JOURNAL OF LAPAROENDOSCOPIC & ADVANCED SURGICAL TECHNIQUES
Volume 16, Number 3, 2006

Case Report

Robot-Assisted Thoracoscopic Esophagectomy with the Patient in the Prone Position

GIOVANNI DAPRI, MD, JACQUES HIMPENS, MD, and GUY-BERNARD CADIÈRE, MD, PhD

ABSTRACT

We describe a new technique of esophagectomy by robot-assisted thoracoscopy with the patient in the prone position, followed by laparoscopy and left cervicotomy with the patient in the supine position. We report two procedures performed November 2002 and September 2003. The technique should allow more thorough lymph node removal while reducing postoperative pain and morbidity. The thoracoscopy is robot-assisted and the articulations within the pleural cavity improve the surgeon's dexterity and reduce trocar movements. The prone position allows mobilization of the esophagus with only three trocars because the lung, which is partially deflated, does not block access. With the patient in the prone position, bleeding does not obscure the operative field. Stomach mobilization, gastric tube creation, and celiac lymphadenectomy are performed by laparoscopy. The esogastric anastomosis is a totally mechanical side-to-side anastomosis realized by left cervicotomy.

INTRODUCTION

We have routinely performed esophagectomy in our department by thoracoscopy, laparoscopy, and cervicotomy since 1991. In 2002 we began using the prone position for the patient during thoracoscopy for the dissection of the thoracic esophagus and for mediastinal lymphadenectomy. In this position (1) the force of gravity partially deflates the lung, which always remains out of harm's way, obviating the need for a fourth trocar; (2) the esophagus and aortopulmonary lymph nodes are reached under excellent and accurate vision; and (3) bleeding does not obscure the operative field, because blood drops back into the chest cavity. Postoperative pain can be considerable in thoracoscopy, probably due to the movement of the trocars in the intercostal spaces. The da Vinci® robotic system (Intuitive Surgical, Mountain View, CA) causes reduced trauma in the intercostal spaces by reducing motion of the trocars thanks to the articulations inside the pleural cavity.

The patient is then placed in the supine position and the procedure is completed by a laparoscopic step with the creation of a gastric tube and the performance of a celiac lymphadenectomy and ends with the cervical step, where the anastomosis is performed.

We describe our technique of robot-assisted thoracoscopic esophagectomy with the patient in the prone position, and laparoscopy and left cervicotomy with the patient in the supine position, and report two cases performed November 2002 and September 2003.

Department of Gastrointestinal Surgery, European School of Laparoscopic Surgery, Saint-Pierre University Hospital, Brussels, Belgium.

FIG. 1. Operating room setup during robot-assisted thoracoscopy.

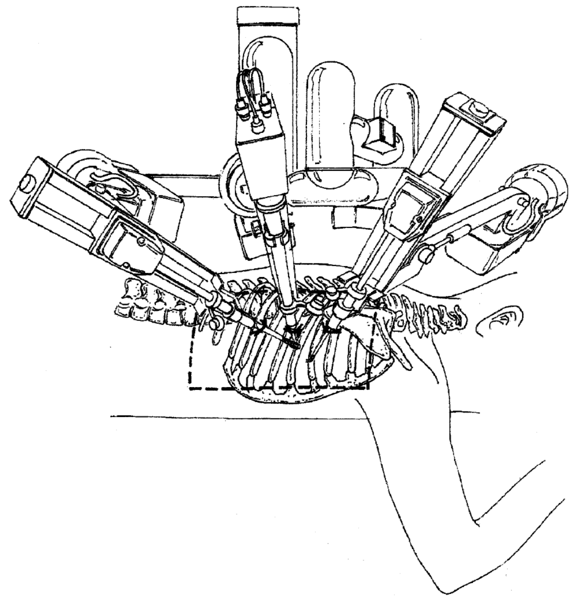

FIG. 3. Robotic placement in the right chest cavity.

CASE REPORTS

Case 1

A 56-year-old man was admitted for an 8-cm-long tumor of the middle third of the esophagus that began just below the tracheal bifurcation, and was found at gastroscopy. Preoperative biopsy demonstrated a squamous cell carcinoma. No thoracic or abdominal metastases were evidenced at the computed tomography (CT) scan. The patient was operated on with the technique described below. Histologic examination confirmed the tumor. Three paraesophageal nodes, 8 paracardial lymph nodes, and 7 celiac nodes were also examined. The final staging was pT3N0Mx. There were no postoperative complications and the patient was discharged on postoperative day 7. Adjuvant therapy was undertaken, but the patient died 22 months later from distant metastases (lung, liver, and kidney).

Case 2

A 63-year-old man presented with a lesion of the middle third of the esophagus, at 30 cm from the mouth. Preoperative biopsy indicated a squamous cell carcinoma. There was no evidence of any thoracic or abdominal metastases at preoperative CT scan. An esophagectomy was performed. The histologic examination confirmed squamous cell carcinoma and 13 paraesophageal and 8 paracardial lymph nodes were isolated. The final staging was pT1N0Mx. The postoperative course was uneventful and patient was discharged on postoperative day 12. At 19-month follow-up, the patient was clinically and radiologically free of disease.

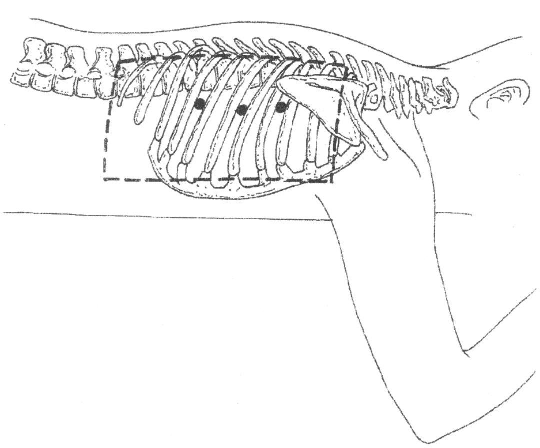

FIG. 2. Patient and trocar positioning during thoracoscopy in prone position.

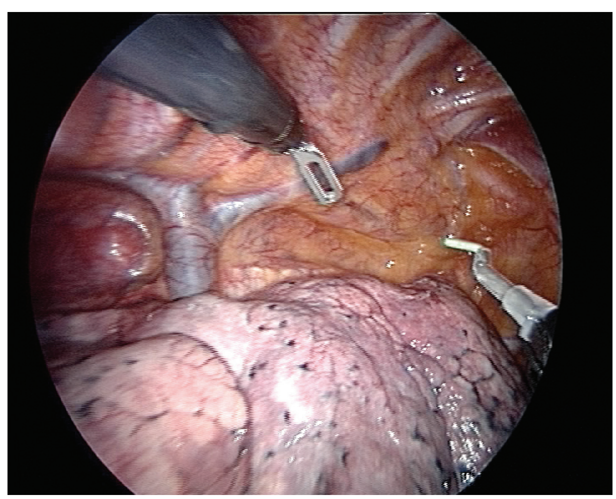

FIG. 4. Prone position: direct access to the thoracic esophagus.

TECHNIQUE

Robot-assisted thoracoscopy in the prone position

The patient is placed in the prone position after induction of general anesthesia and insertion of a double-lumen endotracheal tube. The patient's right arm is positioned in front of and beside the head, to obtain an open angle between the scapula and spine. The robot is placed to the left of the patient (Fig. 1).

Three trocars are used for the procedure: a 10-mm trocar for the optical system in the 7th intercostal space, an 8-mm trocar in the 9th intercostal space for the grasping forceps, and an 8-mm trocar in the 5th intercostal space for the coagulating hook (Figs. 2 and 3). Pneumothorax is established at 6–8 mm Hg to achieve good exposure. Later in the operation the lung is partially deflated.

Thanks to gravity the aortopulmonary window nodes drop back and the dissection space is directly opened (Fig. 4). The mediastinal pleura overlying the esophagus is incised and the esophagus is circumferentially mobilized along the trachea (Fig. 5) and the descending aorta (Fig. 6), reaching the right diaphragmatic pillar. All fatty tissue is separated from the pericardium and descending aorta. The arch of the azygos vein is isolated, ligated by 2/0 silk stitches with clips and divided (Fig. 7). Paraesophageal, paratracheal, subcarinal, bilateral tracheobronchial, right peripulmonary artery and veins lymph nodes are dissected so as to remain en bloc with the surgical specimen. A 28Fr chest tube is inserted in the 11th intercostal space on the anterior axillary line at the end of this step.

Laparoscopy in the supine position

The patient is now placed in the supine position. The surgeon stands between the patient's legs, the first assistant stands on the patient's right side, the second assistant stands to his left, and the scrub nurse stands beside the patient's left leg (Fig. 8). The patient is draped to allow trocar placement in the abdomen and an incision along the left sternocleidomastoid muscle in the neck.

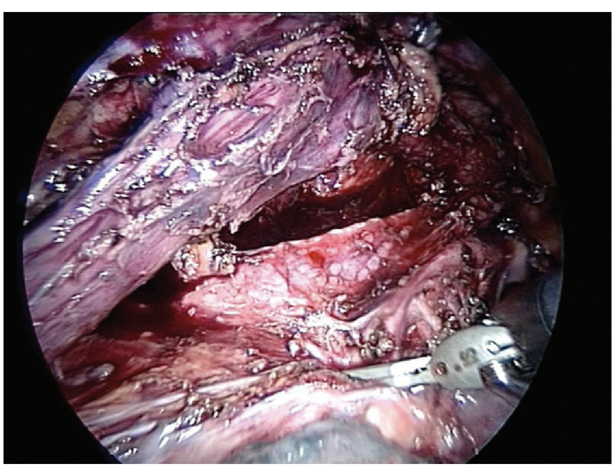

FIG. 5. Upper thoracic esophagus dissection close to trachea.

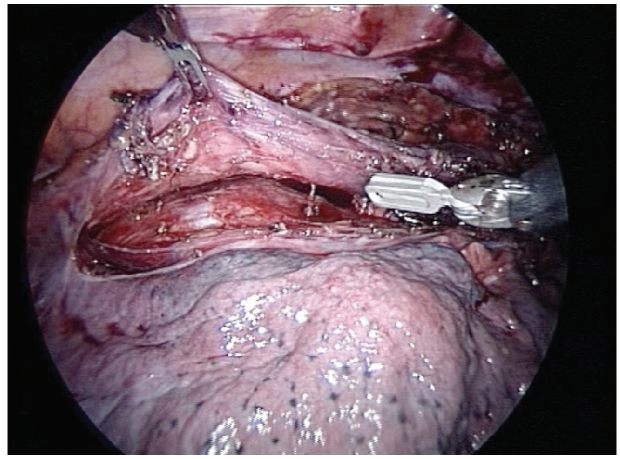

FIG. 6. Lower thoracic esophagus dissection along the descending aorta.

Five trocars are used: a 10-mm trocar 2 cm above the umbilicus, a 5-mm trocar on the midclavicular line under the left costal margin, a 5-mm trocar half way between the first two trocars, a 10-mm trocar on the right midclavicular line under the right costal margin, and a 10-mm trocar under the xyphoid process (Fig. 9).

The dissection of the lesser omentum starts to the left of the right gastric artery and follows the latter towards the hepatic hilus, moving then to the left side of the liver until it reaches the right crus. Then the anterior sheets of the esogastric and phrenogastric ligaments are dissected (Fig. 10). Dissection of the right pillar is important to reach a good opening of the hiatus and to remain at a distance from the tumor. The right pillar is sectioned up to the edge of the aorta.

The section of the gastrocolic ligament and thus the opening of the lesser sac is carried out just lateral to

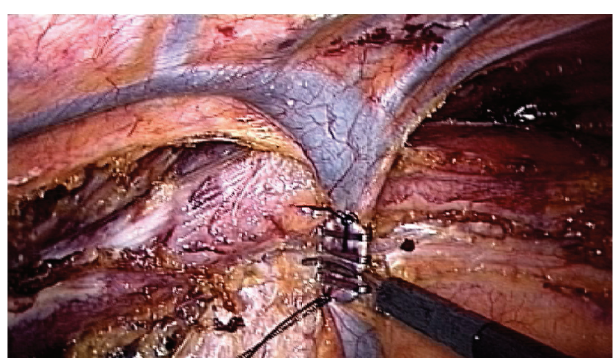

FIG. 7. Section of the azygos vein.

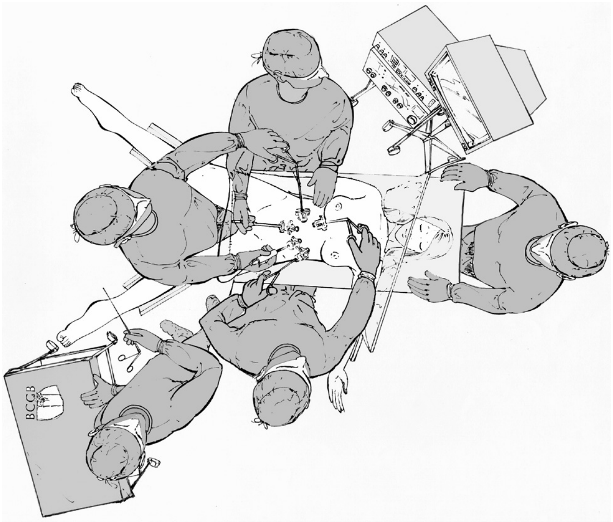

FIG. 8. Patient positioning during laparoscopy and cervicotomy.

the right gastroepiploic artery and vein (Fig. 11). The lesser sac is opened in the direction of the spleen, always respecting the right gastroepiploic vessels. Section of the gastrosplenic ligament reaching the previous section of the phrenogastric ligament ends this phase of the procedure. Subsequently, dissection of the lesser sac is resumed in the dissection of the gastroduodenal artery. The greater omentum is then separated from the mesocolon up to the colic angle. The duodenum is freed completing the Kocher's maneuver (Fig. 12).

Vision of the superior limit of the pancreatic tail, the celiac trunk, and the hepatic pedicule is enhanced by the 30-degree videoscope and by pulling the gastric

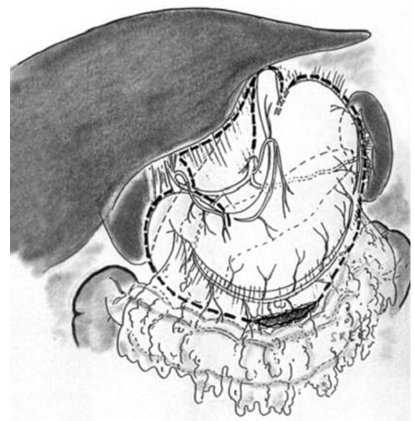

FIG. 10. Mobilization of the esogastric junction, small and greater curvature.

antrum down to the left side of the patient. The peritoneal sheet joining the tail of the pancreas is dissected with the coagulating hook (Fig. 13). All lymphoglandular tissue from this point towards the right is sampled, while preserving the right gastric artery and the hepatic pedicule. The portal vein and hepatic pedicule are skeletonized using the coagulating hook. The assistant pulls the perivascular fatty and lymphoglandular tissue to the left side of the patient. A careful dissection of the common hepatic artery going upstream reaches the celiac trunk. The left gastric vein and artery are isolated and divided between clips (Figs. 14 and 15). Dissection of all lymphoglandular tissue is completed along the abdominal aorta until the diaphragmatic pillars are reached (Fig. 16). A complete mobilization of the stomach is performed. The gastric tube is outlined by superficial scoring of the stomach. Several applications of a linear stapler are necessary. The first firing

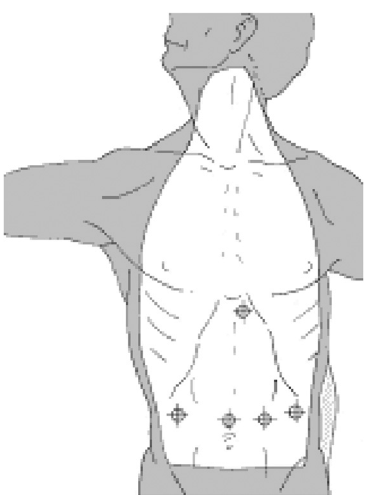

FIG. 9 Disposition of the trocars in the abdomen.

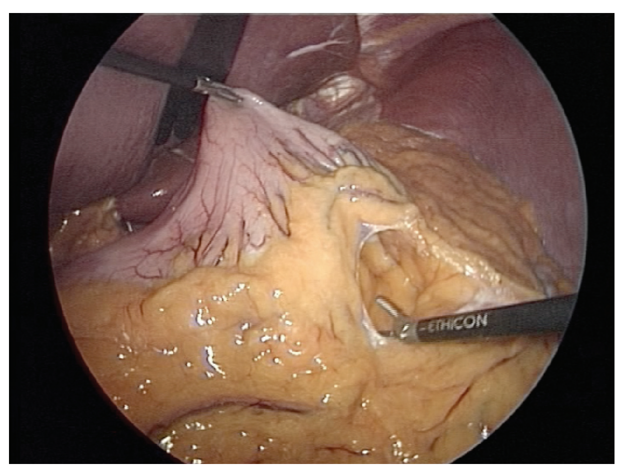

FIG. 11. Section of the gastrocolic ligament.

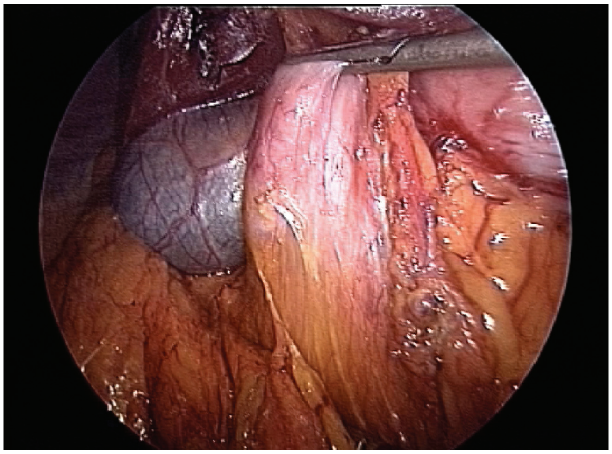

FIG. 12. Kocher's maneuver.

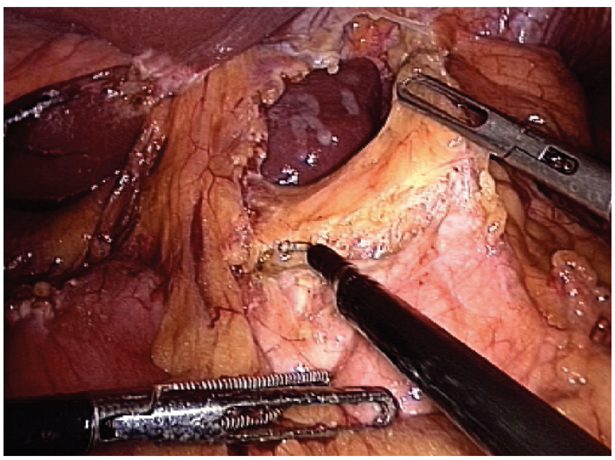

FIG. 13. Beginning of the celiac lymphadenectomy close to the pancreas.

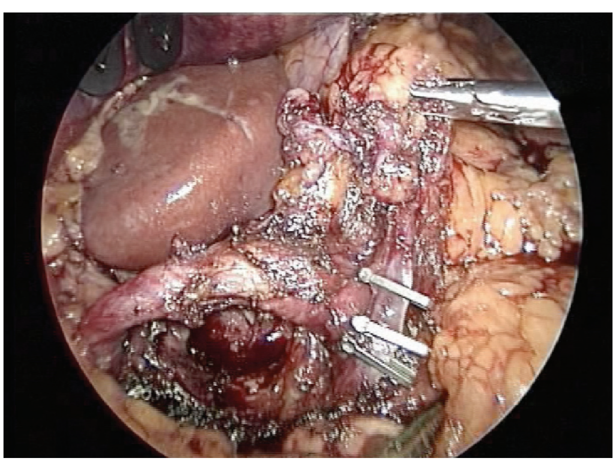

FIG. 14. Section of the left gastric vein.

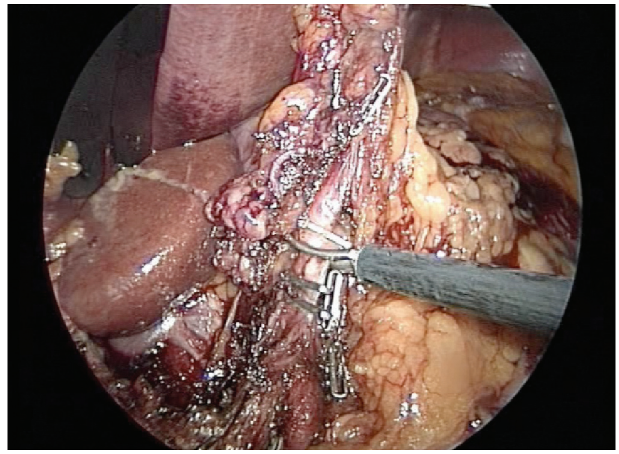

FIG. 15. Section of the left gastric artery.

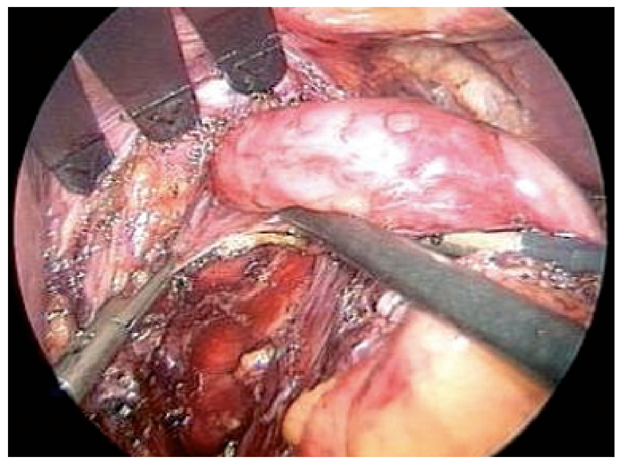

FIG. 16. Lymphadenectomy along the abdominal aorta.

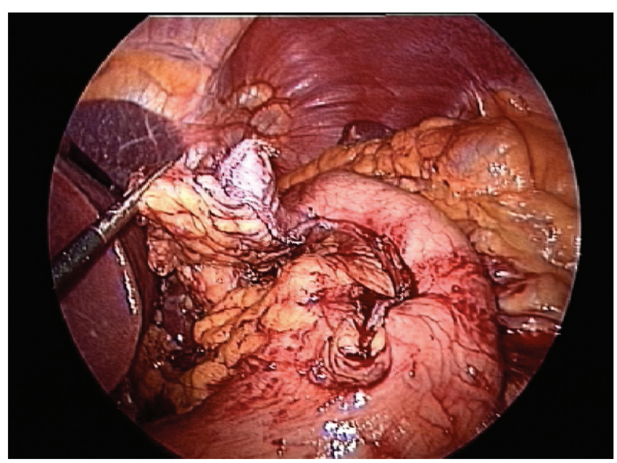

FIG. 17. Creation of the gastric tube.

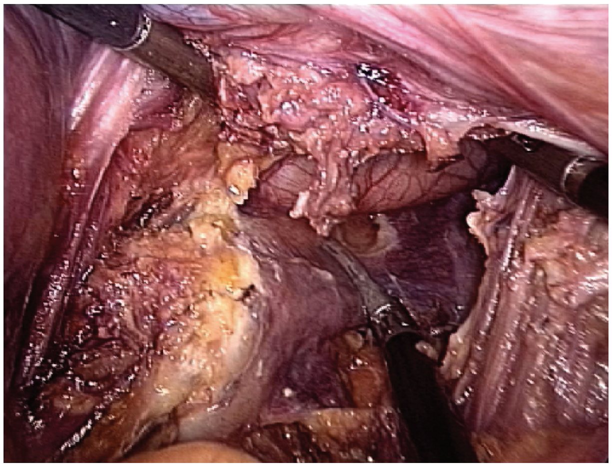

FIG. 18. Section of the inferior pulmonary ligament.

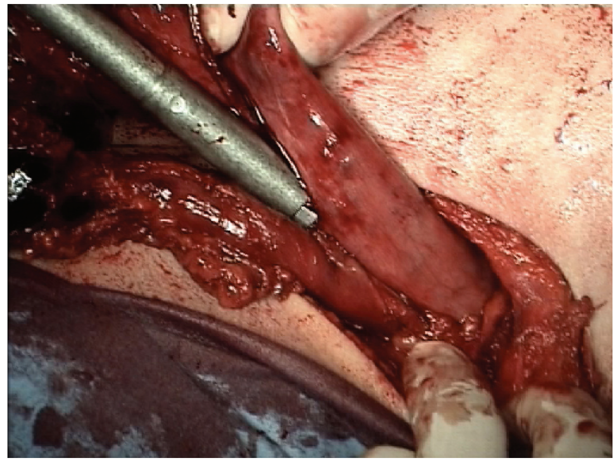

FIG. 20. First firing of linear stapler, during the esogastric anastomosis.

of the stapler begins at the level of the crow's foot, perpendicular to the lesser curvature. Other firings are placed parallel to the greater curvature. The section is kept incomplete and ends some 4 cm distal to the summit of the fundus (Fig. 17). The stapler line is reinforced by separate 2/0 silk stitches.

A vertical phrenotomy is achieved at the summit of the crural pillars. The limits of the mediastinal dissection are: anteriorly, the pericardium and the left inferior pulmonary vein; on the left side, the left pleura; on the right side, the right pleura; and posteriorly, the aorta. In case of cancer of the cardia, both mediastinal pleura are resected. The right pulmonary triangular ligament is sectioned if necessary (Fig. 18). A careful dissection is achieved with the ultrasonic or coagulating hook, until the previous intrathoracic dissection is reached.

Left cervicotomy

The patient remains in the supine position and the pneumoperitoneum is deflated. The patient's head is turned to the right side in hyperextension. The surgeons place themselves around it. An incision is performed lateral the left sternocleidomastoid muscle (Fig. 19).

The omohyoid muscle is identified and sectioned. The cleavage planes are easily found as already started by the pneumomediastinum. The esophagus is mobilized at its left posterior side until the surgeon can insert one hand in the posterior upper mediastinum, reaching the cervicomediastinal space. The anterior face of the esophagus is separated by the tracheal membrane until the previous intrathoracic dissection is reached. The esophagus containing the tumoral mass and the upper

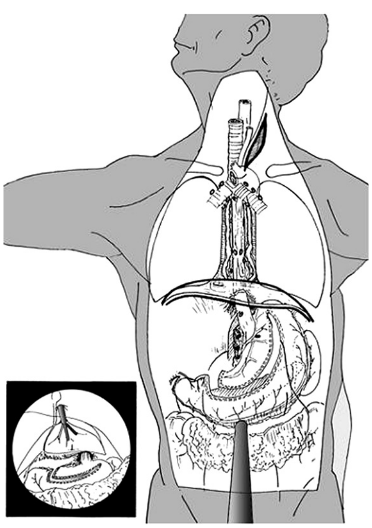

FIG. 19. Final view of procedure during cervical anastomosis.

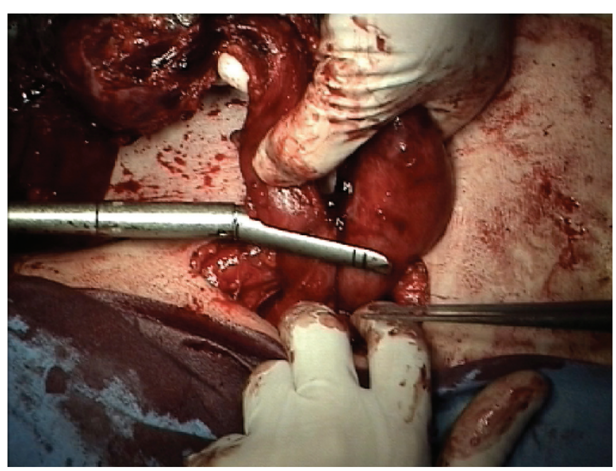

FIG. 21. Second firing of linear stapler, during the esogastric anastomosis.

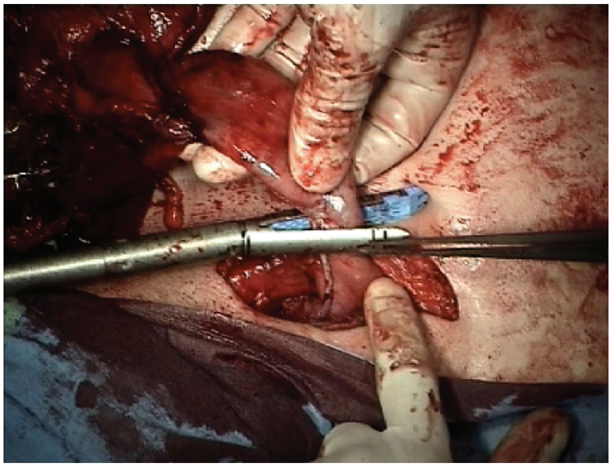

FIG. 22. Third firing of linear stapler, during the esogastric anastomosis.

stomach is lifted under laparoscopic control. A totally mechanical side-to-side esogastric anastomosis is performed using three firings of the stapler that was used for the gastric tube. The first firing is done inserting the linear stapler in the proximal esophagus and distal stomach (Fig. 20). The other two firings are close to the edges of the first and allow isolation of the surgical specimen (Figs. 21 and 22).

The procedure ends with placement of a drainage tube in the neck and an abdominal drainage in the hiatus.

DISCUSSION

In classic thoracotomy and laparotomy, the position of the esophagus can lead to considerable parietal damage in reaching the target organ. The minimally invasive character of laparoscopy decreases the parietal trauma and therefore, theoretically, this morbidity. Different mini-invasive approaches have been described, including robot-assisted transhiatal or thoracoscopic esophagectomy.[1–7] The limitations due to the rigidity of the chest can be obviated by the use of a robot.[1]

Esophagectomy with the patient in the prone position was first reported by Cuschieri and colleagues in 1992.[7] The prone position, as by thoracoscopy without the use of a robot, appears to allow for a more direct approach to the aortopulmonary window under excellent vision and ergonomic circumstances. Dissection of the hilar structures and performance of the lymphadenectomy appear more straightforward. In this technique the lung always remains out of harm's way due to gravity and no more than three trocars are needed. Even moderate bleeding does not obscure the operative field. In our technique, the lung is partially deflated and the pneumothorax is usually well supported by the patient.

The robot-assisted thoracoscopy improves postoperative pain as reported by Gerhardus,[8] because all movements are perfomed interiorly to the intercostal spaces by the robotic articulations. Morgan et al. reported improved the visualization and instrument dexterity.[9] In addition, the dissection of the esophagus is improved, because the movements are more accurate and gentle. The intrapleural articulations allow for a better reach during the extended mediastinal and paraesophageal lymphadenectomy.

We usually perform the laparoscopic step without the help of the robot and with the patient in the classic supine position. Thanks to the optical system, the surgeon can perform a precise celiac lymphadenectomy up to the previous dissection realized by the thoracoscopy. The creation of the gastric tube arrives until the gastric fundus as to reach a safe margin from the tumor. The last step is the left cervical access, where the anastomosis is realized. Given our experience, we have standardized this type of totally mechanical side-to-side anastomosis; however, an intrathoracic anastomosis, as reported by Melvin and colleagues, remains a viable option.[6]

CONCLUSION

Larger series of patients are needed to determine the benefits of this approach. More research is also needed for further improvement in console setup, computer performance, tool design, and arrangement of optics.

REFERENCES

1. Bodner J, Wykypiel H, Wetscher G, Schmid T. First experiences with the da Vinci operating robot in thoracic surgery. Eur J Cardiothorac Surg 2004;25:844–851.
2. Espat NJ, Jacobsen G, Horgan S, Donahue P. Minimally invasive treatment of esophageal cancer: laparoscopic staging to robotic esophagectomy. Cancer J 2005;11:10–17.
3. Horgan S, Berger RA, Elli EF, Espat NJ. Robotic-assisted minimally invasive transhiatal esophagectomy. Am Surg 2003;69:624–626.
4. Giulianotti PC, Coratti A, Angelini M, et al. Robotic in general surgery: personal experience in a large community hospital. Arch Surg 2003;138:777–784.
5. Talamini MA, Chapman S, Horgan S, Melvin WS. A prospective analysis of 211 robotic-assisted surgical procedures. Surg Endosc 2003;17:1521–1524.

6. Melvin WS, Needleman BJ, Krause KR, et al. Computer-enhanced robotic telesurgery: initial experience in foregut surgery. Surg Endosc 2003;16:1790–1792.
7. Cuschieri A, Shimi S, Banting S. Endoscopic oesophagectomy through a right thoracoscopic approach. J R Coll Surg Edinb 1992;37:7–11.
8. Gerhardus D. Robot-assisted surgery: the future is here. J Health Manag 2003;48:242–251.
9. Morgan JA, Ginsburg ME, Sonett JR, et al. Advanced thoracoscopic procedures are facilitated by computer-aided robotic surgery. Eur J Cardiothorac Surg 2003;23:883–887.

Address reprint requests to:
Guy-Bernard Cadière, MD, PhD
Department of Gastrointestinal Surgery
European School of Laparoscopic Surgery
Saint-Pierre University Hospital
322 Rue Haute
1000 Brussels
Belgium

E-mail: coelio@resulb.ulb.ac.be