Laparoscopic total gastrectomy in gastric cancer: Our experience in 92 cases

FRANCESCO CORCIONE, FELICE PIROZZI, DIEGO CUCCURULLO, PIERLUIGI ANGELINI, VINCENZO CIMMINO & ANNA SETTEMBRE

General Surgery Department, Laparoscopic and Robotic Surgery Center, Highly Specialized and of National Importance Hospital “V. Monaldi”, Naples, Italy

Abstract

Introduction: Laparoscopic total gastrectomy (LTG) is seldom used for gastric cancer because the complex vascularization and lymphatic drainage makes lymphadenectomy and esophagojejunostomy difficult and requires special skills. Our aim was to demonstrate the feasibility and accuracy of LTG in gastric cancer with D2 lymphadenectomy. Material and methods: Eighty-eight LTG and four laparoscopic remnant gastrectomies (LRGs) were performed over >12 years. The median patient age was 64 years, and the male/female ratio was 1.49/1. Eighty-seven patients had a D2 and only five patients had a D1 lymphadenectomy. We propose the retrospective analysis of intra- and perioperative mortality and morbidity. Results: In only four of 96 cases approached by laparoscopy, a conversion to laparotomy was needed. There were two (2.17%) perioperative deaths in 92 procedures and few complications. Histological data show 79 advanced gastric cancers (AGC), 11 early gastric cancers (EGC), and two gastric diffused lymphomas. The five-year Kaplan-Meier overall survival in patients with EGC and AGC was 100% and 58%, respectively. Conclusions: The results demonstrate the feasibility of an oncologically correct minimally invasive total gastrectomy. We would like to promote comparisons among different institutions to achieve better standardization of indications and techniques for a laparoscopic approach to gastric cancer.

Key words: Laparoscopic gastric surgery, gastric cancer, laparoscopic lymphadenectomy

Introduction

Interest in laparoscopic treatment of gastric cancer has increased substantially, but still few centers are dedicated to this approach especially because the particularly varied vascularization and lymphatic drainage of the stomach requires a high degree of technical ability and experience in advanced laparoscopy in order to perform a correct oncologic surgery. Laparoscopy for advanced gastric cancer (AGC) requires appropriate training with resections for benign gastric ulcers and gastrointestinal stromal tumors (GIST) followed by early neoplasms (1). For early gastric cancer (EGC), after Kitano’s preliminary report in 1995 (2), numerous series have documented the oncologic validity of the laparoscopic method. Tanimura (3) has the largest series of laparoscopic gastrectomies, which consisted of 612 patients operated for neoplasms with staging up to T2N1, and reported, in 175 cases of AGC, a survival rate that overlaps that of his open group. Furthermore, in proximally located neoplasm where total gastrectomy is indicated, many surgeons still view the laparoscopic method as complex because of the difficulties posed by D2 lymphadenectomy and esophagojejunal anastomosis. We believe that our retrospective analysis of 88 laparoscopic total gastrectomies (LTG) and four laparoscopic remnant gastrectomies (LRG) for cancer contribute to an increasing awareness of the feasibility and advantages of laparoscopy at specialized centers.

Material and methods

From January 1999 to June 2011, 88 LTGs and four LRGs for cancer were performed at our center. Also
47 diagnostic laparoscopies with biopsies were performed in patients with gastric cancer, which did not result clearly inoperable at preoperative workups. Our indications for LTG included 59 proximally located neoplasms (11 EGC and 48 AGC) not involving the esophagogastric junction, 31 particularly sizeable AGCs of the proximal antrum or the antrum-corpus boundary in young patients (<65 years), determined by endoscopic biopsy as a G3 and/or diffuse infiltrative histotype, and two diffuse gastric lymphomas. Four LRGs (4,5) were performed in three patients who all had undergone a gastric resection between 15 and 26 years earlier with Billroth 2 reconstruction for benign ulcerous pathologies and with an actual cancer of the gastric stump. The average age of the 92 patients was 64 years (range 36–79). The male/female ratio was 1.49/1. The distribution of anesthetic risk classes according to the classification of the American Society of Anesthesiology (ASA) was of 21 ASA I, 44 ASA II and 27 ASA III. The preoperative workups (6) included at least an esophagogastroduodenoscopy with biopsies, an ultrasound abdominal scan, and a total body CT scan. Only 13 patients underwent PET/CT scans with no significant adjunctive data. Echoendoscopies were performed in all the suspected EGC and in the four cancers of the gastric stump. Intraoperative echo-laparoscopies (7) were performed in 18 cases. No patient underwent neoadjuvant chemotherapy. D2 lymphadenectomy was performed in 87 cases, and D1 was chosen in three old patients with high ASA risk score (8), and in two lymphomas. Until 2005, the indication for LTG in patients with proximal lesions was limited to localizations on the right side of the stomach up to T3. A modified D2 lymphadenectomy was performed with LTG, which did not include the removal of the splenic hilum. In localizations along the greater curvature, open TG with D2 lymphadenectomy including station 10 with or without splenectomy was preferred. For the last six years, in accordance with the Italian Gastric Cancer Study Group (9), an LTG was performed that abstained from the dissection of station 10 also for six proximal EGCs along the greater curvature, preoperatively staged as T1 N0. Fifteen cases of LTG involved a cholecystectomy (10). Fifteen of 31 patients with previous surgeries (11) needed an extensive adhesiolysis. A wedge resection of a small metastasis of the 3rd hepatic segment was performed in one case. A nasojejunal feeding tube was ever left at the end of the operations.

**Technique**

**Patient position, surgical access, instruments** The French position was assumed by the patient and anti-Trendelenburg positions with variable degrees of tilt to the left and right inclinations in different phases of the operation were used. Pneumoperitoneum was induced with the open Veress-assisted technique: The needle was inserted under the left costal margin, an operating pressure of 12 mmHg was established, and a 10–12 mm optical trocar (T1) was positioned 2 cm above the navel after aspiration tests of CO₂ were conducted. In 19 patients, the first trocar was positioned in the left or right hypochondrium (T2 or T3) due to scars present along the median line. A 30° telescope was used in all cases. The second and third 10–12 mm (T2 and T3) trocars were positioned in the left and right hypochondrium, respectively, normally slightly cranially to the optical trocar. The 5-mm fourth trocar (T4) was positioned at the subxiphoid area. A fifth supplementary trocar was sometimes necessary for the preliminary adhesiolysis or for support, particularly in LRGs. Dissection and hemostasis were accomplished mostly with harmonic scalpels and bipolar forceps. Laparoscopic surgical staplers with cartridges of different lengths (45–60 mm) and different sized staples (green/4.1; blue/3.5; white/2.8) were used for visceral dissection and anastomosis. In the last 45 procedures, following subclinical leaking, a collagen reinforcement band on a nonabsorbent braided polyester support was used for the jaws of the endo-stapler used in the transection at the gastroesophageal junction. Two peritoneal drains were positioned in all procedures.

**LTG** The essential steps in the procedure are:

- Coloopiploic detachment and dissection of the gastrocolic ligament and progression towards the spleen, then upwards, completing the dissection of the gastroplenic ligament and short vessels by harmonic scalpel, including the dissection of the group 4 lymph nodes. Preparation of the left pillar of the diaphragm and freeing of at least 2–3 cm of the left side of the thoracic esophagus with lymphadenectomy of the left cardiac lymph nodes (group 2).

- Completing dissection of the gastrocolic ligament towards the right up to the duodenum with dissection of the right gastroepiploic vein at the Henle’s trunk, and of the right gastroepiploic artery at the origin including the dissection of the distal lymph nodes of stations 4 and 6.

- Passage below the duodenum, freeing it from pancreatic adhesions, and subsequent dissection with a 60 mm white load endo-stapler.

- Opening the hepatoduodenal ligament near the liver, and dissection of lymph node group 12 by lowering the loose connective tissue towards the
stomach. Dissection of the right gastric artery at the origin and dissection of lymph nodes of group 5. Lymphadenectomy of station 8 (hepatic artery), which can alternatively be performed with a left to right progression starting from the celiac trunk after the next step (Figure 1).

- Stomach-lifting with the omentum using a grasper through T4, dissection of the left gastric vessels, and lymphadenectomy of groups 7, 9 and 11p using the retrogastric approach. Completion of the lymphadenectomy along the vertical portion of the lesser curvature (group 3) with opening of the hepatogastric ligament (eventually preserving any additional left hepatic artery), continuing the dissection upwards along the lesser curvature until completing the dissection of group 1 lymph nodes.
- Opening the Laimer-Bertelli membrane and preparing the right side of the distal esophagus and dissection of the vagal nerves. Retraction of the nasogastric tube and subtotal resection of the esophageal-cardiac junction with 45 or 60 mm green load endo-stapler. This is carefully moved from right to left to achieve a subtotal resection. The residual continuity on the left side will assure the support in situ of the esophageal stump, avoiding inconvenient retractions, which can easily occur.
- Trendelenburg position and location of the third jejunal loop for the construction of an omega loop via the transverse mesocolon for side-to-side anastomosis according to Billroth II (first 10 cases) (12). Alternatively (last 82 cases), dissection with a 45 or 60 mm white load endo-stapler of the third jejunal loop for the construction of a Roux-en-Y loop, also done via the transverse mesocolon. Side-to-side esophagojejunal anastomosis, with 45 or 60 mm green load endo-stapler applied between the posterior wall of the esophagus and the anterior wall of the top of the omega loop according to Billroth and with Braun at the foot of the loop (in the first ten cases), or of the Roux-en-Y loop similar to what Orringer described for esophagogastroplasty (13,14) (in the last 82 cases) (Figure 2).
- Completion of the transection of the gastroesophageal junction with a second application of green load endo-stapler, placing the specimen in an endobag and closure of the access to the stapler with manual interrupted 3-0 polyglycolic acid sutures with intracorporal suturing and hydro-pneumatic testing with methylene blue solution and air through a nasojejunal tube. Jejunojejunal side-to-side anastomosis at the foot of the omega loop (Braun) or of the Roux-en-Y loop with white load 45 or 60 mm stapler. All procedures according to Braun and most (64 of 82) anastomoses at the foot of the Roux-en-Y loop were performed through the extractive mini-laparotomy.
- Peritoneal toilet, subhepatic drain from T3 and drain near the esophagojejunal anastomosis from T2. Minilaparotomy (15) for longitudinal expansion (of about 4 cm) of T1 and extraction of the endobag removed by the grasper in T4. Extraction of T4 and suturing port access and minilaparotomy.

LRG
- Adhesiolysis, requiring an additional 5-mm trocar (T5) on the left side followed by dissection of the afferent and efferent loops of the gastrojejunal anastomosis with two applications of white load endo-stapler, while performing an en bloc resection of the
entire mesentery of the jejunal portion of the anastomosis and extensive mobilization of the jejunal trunks (especially difficult in patients with transmesocolic anastomosis).

- Total remnant gastrectomy for the residual stomach with a D2 lymphadenectomy and reconstruction of the passageway with Roux-en-Y esophagojejunal anastomosis as for LTG, except for steps concerning anatomical structures that had been previously removed.

**Results**

Among 96 candidates for LTG, the overall rate of conversion to laparotomy was 4.2%. Three conversions were necessary because of very large neoplasm or extensive lymph node involvement, and one because of an inter-operative ischemic lesion of the transverse mesocolon. The average operating time was 200 minutes (range 160–360) for LTGs and 200 minutes (range 160–260) for LRGs. Of note, it was 240 minutes for the first ten LTGs compared with 180 minutes during the last ten. The average post-operative hospital stay was nine days (range 7–40) for LTGs and ten days (range 7–18) for LRGs. The histology showed two diffuse gastric non-Hodgkin’s lymphoma, 79 AGC and 11 EGC. The average number of lymph nodes removed (16) was 28 (range, 18–46). Histological data according to the sixth edition of the TNM are reported in Table I. All N+ or T >2 patients were referred to oncologists for adjuvant chemotherapy. The principal intraoperative complications are reported in Table II. An ischemic lesion of the transverse mesocolon during the LTG resulted in conversion and colic resection with primary anastomosis. A left gastric artery hemorrhage resulted in one temporary clamping of the celiac trunk for a more proximal clipping. The construction of a Roux-en-Y jejunal loop was three times complicated by a mesenteric ischemic lesion which resulted in loop resection and another construction. None of these patients had significant complications, and only the patient with the colic resection had an extended hospital stay (12 days). The main postoperative complications (17,18) are listed in Table III. An undesired anchorage of the top of the nasojejunal tube with the poliglactic acid 3/0 suture performed to close the access of the stapler required the endoscopic cutting of the suture. An X-ray with oral iodine contrast before progressively resuming normal feeding was performed on the 4th postoperative day and showed a subclinical leak in two patients (one esophagojejunostomy sec. Orringer’s method, and one jejunojejunostomy at the foot of the Roux-en-Y loop). Both patients were treated successfully with conservative measures (fasting, parenteral nutrition, leaving drains in). Treatment of three duodenal fistulas identified between days 3 and 5 after the LTG was also conservative. A fourth duodenal fistula was found later on day 14 after the LTG in a patient who had already been released in good condition on the 9th day and who returned to the hospital with generalized biliary peritonitis. The patient was immediately operated but died of sepsis five days later. Three hemorrhages occurred during the post-operative period. A laparoscopic revision of hemostasis was necessary in bleeding of the duodenal-pancreatic region. Blood

<table>
<thead>
<tr>
<th>pTNM (6th Ed.)</th>
<th>Stage</th>
<th>Type: I = intestinal, D = diffuse</th>
<th>Grading G1/G2/G3</th>
<th>Localization: L/M/U/Lin</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1N0M0</td>
<td>IA</td>
<td>9 I – 2 D</td>
<td>5/5/1</td>
<td>4M/7U</td>
<td>11 (12.2%)</td>
</tr>
<tr>
<td>T2N0M0</td>
<td>IB</td>
<td>12 I – 6 D</td>
<td>3/12/3</td>
<td>2L/11M/5U</td>
<td>18 (20%)</td>
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<tr>
<td>T2N1M0</td>
<td>II</td>
<td>13 I – 5 D</td>
<td>6/10/2</td>
<td>5L/6M/7U</td>
<td>18 (20%)</td>
</tr>
<tr>
<td>T3N0M0</td>
<td>II</td>
<td>3 I – 4 D</td>
<td>2/3/2</td>
<td>4L/2M/1U</td>
<td>7 (7.8%)</td>
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<td>IIIA</td>
<td>1 I – 2 D</td>
<td>0/2/1</td>
<td>2L/1U</td>
<td>3 (3.3%)</td>
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<tr>
<td>T3N1M0</td>
<td>IIIA</td>
<td>11 I – 8 D</td>
<td>6/8/5</td>
<td>1Lin/12L/4M/2U</td>
<td>19 (21.2%)</td>
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<tr>
<td>T3N2M0</td>
<td>IIIB</td>
<td>6 I – 6 D</td>
<td>3/6/3</td>
<td>1Lin/6L/4M/1U</td>
<td>12 (13.3%)</td>
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<tr>
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<td>1 D</td>
<td>0/1/0</td>
<td>1M</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>T4N1M0</td>
<td>IV</td>
<td>1 I</td>
<td>0/1/0</td>
<td>1M</td>
<td>1 (1.1%)</td>
</tr>
</tbody>
</table>

G, grade.
L, lower third of stomach.
M, middle third of stomach.
U, upper third of stomach.
Lin, linitis.

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<td>19 (21.2%)</td>
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<tr>
<td>T3N2M0</td>
<td>IIIB</td>
<td>6 I – 6 D</td>
<td>3/6/3</td>
<td>1Lin/6L/4M/1U</td>
<td>12 (13.3%)</td>
</tr>
<tr>
<td>T3N1M1</td>
<td>IV</td>
<td>1 D</td>
<td>0/1/0</td>
<td>1M</td>
<td>1 (1.1%)</td>
</tr>
<tr>
<td>T4N1M0</td>
<td>IV</td>
<td>1 I</td>
<td>0/1/0</td>
<td>1M</td>
<td>1 (1.1%)</td>
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transfusions were sufficient in one patient with persistent moderate blood drainage for 72 hours. Endoscopic sclerotherapy on the third day resolved a hemorrhage from an open artery at an Orringer esophagojejunal anastomosis with abundant melena. Two partial dehiscences to the supraumbilical minilaparotomy occurred in obese patients. One neo-plastic seeding at a trocar site (19) required additional surgery. A Wernicke-Korsakov syndrome occurred in alcoholics and was resolved with suitable nutritional and pharmacological support. Two post-operative deaths occurred in two AGCs. A death after protracted stay in post-operative intensive care unit (PICU) was due to severe respiratory insufficiency after LTG with no evident surgical complications. Other two patients, including one with duodenal fistula, were placed in PICU for transitory respiratory distress.

**First follow-up**

Of the 90 surviving patients, 80 (11 EGC, 67 AGC, and two lymphoma) took part in studies (questionnaires, clinical exams, hematochemical tests, CEA, Ca 19.9, Ca 15.3, endoscopy, thoracic X-rays or CT scans in AGC patients, abdominal ultrasound or CT, bone scintigraphy in 3rd and 4th state, and differential protocols for lymphomas), with the first follow-up six months after the operation, or within nine months after adjuvant chemotherapy. An AGC patient who underwent adjuvant chemotherapy died of acute pulmonary edema four months after surgery. All eleven (100%) patients operated for EGC were free of disease at the first follow-up. Recurrences were found in four (6%) AGC: three hepatic metastases (one T3N1 and two T3N2), one hepatic and pulmonary metastasis (T2N2).

### Table II. Intraoperative complications.

<table>
<thead>
<tr>
<th>N</th>
<th>Intra-operative complications</th>
<th>Treatment of complication</th>
<th>Conversion in extensive lesions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total gastrectomy</td>
<td>88 +4</td>
<td>1 mesocolon incision</td>
<td>3 Conversion + resection of transverse colon isolation and proximal ligature</td>
</tr>
<tr>
<td>Remnant gastrectomy</td>
<td>4</td>
<td>none</td>
<td></td>
</tr>
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</table>

### Table III. Postoperative complications in 92 total laparoscopic procedures.

<table>
<thead>
<tr>
<th></th>
<th>n (% )</th>
<th>Treatment</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anastomotic fistulas</td>
<td>2 (2.2)</td>
<td>conservative with drainage and parenteral nutrition</td>
<td>2 resolved</td>
</tr>
<tr>
<td>Duodenal fistulas</td>
<td>4 (4.4)</td>
<td>3 conservative</td>
<td>3 resolved</td>
</tr>
<tr>
<td>Cavitary hemorrhage</td>
<td>2 (2.2)</td>
<td>1 drainage and blood transfusion</td>
<td>2 resolved</td>
</tr>
<tr>
<td>Melena</td>
<td>1 (1.1)</td>
<td>sclerotherapy of open vessel at esophagojejunal anastomosis</td>
<td>resolved</td>
</tr>
<tr>
<td>Nasogastric tube fixing</td>
<td>1 (1.1)</td>
<td>suture cut with endoscopic procedure</td>
<td>resolved</td>
</tr>
<tr>
<td>Dehiscence of minilaparotomy</td>
<td>2 (2.2)</td>
<td>2 surgical revisions</td>
<td>2 resolved</td>
</tr>
<tr>
<td>Metastasis to trocar site</td>
<td>1 (1.1)</td>
<td>surgical revision</td>
<td>resolved</td>
</tr>
<tr>
<td>Wernicke-Korsakov Syndrome</td>
<td>1 (1.1)</td>
<td>parenteral nutrition and pharmacological support</td>
<td>resolved</td>
</tr>
<tr>
<td>Respiratory insufficiency</td>
<td>3 (3.3)</td>
<td>intensive care</td>
<td>2 resolved</td>
</tr>
<tr>
<td>Total mortality</td>
<td>2 (2.2)</td>
<td></td>
<td>1 death</td>
</tr>
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important advantage compared with open methods (23, 25, 27, 29–32), including reduced blood loss, amount of time before returning to normal bowel movement and oral feeding, length of hospital stay, and reduction in greater cardio-respiratory complications (17, 18, 33). The substantial number of avoided explorative laparotomies (34) must also be considered in patients whose preoperative clinical and instrumental assessment was unable to clearly determine inoperability. These advantages likely compensate for the greater technological costs of advanced laparoscopy. Finally, although laparoscopic gastric surgery is still far from being recognized as the gold standard, we believe that our results should encourage a greater commitment to standardize education for both indications and techniques, similar to what has taken place in other areas such as the gallbladder, esophagus, colon, and adrenal gland.

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References


