

Laparoscopic Minimally Invasive Total Gastrectomy with Linear Stapled Oesophagojejunostomy – Experience from the First Thirty Procedures

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Abstract. *Background:* There are only few reports on total gastrectomy by a laparoscopic surgical approach. One explanation is the fear of complications due to anastomotic dehiscence in oesophagojejunal anastomosis known to carry high morbidity and mortality. The introduction of staplers have contributed to making anastomosis safer and easier to perform and has facilitated more advanced laparoscopic surgery. In open surgery, most surgeons use a circular stapler for oesophagojejunal anastomosis or a hand sutured technique. Both techniques are difficult to use in laparoscopic surgery, especially if the oesophagus is narrow. To facilitate the creation of oesophagojejunal anastomoses, we have adopted a technique with a linear stapled anastomosis. Our method is based on a stapling technique where the oesophagus is divided above the gastric cardia followed by a oesophagojejunostomy performed with Covidien's new Endo GIA-60™ Ultra Universal stapler. The residual opening is closed with a 3-0 re-absorbable suture. *Patients and Methods:* From June 2009 to May 2012, 14 men and 16 women (median age=66 years, range=39-84 years) underwent laparoscopic total gastrectomy due to gastric cancer. *Results:* One patient died during hospital stay; corresponding to a postoperative mortality of 3,3%. Leakage in the oesophagojejunal anastomosis occurred in three patients (10%). Two of the patients with leakage in the oesophagojejunal anastomosis had an additional duodenal bulb leakage, which might have caused anastomotic dehiscence. The patients had a median postoperative hospital stay of six days (range=3-156 days). Six patients had a re-

operation due to complications, including one endoscopic stent application in the anastomosis. *Conclusion:* Even though a leakage rate of 10% can be considered high, this study describes a simple method for performing oesophagojejunostomy after gastrectomy by a laparoscopic approach independently of the width of the oesophagus. This study also shows that laparoscopic gastrectomy can be performed in more advanced stages of gastric cancer.

Since the first report in 1994 by Kitano *et al.* of laparoscopy-assisted distal gastrectomy for gastric cancer (1), several cases have been reported, primarily performed in Japan and Korea. Despite the exponential increase per year in the number of laparoscopic procedures performed (2), its acceptance compared to the open procedure remains controversial. Despite the increasing laparoscopic experience and activity, laparoscopic gastrectomy remains an investigational procedure, almost exclusively reserved for early gastric cancer and, for technical feasibility, primarily performed as laparoscopic distal gastric resection (3). The laparoscopic approach to more advanced gastric cancers remains to be further investigated and the procedure still to acquire wider acceptance, even among skilled and experienced laparoscopists. Oesophagojejunostomy is not easy to perform, especially if the oesophagus is narrow. At open surgery, a circular stapler is often used or a hand-sutured technique. These techniques are not easy to use in laparoscopy, even though there is a new device, OrVil™ (Covidien, Mansfield, MA 02048, USA), where the cartridge of the circular stapler is connected to a gastric tube to facilitate the intubation of the oesophagus through the patient's mouth. Beside the technical problems involved in oesophagojejunostomy, there is a discussion regarding oncological adequacy: Is it possible to obtain an R0 resection and gain at least the same high number of resected lymph nodes as in open surgery? (4). Secondly, even though a few randomized clinical trials compared laparoscopic *versus* open gastrectomy, large-scaled prospective randomized trials with long-term survival data remain to be carried out (5, 6). Finally, the laparoscopic approach is complex and involves a long

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learning curve (2, 7). Trying to implement the procedure and acquire the technique is time consuming and expensive, not least in the handling of the increased occurrence of complications in the learning phase. In this study, we present the results from our series of consecutive laparoscopic total gastrectomy where the anastomosis is applied with a linear stapling device known to create a significantly wider stapled anastomosis compared to the circular device (8).

Patients and Methods

Patient data collection was accepted by the Danish National Health Authority. Between June 2009 and May 2012, 30 patients with a biopsy-proven gastric tumor underwent a laparoscopic total gastrectomy at our department. Twenty-eight patients had a biopsy-proven gastric carcinoma and two patients had metastatic cancer in the stomach: one patient with previous breast cancer and one patient with a previous squamous cancer in the oropharyngeal region, both with gastric metastasis. The tumors were located in the upper third of the stomach in four patients, in the middle third in 10 patients and in the lower third of the stomach in 12 patients. Four patients had *lientitis plastica*. All patients underwent an extensive evaluation for remote metastasis which, if positive, excluded the patient from operation. Preoperative evaluation included gastroscopy with biopsy from the tumor, laparoscopy and laparoscopic-assisted ultrasonography to rule out spread to adjacent organs and peritoneal seeding, FDG-positron emission tomography and computer-scan. Operability included electrocardiogram and if necessary cardiac and pulmonary function tests. Patients with tumour stage $\geq T2N0$ were selected for neoadjuvant chemotherapy (7). Patients' characteristics are given in Table I.

Surgical technique. Under general anaesthesia the patient was placed in the supine position with legs apart and in a slight head-up position. The surgeon placed in the French position between the patients legs with the camera assistant on the patient's right side and the most experienced assistant was on the patient's left side. Figure 1 shows the operative procedure step by step. CO₂ pneumoperitoneum was induced with the help of Verres canula introduced in the left hypochondrium. Two 5- and two 12-mm ports were placed in line just above the umbilicus and a Natason liver retractor was placed in the top of epigastrium to retract the left liver lobe. Using a 30° forward oblique laparoscope, the peritoneal cavity was inspected for peritoneal seeding and liver metastasis after preoperative chemotherapy. Holding the left liver lobe aside, the gastrohepatic ligament was divided using ultrasonic-activated scissors (UltraCision Harmonic Scalpel®; Ethicon Endo-Surgery, LLC, Guaynabo, Puerto Rico, USA) following the right and left diaphragmatic crus above and around the oesophagus, where the phrenoesophageal ligament and the vagal nerves were divided with the harmonic scissor. The gastrocolic ligament was then divided along the border of the transverse colon, including the greater omentum in the specimen to be resected. The dissection was followed to the right until the pylorus where the infrapyloric and suprapyloric lymph nodes (lymph node station 5 and 6 respectively) were included in the resection. The right gastric artery was divided at its origin from the common hepatic artery with the harmonic scissor. The right gastroepiploic artery and vein is divided at their origin, where the gastroduodenal artery emerges behind the pylorus, either with non-reabsorbable clips or harmonic scissors. The

Table I. *Patients' characteristics.*

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| <ul style="list-style-type: none"> • Number of patients 30 (3 patients 2009, 9 patients 2010, 10 patients 2011, 8 patients 2012) • Number of male/female patients: 14/16 • Age, median 66 (range, 39-84) years • Body mass index, median 23 (range, 17-30) • ASA-score, number of patients: ASA I 9, ASA II 19, ASA III 2 |
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specimen to be resected was then divided below in the duodenal bulb just below the pylorus with 60 mm Endo-Gia Duet™, brown magazine, medium height (Covidien). Lymph nodes of the anterior region of the hepatoduodenal ligament and lymph nodes at the front of the common hepatic artery were then resected (station 8 and station 12 respectively). The coronary vein and left gastric artery were divided with non-reabsorbable clips where they emerge at the base of the celiac trunk. Lymph nodes along the celiac trunk and along the splenic artery (station 9 and station 11) were resected with the harmonic scissor. Lymph nodes along the greater gastric curvature were included in the resected specimen, including lymph nodes at the greater gastric curvature (station 4a and 4b). The abdominal portion of the esophagus was mobilized sufficiently to resect lymph nodes station 1 and station 2. The intra-abdominal esophagus was transected with 60 mm Endo-Gia.

A Roux-en-Y loop was prepared 30 cm below the ligament of Treitz and anastomosed *ante colic* as a side-to-side oesophagojejunostomy to the posterior wall of the stapler closed the intra-abdominal part of the oesophagus with a 60 mm Endo-Gia 60, medium height. A non-interrupted running reabsorbable 3-0 suture was used to close the access opening of the stapled anastomosis. At the end of the gastrointestinal reconstruction, the anastomosis was tested for unexposed leakage with methylene blue introduced in the anastomosis through a trans oral tube. Fifty centimeters distal from the oesophagojejunal anastomosis, the distal side-to-side enteroanastomosis according to Roux was performed with a 60 mm Endo-Gia 60, medium height. The access opening was closed with a reabsorbable 3-0 or a V-lock suture. When the two anastomoses were performed, the biliary leg in the Roux-en-Y loop was divided near the oesophagojejunostomy with a 60 mm End-Gia, brown magazine, medium height, care been taken not to transect the loop to close to the oesophagojejunostomy, avoiding devascularized intestinal tissue between the two stapler lines. The specimen was then inserted in a bag and extracted through an extended port-hole. Finally the 12 mm port-holes were closed at the fascia level with reabsorbable suture. The skin was closed with body skin stapler, Appose™ ULC (Covidien, Mansfield, MA, USA).

Postoperative care. The patients were allowed 300 ml water from day 0. From day 1 to day 14 the patients were allowed a fluid diet. No nasogastric tube, central venous catheter or epidural catheter were used. Analgesia was restricted to transcutaneous fentanyl delivery system and paracetamol.

Results

Thirty laparoscopic total gastrectomies were performed. Furthermore, two procedures were converted to open gastrectomy on the indication of locally advanced cancer involving a colon resection and a splenectomy in one case and

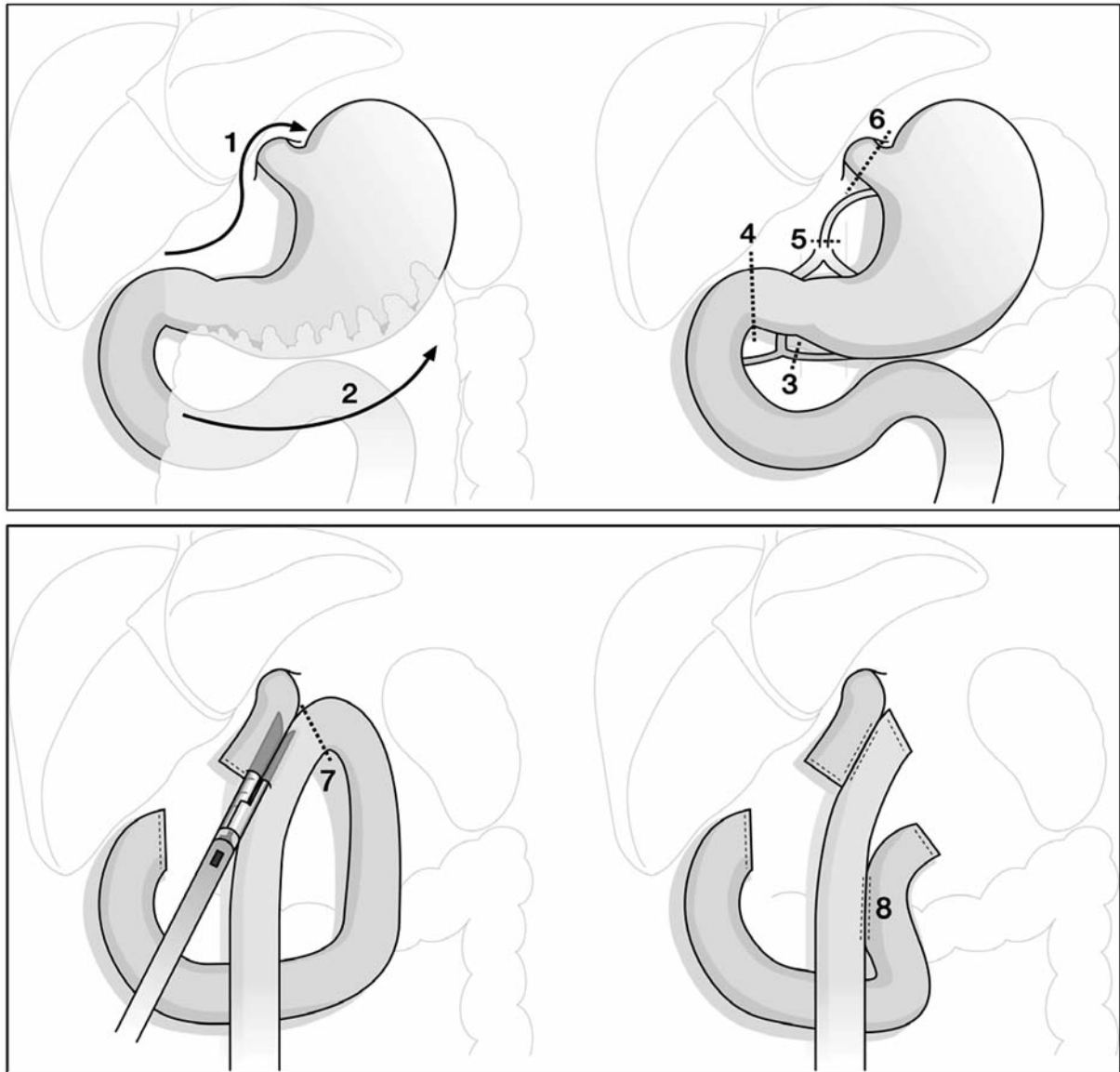


Figure 1. Illustration of the operative procedure: 1: Division of the hepatogastric ligament. 2: Mobilization of the gastric major curvature dividing the gastrocolic ligament including the omentum in the resected specimen. 3: Division of the right gastroepiploic artery and vein, harvesting lymph nodes station 5 and 6. 4: Division of the duodenal bulb with a linear stapler. 5: Division of the coronal vein and the left gastric artery close to the celiac trunk, harvesting lymph nodes station 8,9 and 11. 6: Resection of the oesophagus at the gastrooesophageal junction in the oesophageal hiatus. 7: Performing the oesophagojejunal anastomosis side-to-side with 60 mm Endo-GIA. 8: Performing the Roux-en-Y anastomosis side-to-side with a 60 mm Endo-GIA approximately 50 cm from the gastrooesophageal anastomosis on the alimentary trunk before dividing the biliary trunk just below the gastrojejunal anastomosis with an Endo-GIA.

on the indication of unclear resection margins in the other case. Pathological tumor-node-metastasis (pTNM) classifications are given in Table II. It is notable that one third of the resections include patients with stage IIb – III disease. Perioperative outcomes of laparoscopic total gastrectomy are listed in Table III and complications in Table IV.

There were four patients with either radiological or clinical signs of anastomotic leakage or sign of leakage from the

stapled closure of the duodenum. Out of the three patients with leakage from the oesophagojejunal anastomosis, two had also leakage from the duodenal bulb. One patient had an isolated leakage from the resection line of the duodenal bulb. Another patient was reoperated within hours of the operation because of bleeding from the stapler line in the jejunojunal Roux-en-Y anastomosis and was handled with a laparoscopically-assisted application of a hemostatic clip. One

Table II. Pathological tumor node metastasis classification (pTNM).

pTNM	Number of patients
pT1N0M0	5
pT1N1M0	1
pT2N0M0	6
pT2N1M0	5
pT2N2M0	3
pT2N3M0	1
pT3N0M0	1
pT3N1M0	1
pT3N2M0	1
pT3N3M0	1
pT4N1M0	1
pT4N3M0	1

patient was re-operated one week postoperatively because of small bowel herniation in the oesophageal hiatus. Altogether, six patients had a major complication, of whom five required re-operation. One major complication was treated conservatively with endoscopic insertion of a covered oesophageal stent for anastomotic leakage. Patients who acquired a major complication were also responsible for 75% of the registered minor complications.

Discussion

This study shows that minimally invasive total gastrectomy can also be performed for more advanced stages of gastric cancer in contrast to most previous studies where minimally invasive techniques have been restricted to early gastric cancer (T1-T2 tumors) in the distal part of the stomach. The approach has been distal gastric resection mainly using a laparoscopically-assisted technique (2, 9). The surgical experience in more advanced cancer suitable for laparoscopic total gastrectomy has been limited, partly due to scepticism and for this there are several reasons. First of all due to the biological nature of gastric cancer, where the number of lymph node metastases is important for the prediction of the prognosis.

The sample size in previous randomized clinical trials has been small. Even though meta-analysis of data from these randomized clinical trials has been published in recent years the controversy concerning safety in terms of complications, radical surgery (R0 resection) and longterm survival still exists (3, 4, 6). The skills needed to carry out the laparoscopic procedure, demand for surgeons with a high volume experience in laparoscopic surgery. Furthermore it requires surgeons with a specific training and interest in laparoscopic gastric surgery and involves a long learning curve (2, 10). Trying to implement the procedure and acquire the technique is time consuming in the learning phase.

In the preliminary data from our first 30 procedures in

Table III. Laparoscopic total gastrectomy: Results are given as median with range.

Number of lymph nodes dissection	23 (7-53)
Blood loss, ml	100 (50-650)
Operating time, min	180 (120-330)
Hospital stay, days	6 (3-156)

laparoscopic total gastrectomy presented here, the number of retrieved lymph nodes in our laparoscopic D1+ resection is acceptable and fully comparable to that of an open gastrectomy (3, 11). The number of lymph nodes obtained was comparable to data registered in the Danish national register for gastric cancer concerning open total gastrectomy (7). The operative time was comparable to our experience in open surgery. From a meta-analysis investigating patients undergoing D1+ to D2 resection, the operative time is expected to be prolonged by approximately 60 minutes, at least, in laparoscopic distal resections undergoing D2 resection (3). Nevertheless the operative time was, in our experience, comparable to what is expected from open gastrectomy, even though this can be considered to be the start of the learning curve. As expected, the blood loss was limited. Use of a harmonic ultrasonic scalpel is crucial to the ability to perform laparoscopic gastrectomy, although the gastroepiploic artery and left gastric artery were divided after first applying vascular clips to the base of the vessels. The length of hospital stay was minimized in the minimally invasive procedure and estimated to have been halved compared to open surgery. Furthermore, patient satisfaction with the minimally invasive laparoscopic procedure without complication, was high in accordance with randomized clinical studies (12). A leakage occurred in the duodenal bulb in two out of the three patients with a leakage of the oesophagojejunostomy. A leaking duodenal bulb, which is one of the most feared complication, are known to create fistulas by duodenal content. This might explain the impaired tissue healing in the oesophagojejunostomy. However, it also raises the question about the sufficiency of only sealing the divided duodenal end with a stapler. It might in our case be necessary to oversee the duodenum with interrupted re-absorbable sutures. Suffering a major complication brings with it other complications as demonstrated by the high frequency of minor complications in these preliminary data.

We did choose a linear stapled anastomosis for both the oesophagojejunostomy and the enteroanastomosis. This technique has several advantages over the circular stapled anastomosis (13). First of all it creates a significantly wider anastomosis. Furthermore, it excludes the problem of a narrow oesophagus or the purse-string suture often required with circular stapled anastomosis. We had no leakage from

Table IV. *Laparoscopic total gastrectomy: Complications experienced.*

Major, 6 patients	Leakage from the oesophagojejunal anastomosis	3
	Duodenal bulb leakage	3
	Postoperative bleeding	1
	Hernia in oesophageal hiatus	1
Minor, 8 patients	Pneumonia	5
	Pneumothorax	1
	Cardial arrhythmia	4
	Abdominal abscess	2

the Roux-en-Y anastomosis, however, the leakage rate from the upper anastomosis was high, underlining the difficulties in doing the upper anastomosis. The oesophagus is known to have an insufficient blood supply and it is important not to dissect too high up in the mediastinum, which will devascularize the distal part of the oesophagus.

The laparoscopic total gastrectomy, still being a controversial procedure in regard to longterm survival, should be considered as a high risk procedure and the surgical safety has to be considered. Laparoscopic total gastrectomy is a complex and demanding procedure. The learning curve is long and performance of the procedure requires it to be centralized in high volume centers. The Japanese experience suggests that this laparoscopic procedure will benefit from a formalized education program (14).

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