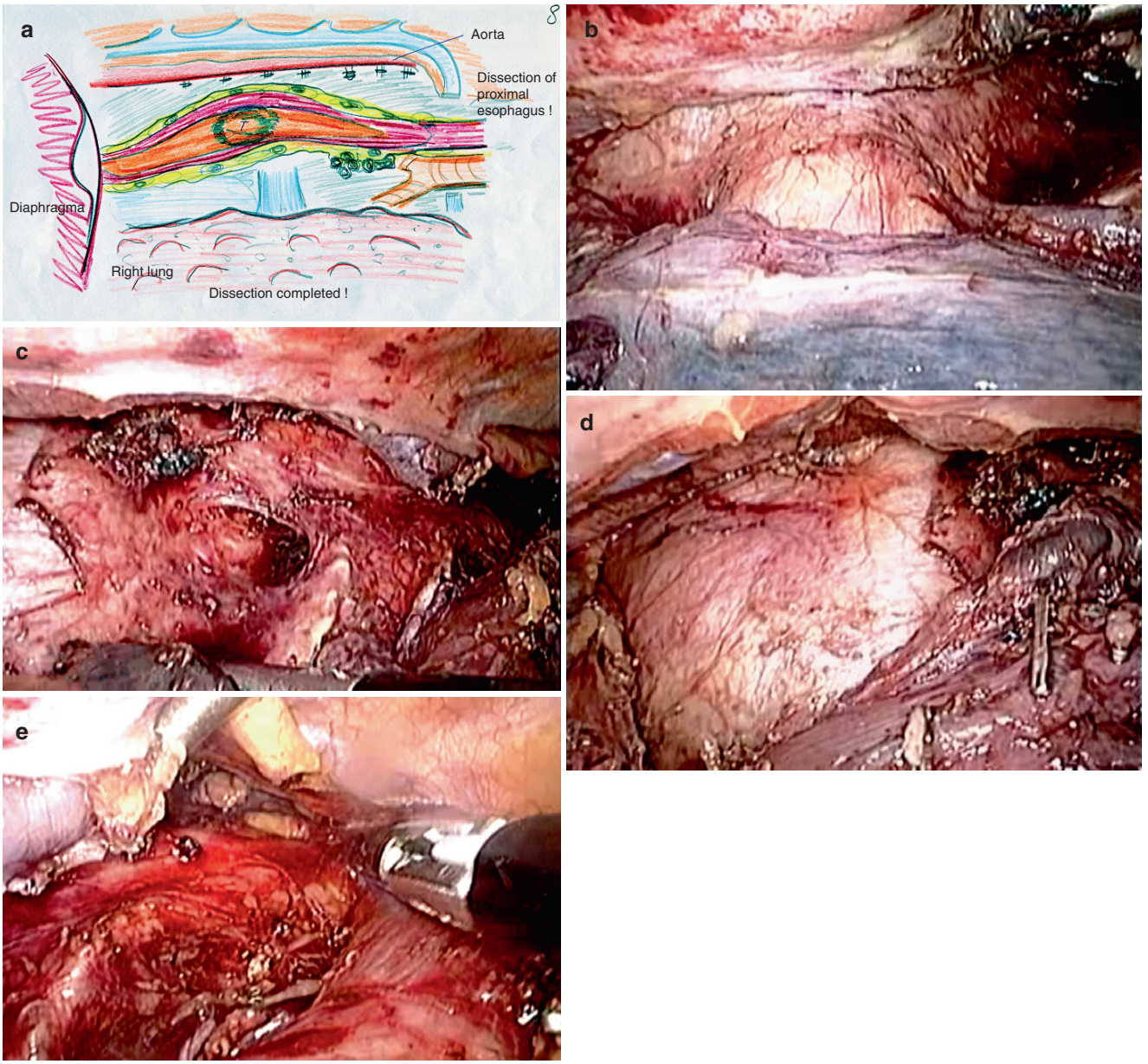


Fig. 6.6 (**a**) General inspection once the dissection is completed. (**b**) Right pulmonary vein; (**c**) carina; (**d**) pericard sac, left atrium and (**e**) trachea

10. After hemostasia control, a thoracic drain is left in the posterior mediastinum and the thoracoscopic phase is considered finalized after general inspection for hemostasia (Fig. 6.6a–e).

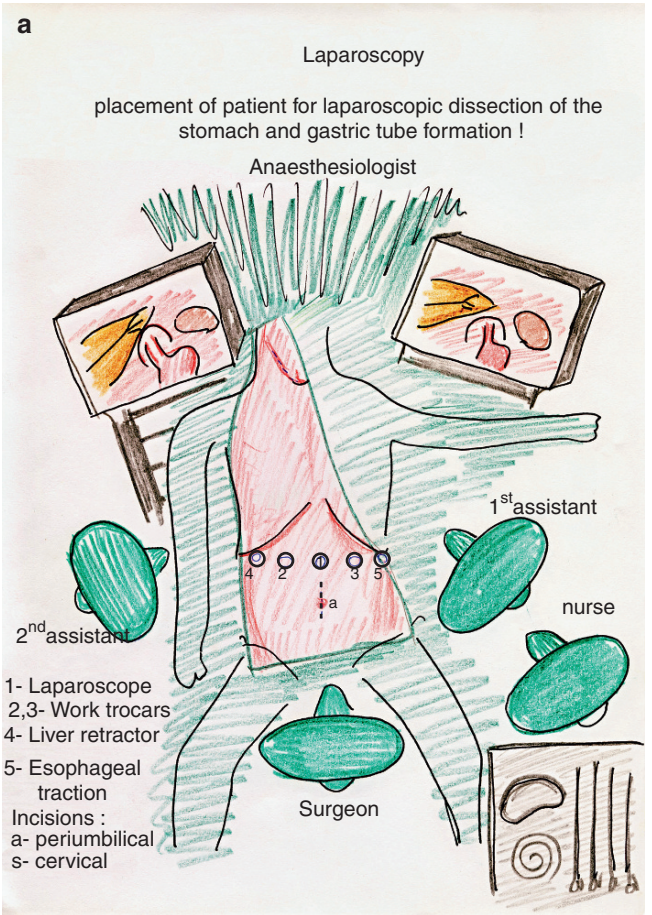
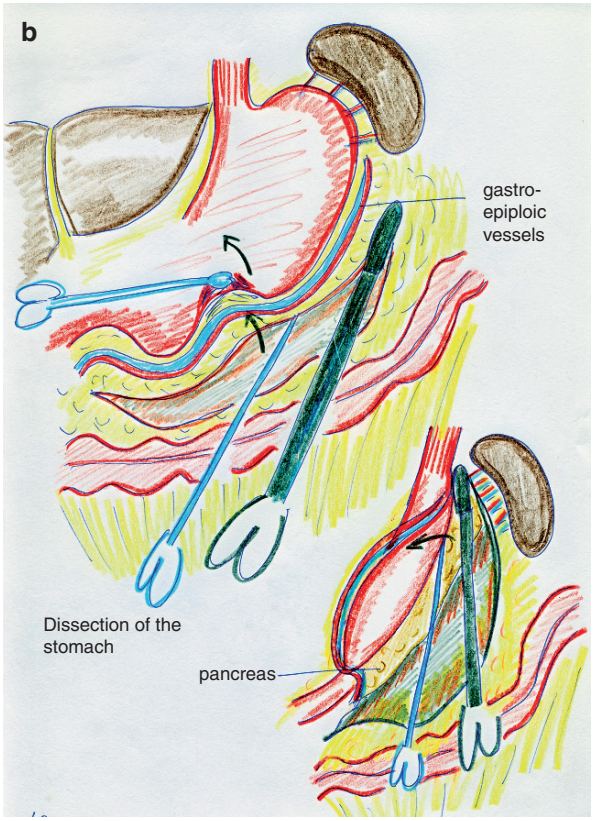
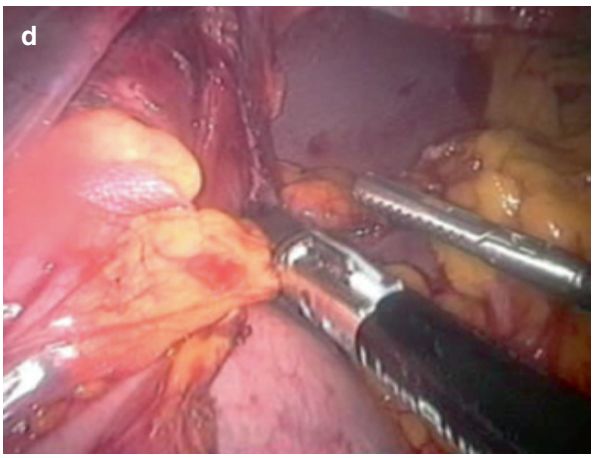
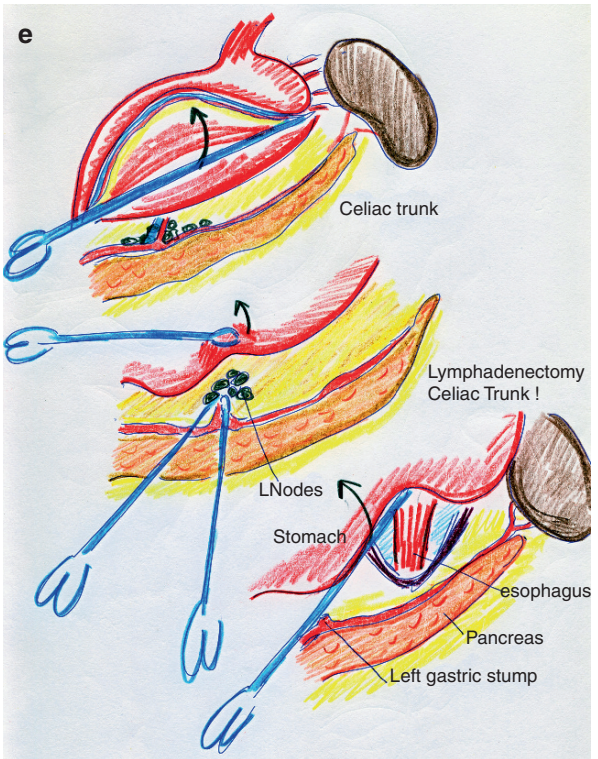


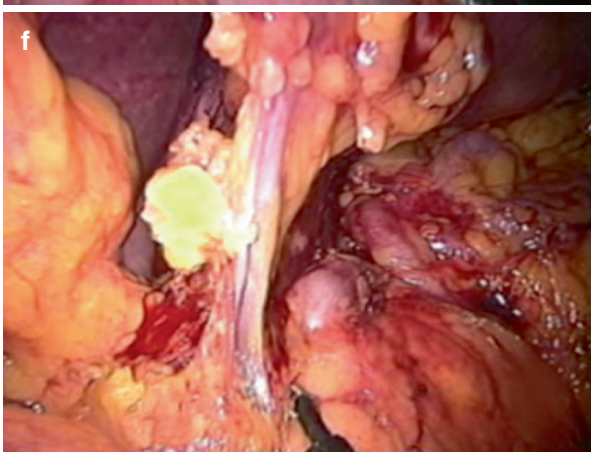
Fig. 6.7 Operating room set-up for laparoscopic dissection of the stomach (**a**), gastric dissection a long the greater curvature (**b-d**), performing an extensive lymphadenectomy of the celiac trunk (**e–f**)

11. Patient is placed for the laparoscopic and cervical phase of the operation (Fig. 6.7a). Stomach is mobilized completely with preservation of the gastro-epiploic vessels and an extensive lymphadenectomy of the celiac trunk is performed (Fig. 6.7b–f). Last part of the laparoscopic approach is the dissection of the hiatal area in which the hiatus is enlarged anteriorly and carefully a communication is made with the thoracic dissected area. Take care that all the specimen, esophagus, and stomach are completely free! At the end of the laparoscopic phase a second team will approach the esophagus at









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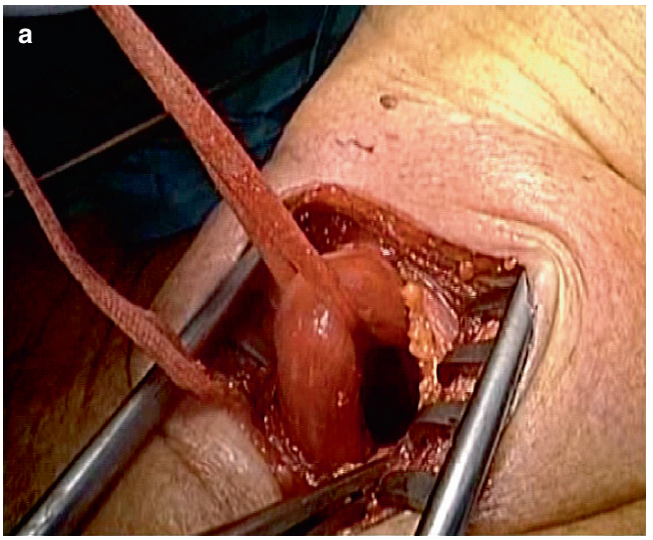
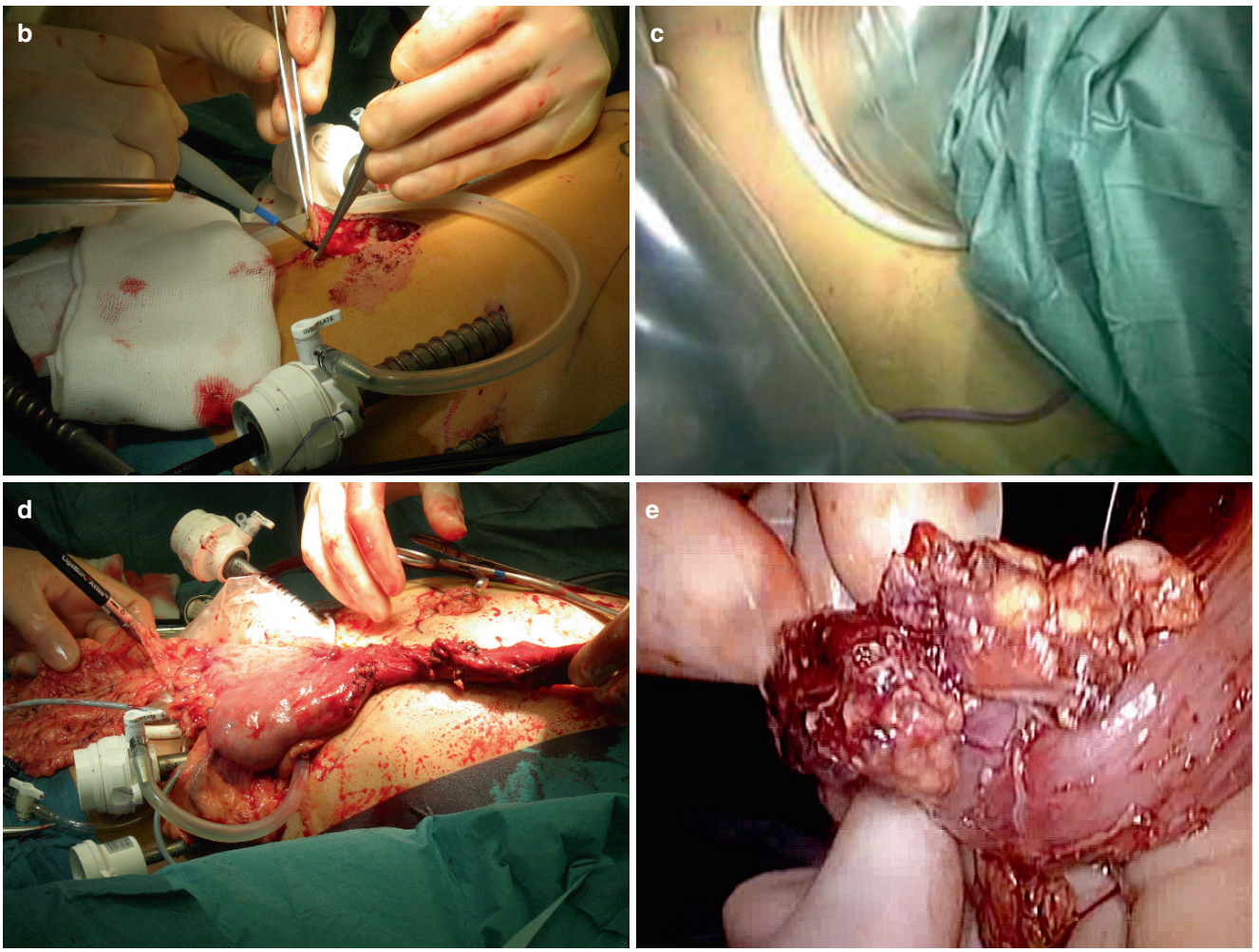


Fig. 6.8 Through a cervical incision the esophagus is dissected free (**a**). The specimen is retrieved through a hand assisted device transumbilical positioned (**b**–**e**). A gastric tube is created by means of GIA stapler (**f**–**g**) and pulled up (attached to a nasogastric tube) into the cervical wound (h) and anastomosed to the proximal esophagus. Aspect of the scars at 10 days postoperative (**i**, **j**)

the cervical area (Fig. 6.8a) and after division of the esophagus (and attached a NG tube to the distal part of the divided esophagus) the specimen is retrieved by the abdominal surgeon through a transumbilical incision of 7 cm, protected by a hand assisted device



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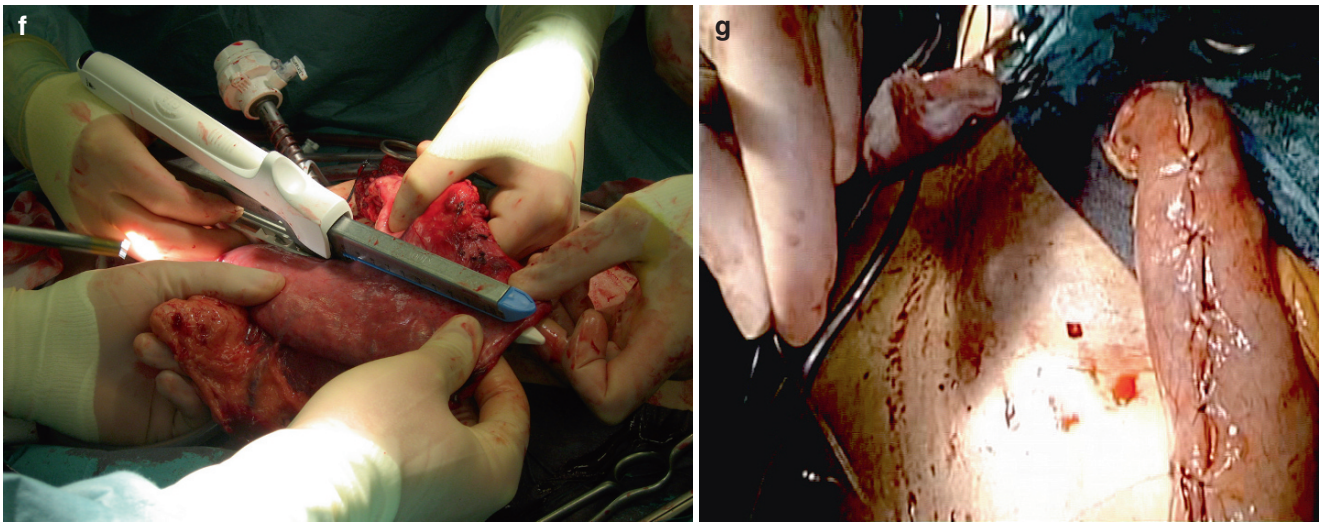

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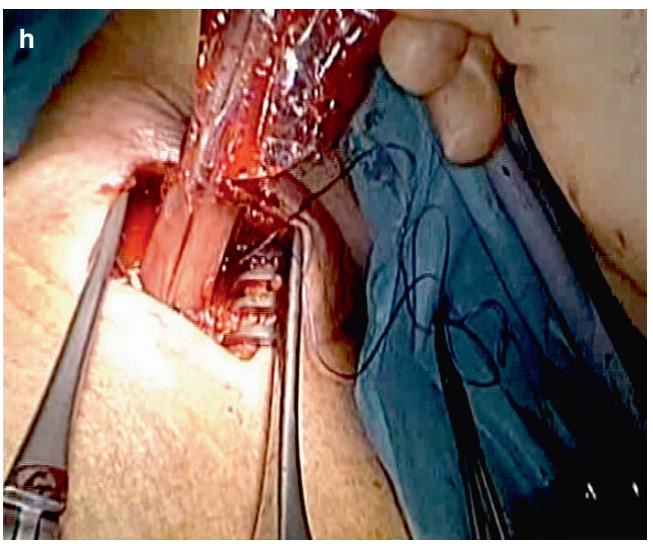
(Fig. 6.8b–e). A 4 cm wide gastric tube is created extracorporeally by means of a 10 cm linear stapler device (Fig. 6.8f–g). No pyloromyotomy or pyloroplasty or Kocher maneuver are performed. After closure of the abdominal wound, insufflation is restarted and under laparoscopic control, the gastric tube, fixed to the NG tube is transhiatal placed into the cervical region (Fig. 6.8h). Final situation is depicted in Fig. 6.8i–j.



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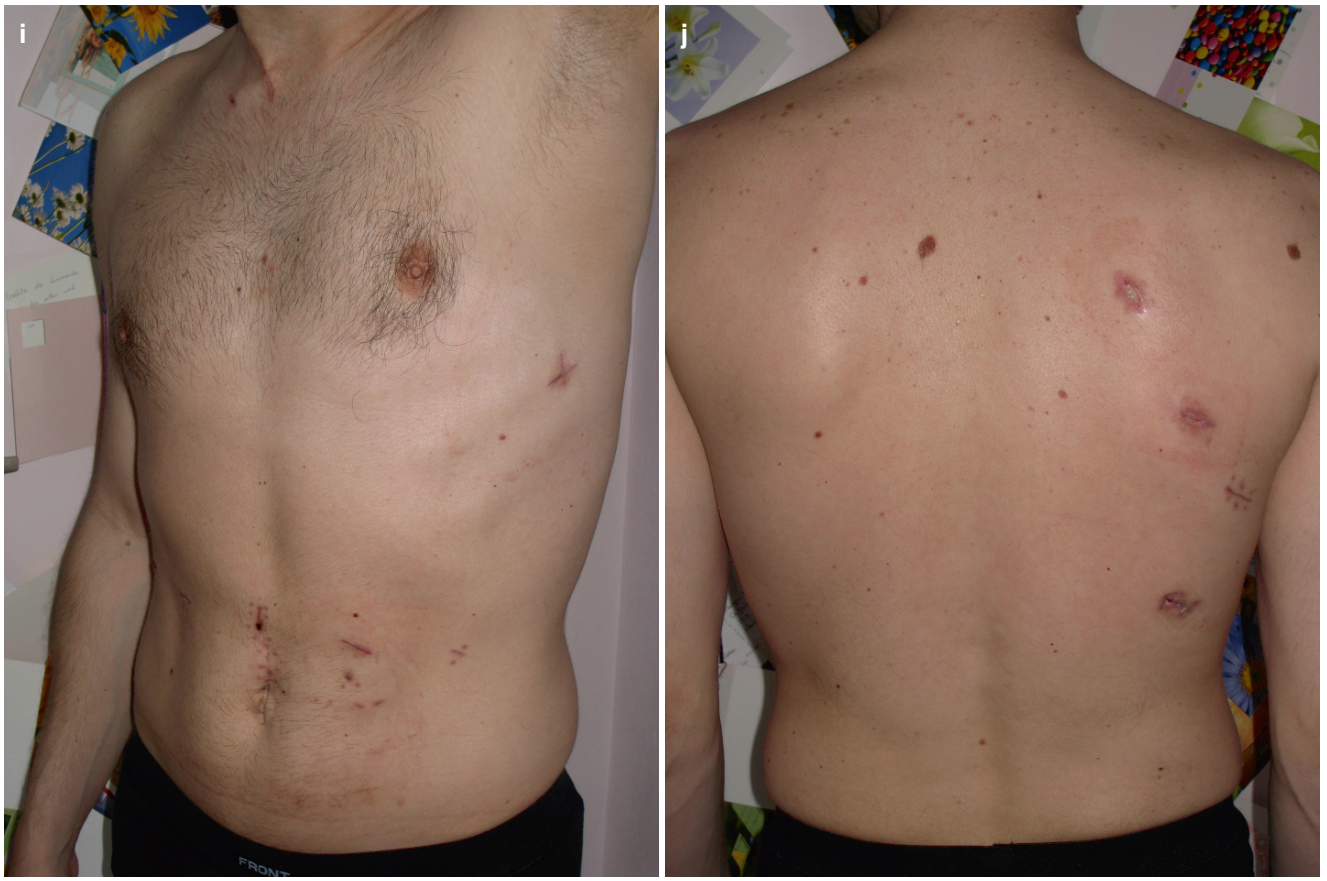

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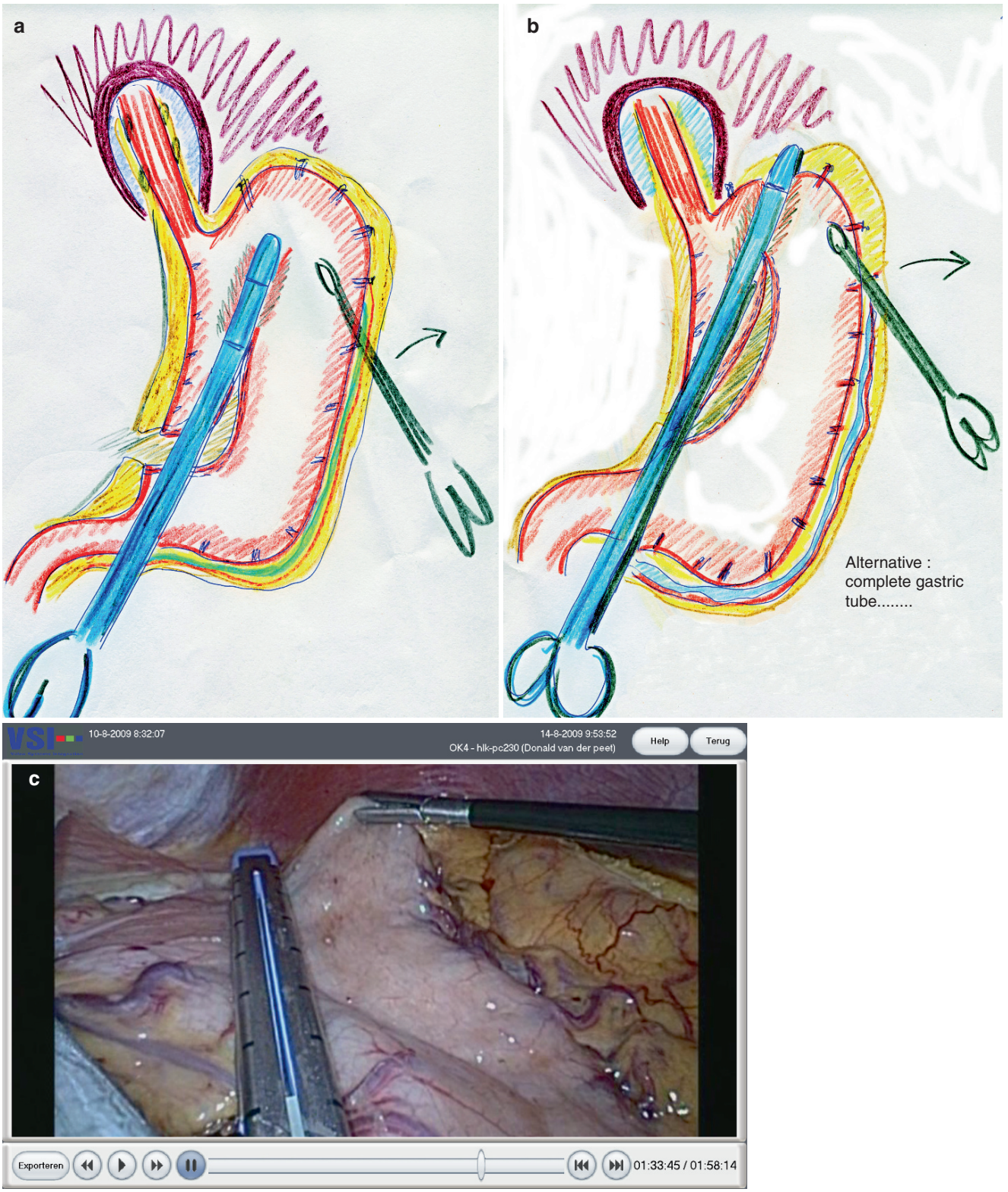
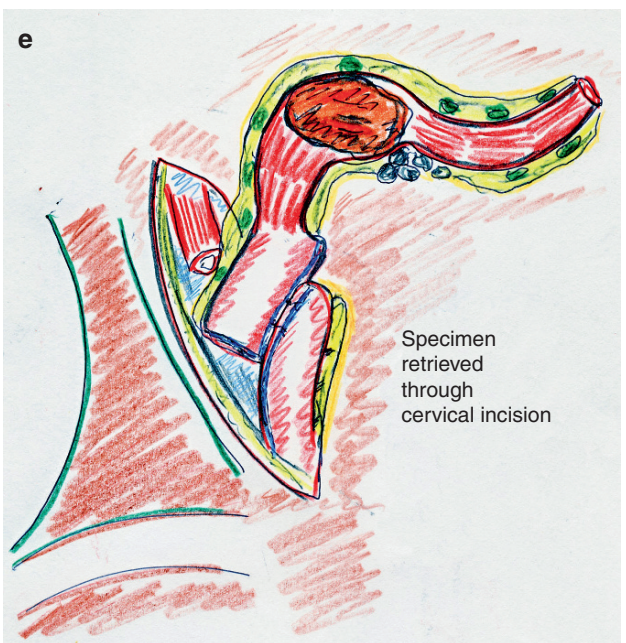


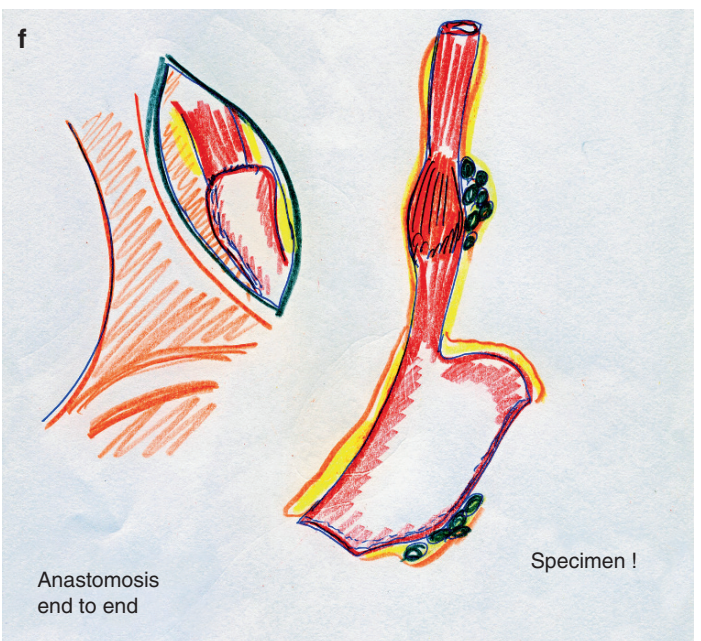
Fig. 6.9 Alternative for the extracorporeal created gastric tube is the total laparoscopic creation of the gastric tube by means of division of the stomach by means of the endostapler (**a**–**c**). The gastric tube is attached to the fundus and retrieved through the cervical wound (**d**–**f**)

12. Other option will be to create the gastric tube totally intraabdominal. Once the gastric mobilization has been accomplished, the stomach is divided by means of a 6 cm endostapler in order to create a gastric tube 4 cm wide along the greater curvature (Fig. 6.9a–c). Once this is done the gastric tube is left attached to the gastric fundus by two strong

Fig. 6.9 (Continued)

stitches or by a small bridge of fundus (Fig. 6.9d). Through the neck the specimen and the gastric tube can be retrieved and both exteriorized in the neck. After resection, an esophago-gastric tube anastomosis is performed (Fig. 6.9e–f).





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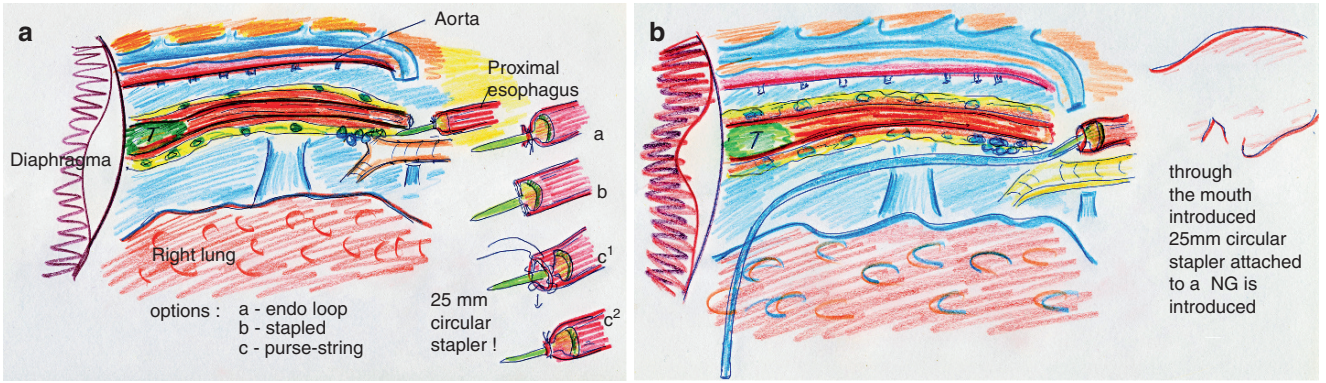
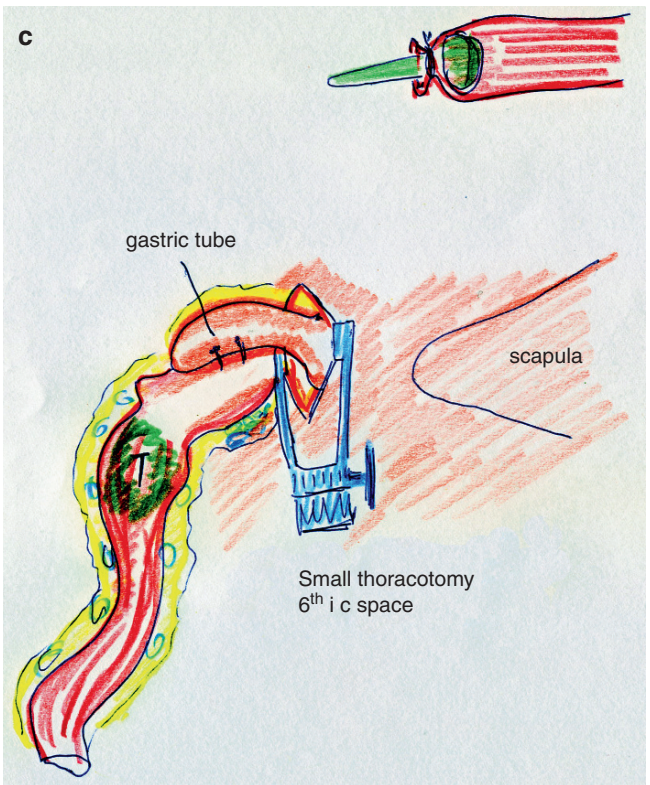


Fig. 6.10 In the case of distal esophageal or junction tumors, alternative for the cervical anastomosis is the Ivor Lewis two stage operation. Patient is placed in prone decubitus position. Dissection of esophagus is performed with lymphadenectomy of the carina (**a**–**b**). Circular stapled anastomosis is performed in an end-to side fashion between the proximal esophagus and the gastric tube through a protected 4 cm posterior thoracotomy (**c**–**d**) after retrieval of the specimen. There are different ways to perform the anastomosis (endo-loop, stapled esophagus or purse string), our choice is the purse string method (**e**–**h**)

13. An Ivor–Lewis approach with an intrathoracic esophago-gastric tube anastomosis is an optional alternative for distal esophageal tumors (see video 4). The operation starts with the laparoscopic procedure with mobilization of the stomach, lymphadenectomy of the celiac trunk and intracorporeal formation of the gastric tube. The patient is then placed in a prone decubitus position for right thoracoscopy. After mobilization of the esophagus and lymphadenectomy of the carina, the esophagus is divided at the level of the azygos vein and stapled or sutured in a purse string fashion (Fig. 6.10a, b).

A small 4 cm posterior thoracotomy is performed at the 6th intercostal space, the anvil of 25 mm circular stapler placed in the thorax, introduced in the proximal esophagus and knotted. The specimen (and the gastric tube) are retrieved through the incision, the specimen is resected and through the gastric tube (Fig. 6.10c,d) the 25 mm circular stapler is introduced into the thoracic cavity, and there anastomosed in an end to side



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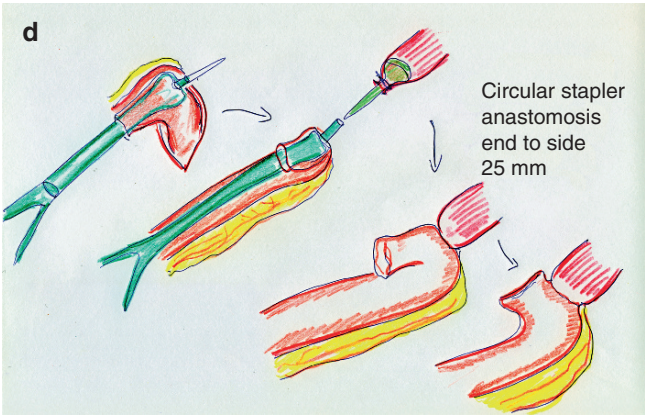

fashion (Fig. 6.10e). The rest of the loop will be excised by means of an endo-stapler (Fig. 6.10d). It is important to check-up the anastomosis by control of the donuts and methylene-blue in order to detect any leakage.

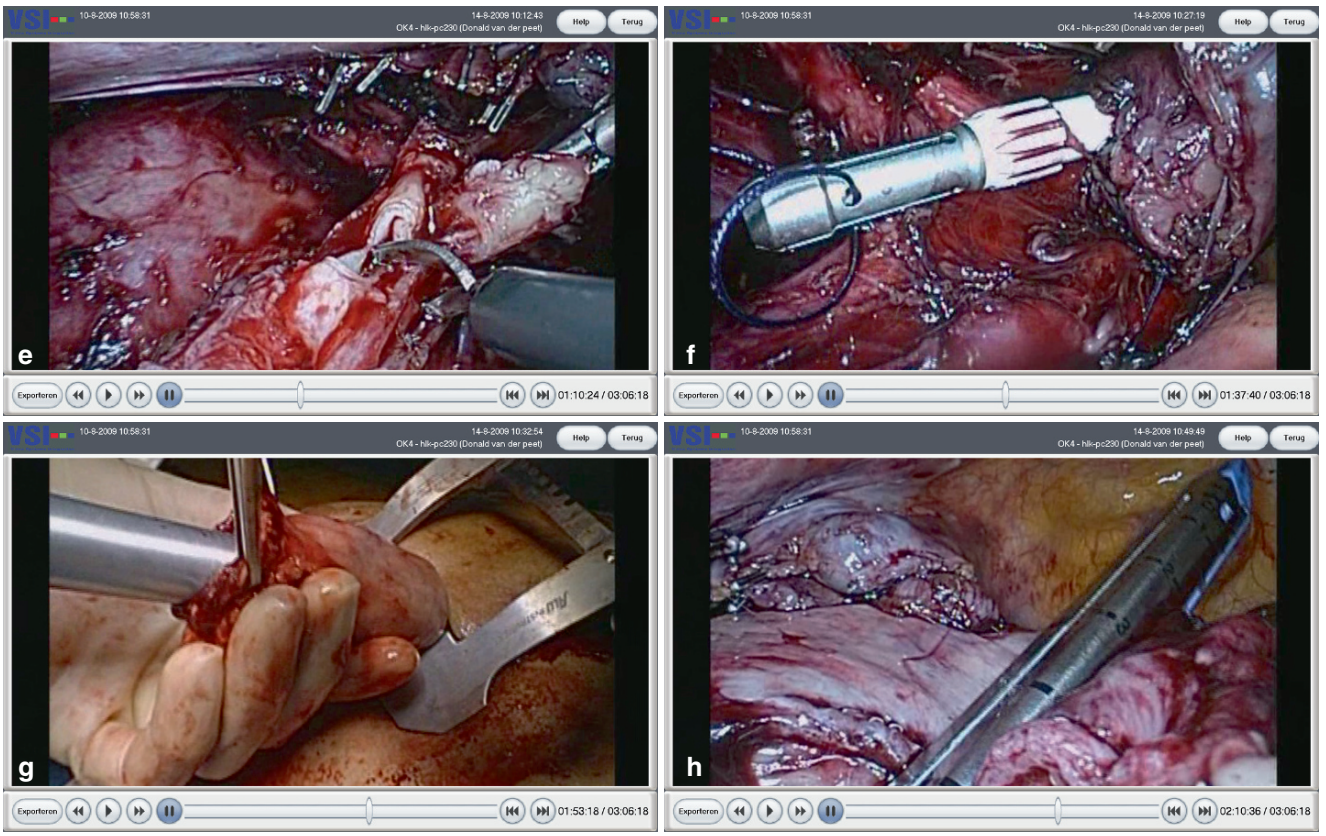

Fig. 6.10e (Continued)

Own Experience

In the period between March 2007 and July 2009, 40 patients have been approached by right thoracoscopic approach in the prone position because of esophageal cancer. Selection of patients has not been made on basis of the stage of the process. Tumors were

located in the thoracic esophagus and found resectable and curable by CT-scan of thorax and abdomen, trans-esophageal ultrasound and PET-scan. There were 30 males and 10 female patients, average age 67 years (range 48–80 years).

Fifteen patients had a squamous cell carcinoma and 25 had adenocarcinoma.

Results

Thirty patients were treated with chemo-radiotherapy and seven with chemotherapy previous to the operation.

One patient was converted to postero-lateral right thoracotomy, after chemoradiation, because a combination of difficult to develop surgical plane along the aorta and moderate bleeding (see video no 5). The patient was turned to lateral position and conventionally approached. Venous bleeding came from a venous plexus at a location between the aorta and azygos vein. Pathological examination showed a complete response of the tumor without any active tumor rest.

In 25 patients abdomen was approached laparoscopically and in fifteen through a median laparotomy because of relative contraindications for laparoscopy such as extreme obesity, PET positive LN at the prepyloric small curvature and previous laparotomy. In one patient conversion to laparotomy was performed because the presence of extensive fibrosis in the celiac trunk after chemotherapy.

Mean operative time of the thoracoscopic approach has been 130 min, the total operative time of 290 min (range 240–460 min). Blood loss was 220ml (range 250–400).

Median ICU stay was 1 day (range 1–37 days) and a median hospital stay of 13 days (range 12–78 days). There is no mortality recorded.

Postoperative complications were seen in six patients: three anastomosis leak at the cervical wound; a fourth patient with an ischemia/necrosis of the proximal gastric tube, being explored by cervico-laparotomy, with resection of 5 cm of the top of the gastric tube, reanastomosed and protected with a Choo® stent and a limited chylothorax, treated conservatively in the other two patients. In the case of high output chylothorax, the leak can be approached and threated thoracoscopically (see video no 6).

Pathological examination showed an R0 resection in 36 patients with a complete response after chemoradiation in eight patients. Median number of LN resected, in this two field lymphadenectomy operation, was 21 (range 15–33).

Comment

If a comparison has to be made between the right prone and the right lateral thoracoscopic approaches for esophageal cancer, it seems that the prone position may cause less pulmonary complications than the lateral approach in which the right lung has to be blocked. Luketich et al., reports, in a series of 222 patients, an incidence of pulmonary complications in 7.6% of the patients after right lateral thoracoscopy with collapse of the lung [9]. Palanivelu et al., using the prone position in 130 patients, report only (1.5% in their series) [10]. Possible explaination for this difference may be the use of a single endotracheal tube with possible two-lung ventilation. The partial ventilation of the right lung, obtained during the prone decubitus thoracoscopy, will reduce the possibility of arteriovenous shunt. Moreover ventilation–perfusion ratio is well maintained and hypoxia and hypercarbia avoided. This may reduce the extent of pulmonary dysfunction and athelectasia postoperatively. Other important advantages of the prone position may be shorter anesthesia time, excellent exposure of the operative field and better ergonomy for the surgeon.

The early results in our series of 40 patients will confirm the outcome of the aforementioned series: pulmonary complications seems lower in the thoracoscopic prone position than in the lateral position and lower than in the open three-stage procedure,

higher than 50% [11]. Obviously, complications of the anastomosis are related to the gastric conduit and will remain the same as in the open conventional approach.

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