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Minimally Invasive Esophagectomy for Cancer: Prospective Evaluation of Laparoscopic Gastric Mobilization

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Abstract

Background: Esophagectomy carries high morbidity, mainly respiratory. Minimally invasive surgery has been demonstrated to improve postoperative outcome in digestive surgery, without impairment of oncological results. A prospective study was conducted to evaluate feasibility, postoperative outcome, and mid-term oncological results of minimally invasive esophagectomy (MIE) in cancer.

Methods: From July 2001 to August 2005, 25 patients underwent esophagectomy with laparoscopic gastric mobilization (LGM) for epidermoid carcinoma (n = 15) or adenocarcinoma (n = 10). Tumors were located on the cardia (n = 6), on the lower third (n = 14), or on the median third (n = 5) of the esophagus. Following LGM, transthoracic esophagectomy was performed.

Results: Complete LGM was achieved in all patients but 1. Mean operative time for LGM was 191 ± 49 minutes. Fifteen patients (60%) developed complications, mainly respiratory. Anastomotic leakage occurred in 2 patients, with a favorable outcome. Pylorospasm (n = 1) was the only intra-abdominal complication. Median hospital stay was 18 days. Two patients died (8%). Twenty-three patients underwent R0 resection. A mean of 12 ± 4 lymph nodes (range 4–19 nodes) were analyzed. With a mean follow-up of 14 months (1–46 months), actuarial survival at 1 and 2 years was, respectively, 73% and 56%.

Conclusion: Esophagectomy with LGM is feasible with few specific complications. However, no decrease in morbidity and hospital stay could be observed. Mid-term oncological results seem comparable to those of conventional surgery. Further studies are required to evaluate the extent of lymphadenectomy and the oncologic safety of MIE.

Minimally invasive surgery (MIS) has gained acceptance among digestive surgeons because of lower levels of postoperative pain and faster recovery in colorectal surgery[1–3] or upper gastro-intestinal surgery.[4–6] The oncologic safety of MIS has also been demonstrated.[2–4,7] Esophagectomy still carries high morbidity, in up to 70% of cases, especially when a thoracotomy is performed.[8–13] At the beginning of MIS, the initial results by our team when using the thoracoscopic approach in esophageal surgery were disappointing,[14,15] but more recent articles[16–21] report encouraging results.

A prospective study was thus conducted to evaluate feasibility, the postoperative course of MIS for esophageal cancer, and whether or not this technique impairs the oncological course.

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PATIENTS AND METHODS

Patients

From July 2001 to August 2005, a prospective study was conducted to evaluate feasibility, postoperative course, and preliminary oncological results of esophagectomy with laparoscopic gastric mobilization (ELGM). The laparoscopic approach was not proposed in patients:

1. With tumors in the upper thoracic third,
2. With a poor general status,
3. With suspected metastatic disease, extension to adjacent organs, or massive celiac nodes involvement after preoperative assessment.

Preoperative evaluation included esophago-gastric endoscopy with biopsies, and a chest and abdomen CT scan. Endosonography was performed in cases of non-stenotic tumoral disease. Patients with epidermoid carcinoma underwent bronchoscopy and ENT exam. General status was evaluated by routine blood tests including liver tests, electrocardiogram, functional respiratory assessment, and patients were classified according to the American Society of Anesthesiologists (ASA) score.

During the 4-year period, 105 patients underwent esophagectomy for benign (n = 65, mainly esophago-gastrectomy for caustic burns) or malignant conditions (n = 40). Among them, 25 (62.5%) underwent ELGM. There were 8 women and 17 men. Mean age was 60 ± 10 years (range 36–82). Median BMI was 23.5 kg/m^2 (range 16.4–33.1 kg/m^2). Thirteen patients presented with a mean preoperative weight loss of 12.5 ± 8.5% (range 2%–28%). ASA score was I in 5 patients, II in 16 patients, and III in 4 patients. Twenty patients (80%) presented with 1 or more significant comorbidities (Table 1).

Table 1.
Comorbidity in 25 patients treated by esophagectomy with laparoscopic gastric mobilization

Antecedents	Number (%)
Respiratory	15 (60)
Long-term smokers	11 (44)
Chronic bronchitis	3 (12)
Thoracotomy for tuberculosis	1 (4)
Cardiovascular	11 (44)
Hypertension	7 (28)
Myocardial ischemia	3 (12)
Aortic aneurism	1 (4)
Alcoholism	10 (40)
ENT cancer	3 (12)
Major abdominal surgery	3 (12)
Hodgkin's lymphoma	1 (4)
Diabetes	2 (8)
Total	20 (80)

Indications for esophagectomy were epidermoid carcinoma (n = 15), and adenocarcinoma (n = 10). Tumors were located on the gastro-esophageal junction (types I and II in Siewert's classification,[22] n = 6), on the lower thoracic third of the esophagus (n = 14), and on the median thoracic third (n = 5). Five patients were operated following neoadjuvant chemoradiotherapy for stage III tumors with a significant response.

Methods

Operative Technique

Intervention was conducted under general anesthesia, with intubation with a double lumen endotracheal tube. Patients were installed in a slightly supine position, and 5 trocars were introduced. Following pancreatico-duodenal mobilization, a pyloroplasty was performed. Gastro-colic ligament was transsected using a harmonic scalpel (Ultracision; Ethicon Laboratories, Cincinnati, OH, USA), avoiding injury of the gastro-epiploic arcade. Left gastro-epiploic vessels and short gastric vessels were divided and the abdominal esophagus mobilized, removing peri-esophageal tissues. Left gastric vessels were ligated at their origin, allowing en bloc lymphadenectomy, with a stapling/cutting-specific device (ETS, Ethicon Laboratories). Both crus of the diaphragma were incised, allowing hiatal enlargement for lower mediastinal dissection and gastric pull-up. As for the conventional approach, no routine feeding jejunal tube was placed at the end of the laparoscopic procedure.

Esophagectomy and mediastinal dissection with extensive lymph node dissection were performed through a right thoracotomy in the sixth interspace. Gastric tubulization was performed in the thorax, following gastric pull-up. An upper esophageal section was made at least 5 cm above the tumor level. The esophago-gastric anastomosis was thus performed mechanically at or above the level of the azygos vein, using a circular stapling device (CDH, Ethicon Laboratories). Preventive ligation of the thoracic duct was left to the surgeon's choice.

Postoperative Period

Extubation was proposed in the hours following intervention. Patients were not admitted routinely to the Intensive Care Unit (ICU), only in cases of clinical degradation. Naso-gastric tube removal and postoperative feeding were authorized if an upper gastro-intestinal

contrast radiogram performed on day 7 was considered normal. Postoperative parenteral nutrition was conducted until recovery of normal digestive function.

Patients were seen at 1, 3, 6, and 12 months for clinical and oncological evaluation. At the end of follow-up, all patients were called for a last evaluation by phone.

Pathological Assessment

Pathological data included length of proximal and distal margins, tumoral in-depth extension, and involvement of the lateral margins, number of resected lymph nodes with number and localization of metastatic nodes, type of tumor, and degree of differentiation. Tumors were classified according to the TNM-UICC classification.

Statistical Analysis

BMDP statistical software (BMDP, Los Angeles, CA, USA) was used to analyze survival time. Survival was estimated using the Kaplan–Meier actuarial method including postoperative deaths.

RESULTS

Operative Data

Laparoscopy

Initial laparoscopic staging revealed unresectable celiac metastatic lymph nodes in 1 patient with lower thoracic third epidermoid carcinoma; palliative esophagectomy was completed because of severe dysphagia. Neither liver metastasis nor peritoneal carcinomatosis was diagnosed.

Complete laparoscopic gastric mobilization was achieved in all patients but 1. This was an obese patient (BMI = 29.2 kg/m^2) in whom the gastro-epiploic vessels could not be seen safely under laparoscopy; conversion occurred 15 minutes after the abdominal wall incision. Apart from the first patient, all others in the present series underwent pyloroplasty.

Mean operative time for laparoscopy was 191 $\pm$ 49 minutes (range 150–300 minutes). The 2 longest interventions occurred in patients with previous gastric surgery and abdominal aortic repair (270 and 300 minutes respectively). Operative blood loss for laparoscopy was less than 100 ml in all the patients and transfusion was never required.

Esophagectomy

Pleural metastasis less than 5 mm was diagnosed intraoperatively in 1 patient with poorly differentiated mid-thoracic epidermoid carcinoma; palliative esophagectomy was completed because at this time gastric mobilization was yet performed and because of severe dysphagia. No adjacent organs involvement was discovered during thoracic dissection.

Following esophagectomy and gastric tubulization, the blood supply of the gastric tube remained satisfactory in all the patients. The esophago-gastric anastomosis was intra-thoracic in 24 patients. In the remaining patient, the anastomosis was performed at the cervical level, because of the tumor location being above the level of the aortic arch, requiring cervical dissection in order to obtain sufficient proximal esophageal resection.

Mean operative time for thoracotomy was 177 $\pm$ 45 minutes (range 130–210 minutes). In all the patients, gastric pull-up and tubulization were performed uneventfully.

Pathological Results

Pathological assessment revealed safe margins in all the patients. Twenty-three patients underwent R0 resection. Mean proximal margin was 4.6 $\pm$ 2.6 cm (range 1–10 cm) for the whole series, and 3.7 $\pm$ 2 cm (range 1–6 cm) for the 5 patients with midthoracic cancer. A mean of 12 $\pm$ 4 lymph nodes (range 4–19 nodes) were analyzed. The mean number of nodes increased from 10 $\pm$ 5 nodes in the 5 initial patients to 17 $\pm$ 4 in the 5 last patients. Nine patients (36%) presented with metastatic lymph nodes. One patient (4%) had a grade 0 tumor, 4 had grade I (16%), 3 had grade IIa (12%), 9 had grade IIb (36%), 7 had grade III (28%), and 1 had grade IV.

Postoperative Morbidity and Mortality

Fifteen patients (60%) developed complications in the postoperative period (Table 2). Most of them (44%) were respiratory complications. Intrathoracic anastomotic leakage occurred in 2 patients (8%), with a favorable outcome through non-operative management. Pylorospasm was diagnosed at the return to oral feeding in the only patient without pyloroplasty. This was the only intra-abdominal complication of the present series. Two patients died (8%), 1 on the 2nd postoperative day of suspected cerebral stroke, and 1 on the 48th postoperative day, following acute respiratory distress syndrom (ARDS), ascites, herpetic pneumopathy, thrombopeny, and cerebral stroke. Eleven patients (44%) were admitted to the ICU. Median duration of ICU stay in the whole series was 1 day (range: 0–180 days). Median hospital stay was 18 days (range 2–195 days).

Table 2.
Postoperative complications in 25 patients treated by esophagectomy with laparoscopic gastric mobilization

Complications	Number (%)	Treatment
Respiratory	11 (44)	
Pneumonia	7 (28)	Antibiotics, and (n = 1) prolonged ventilation
ARDS	2 (8)	Prolonged ventilation
Pleuritis	1 (4)	Antibiotics and drainage
Pneumothorax	1 (4)	Talcage
Anastomotic leakage	2 (8)	Percutaneous drainage
Pylorospasm	1 (4)	Surgical pyloroplasty
Hemothorax	1 (4)	Surgical hemostasis
Chylothorax	2 (8)	Surgical ligation of the thoracic duct
Ascites	1 (4)	Diuretics
Cerebral stroke	2 (8)	Lethal
Total	15 (60)	

ARDS: adult respiratory distress syndrome.
Some patients had more than 1 complication.

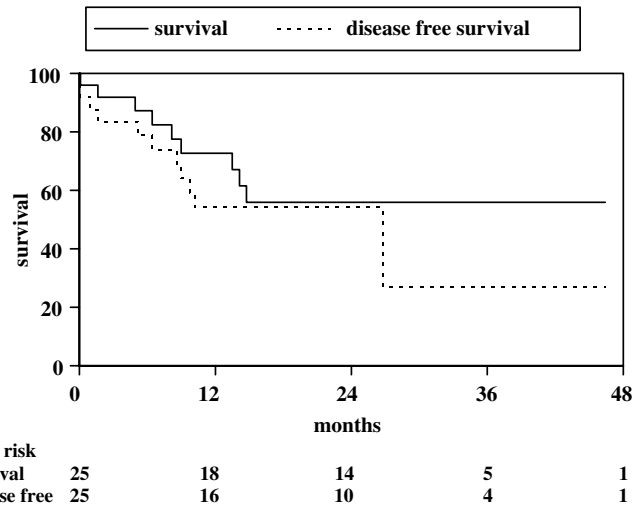

Figure 1. Survival and disease-free survival rates of 25 patients with esophageal carcinoma operated on by minimally invasive surgery.

Oncological Results

Median follow-up was 14 months (range: 1–46 months). Oncological results appear on Fig. 1. Actuarial survival at 1 and 2 years was 73 and 56 months respectively. Disease-free survival at 1 year was 54%. Among the 21 patients surviving the postoperative period and treated with curative intent, 5 received adjuvant radio-chemotherapy. Fourteen (66.7%) were alive and free of disease at the end of follow-up. Six (28.6%) developed loco-regional (n = 2) and/or metastatic (n = 6) recurrence; among them, 4 patients died. One patient died of myocardial infarction at 9 months, without evidence of recurrent disease. No port-site metastasis was discovered during follow-up.

DISCUSSION

Feasibility

Our technique for esophagectomy with laparoscopic gastric mobilization is similar to that described by Jagot *et al.*[23] Including 2 patients with previous extensive abdominal surgery, only 1 patient of the present series required conversion to an open procedure. Mean operative time for laparoscopic gastric mobilization (3 hours) was comparable to common operative times using the conventional approach. There was no gastric necrosis, and in all patients, the gastric transplant was long enough to reach the upper thoracic inlet or the cervical esophagus.

Because we thought pyloroplasty would be too difficult to perform laparoscopically, it was not performed in the first patient of the present series. This patient developed subsequent pylorospasm, requiring reintervention. Since this case, routine pyloroplasty has been performed laparoscopically in each patient, with no further complications. Interest in pyloroplasty for preventing pylorospasm following gastric mobilization and vagal nerve section is still controversial.[24] However, several experienced teams, from high volume institutions[16,25] advocate routine pyloroplasty.

Postoperative Complications

In esophageal surgery, refinement of indications and progress in operative and postoperative management allowed important decreases in mortality, from 30% before the 1980s to less than 5% nowadays. However, recent studies still report high global morbidity rates, from 45%[8] to 70%.[10] Various techniques were developed in order to decrease this morbidity. Esophagectomy without thoracotomy, reducing pulmonary complications, seemed to carry less morbidity[25] than transthoracic esophagectomy. Controlled studies comparing transhiatal and transthoracic esophagectomies[12,13,26] confirmed better results of the transhiatal approach in terms of morbidity, but suggested that the oncological results were worse without thoracotomy.

Considering that the laparoscopic approach has been demonstrated to improve pulmonary function following colorectal and gastro-esophageal surgery,[27,28] it seemed

logical to improve the postoperative course of esophagectomy using MIS. Thoracoscopic esophagectomies were being performed by our team and by others[14,15,29] 10 years ago, but the initial results were disappointing because of technical difficulties and respiratory complications. Because of these previous results and insufficient practice in thoracoscopy, we have not proposed this approach in our patients.

With mortality and global morbidity rates in the present series of 8% and 60%, we failed to improve outcome by using the laparoscopic approach. Hospital stays in the present series were comparable to those in conventional series,[12,30] but were longer than those in other minimally invasive series.[16,19,31–34] Forty-four percent of the patients in the present series experienced pulmonary complications, mainly pulmonary infection and ARDS. This result is comparable to those of recent studies,[8,12,35,36] reporting pulmonary complications in 17%–57% after the conventional transthoracic or transhiatal approach. Recent studies of laparoscopic and thoracoscopic approaches[16–21] report an encouraging rate of pulmonary complications in up to 17%. Two of these studies[19,20] compared MIS and the conventional approach and both demonstrated better outcomes after MIS with a significant reduction in pulmonary complications while increasing experience. Failure to decrease the rate of pulmonary complications in the present series might thus be explained by 2 factors: first, the use of conventional thoracotomy for esophageal dissection, and second, we report herein our early experience, at the beginning of the learning curve. The introduction of thoracoscopy and increasing experience could be solutions for obtaining more satisfactory postoperative outcomes, as stated in a recent publication.[32] Moreover, changes in postoperative management, including the introduction of epidural analgesia and early enteral nutrition through a feeding jejunostomy should allow us to decrease morbidity rates.[37–40]

Oncological Results

The pertinence of MIS for esophageal cancer has to be debated. Laparoscopy was initially suspected to alter oncological outcome, but long-term results of this approach for digestive cancers are comparable to those of conventional surgery.[2–4,7] Three studies focused on the oncological results of minimally invasive esophagectomy. In the large, non-comparative series by Luketich *et al.*,[16] stage-specific survival was similar to open series. In the comparative non-randomized study by Osugi *et al.*,[20] the 3- and 5-year survival rates were similar for patients undergoing MIS and those undergoing conventional procedures. In the series by Nguyen *et al.*, including 38 patients operated on for cancer, 1- and 2-year survival rates compared favorably with those for conventional procedures.[21]

The length of follow-up and the number of patients in the present series are insufficient to draw conclusions about the oncological validity of MIS in esophageal cancer, and further studies are required. However, in the present series, actuarial survival at 1 and 2 years (73% and 56% respectively) seem to compare with commonly reported rates in major series.[8,12,22] Palliative esophagectomy is highly debatable, and we usually do not perform esophagectomy in patients with non-resectable tumors on preoperative assessment. However, recent series report R0 resection rates between 70% and 80%.[12,22] Only 2 patients in the present series (8%) underwent palliative resection for metastatic disease discovered intraoperatively, after gastric mobilization. The mean number of resected nodes in patients operated on by MIS is relatively small or insufficient in the present and in other series.[18,21,33,34] The extent of lymphadenectomy by this technique thus seems questionable. However, increasing experience and more precise pathological assessment allowed us to reach the recommended rate in the later patients.

CONCLUSION

Esophagectomy with laparoscopic gastric mobilization is feasible with few specific complications. However, the total complication rate (mainly respiratory complaints) was relatively high, with consequently long hospital stays. No decrease in morbidity was observed by this technique.

From the oncological point of view, complete R0 resection (92%) was satisfactory, but the extent of lymphadenectomy is questionable. Mid-term oncological results seem comparable to those of conventional surgery. Further studies are required to evaluate both postoperative improvement and the oncological validity of this intervention.

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