Chapter 4

Laparoscopic Surgery for Gastric Cancer

Talha Sarigoz, Inanc Samil Sarici, Ozgul Duzgun and Mustafa Uygar Kalayci

Additional information is available at the end of the chapter

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Abstract

In patients with gastric cancer, surgical resection is the only treatment that can offer cure or increase long-term survival. With the accumulation of experience in laparoscopic radical gastrectomy and the progress in surgical instruments, laparoscopic surgery for gastric cancer has gained popularity despite initial concerns regarding safety and oncological adequacy. As a result, laparoscopic technique has been widely applied in gastric cancer. Different meta-analyses showed that laparoscopic procedures are associated with less blood loss but longer operation time. Many studies have reported outcomes of laparoscopic surgery for early gastric cancer, but several authors also have shown that a laparoscopic approach can also be used in cases of advanced gastric cancer. We therefore conducted this study to expand our experience and to evaluate laparoscopic gastrectomy step by step in the light of recent reports while defining key points and surgical technique.

Keywords: laparoscopic surgery, gastric cancer, gastrectomy, lymphadenectomy, advanced, early gastric cancer, laparoscopic gastrectomy

1. Introduction

Gastric cancer (GC) is the fifth most common malignancy and the third most common cause of cancer-related deaths worldwide in both sexes combined [1]. Surgery with either total or subtotal gastrectomy and lymphadenectomy is the initial treatment [2]. The first example of gastrectomy for cancer was described by Theodor Billroth and the first laparoscopy-assisted gastrectomy was performed by Kitano et al. in 1991 for a patient with early GC [3, 4]. In the last two decades, in parallel to advances in surgical devices and technical expertise, minimally invasive surgery has become the new trend and the laparoscopy has increasingly started being applied for GC as an alternative to open surgery. However, due to complexity of the lymph node structure and contiguity of stomach to gross vascular structures, it is technically

demanding. During the procedure, it is equally important to ensure adequate resection and pay attention to some precautions [5]. In this chapter, we will clarify pre-operative approach, technical considerations as well as clinical outcomes of laparoscopic surgery (LS) for GC based on the recent reports in the literature.

2. Preoperative approach

2.1. Indications for laparoscopic surgery

Most of the reports evaluated early GC population and common consensus is that laparoscopic gastrectomy is appropriate for early-stage GC with benefits of reduced need for painkillers, early discharge, rapid recovery of bowel movement, less pulmonary function disorders, and better cosmetic results [5, 6]. There is agreement about performing laparoscopic total gastrectomy for proximal GC with T1 N0 disease and laparoscopic distal gastrectomy for distal GC with T1–2 N0 disease [5]. Regarding advanced stage cancers, there is still debate over appropriateness of laparoscopy concerning oncologic adequacy of lymphadenectomy with tumor-free margins. Recent meta-analysis and cohorts demonstrated favorable short- and long-term outcomes of laparoscopic gastrectomy for advanced stage GC; but in order to recommend it as an alternative to open surgery, there is still room for prospective clinical trials and longer-follow-up studies [7–9].

2.2. Determination of resection margin

Lack of tactile feedback limits assessment of the tumor during laparoscopic surgery. Since laparoscopic gastrectomy has been performed mostly for early GC and achieving tumor-free margins is important in terms of oncological principles, different methods have been proposed for safe determination of resection line in tumors without serosal surface invasion. Reported various procedures include preoperative or intraoperative endoscopic dye injection, preoperative endoscopic clipping along with intraoperative endoscopy, intraoperative radiography or ultrasonography [10–14]. None of these methods has wide acceptance and choice of technique vary with institution.

2.3. Nutritional status of patients

As gastric cancer is a serious malignancy of the upper intestinal tract, patients are at risk for malnutrition due to maldigestion and malabsorption. On the other hand, surgery itself imposes protein and energy requirements and it can aggravate pre-existing nutritional disorders [15]. There is a lack of clinical evidence about role of laparoscopic gastrectomy in malnourished patients with GC. A recent retrospective study reported significantly less postoperative complications and faster recovery for laparoscopic gastrectomy compared to open surgery [16]. But, prospective clinical trials to analyze short- and long-term effects of preoperative nutritional support, chemotherapy and dissection type are required to recommend laparoscopic gastrectomy for malnourished patients.

2.4. Presence of enlarged lymph nodes in preoperative imaging

There are controversies on the extent of lymphadenectomy for GC. Nevertheless, lymph node dissection is recommended for staging and prevention of local recurrence. Most of the patients with GC are diagnosed at a later stage of the disease, often with enlarged lymph nodes. Since lymphadenectomy is a challenging procedure, especially in laparoscopic setting, enlarged nodes interfere with anatomical structures and disrupt the course of the dissection. In a late retrospective study, performing laparoscopic gastrectomy for GC with pre-operative enlarged lymph nodes was found to be safe and effective [17]. Yet, these results should be supported with prospective research to make recommendation.

2.5. Obese patients

Obese patients carry high risk for comorbid diseases and they are directly associated with intra- and post-operative complications [18]. Obesity was considered as a relative contraindication for laparoscopy, but with the advances in laparoscopic equipment and growing experience, initial studies with laparoscopic surgery in obese patients have shown promise [19]. According to the reports in the literature, due to abundant visceral fat content and difficult manipulation of tissue, operation times in laparoscopic gastrectomy were longer compared to open surgery [20, 21]. Not only obesity, but also high body mass index (BMI ≥ 25 kg/m^2) was shown to affect operation time and retrieved lymph node number negatively [22]. On the other hand, the 5-year survival rates of patients who underwent laparoscopic gastrectomy and open gastrectomy were similar [23]. But regarding early post-operative outcomes, we cannot mention that there is an agreement [20, 21, 23]. Despite negative findings, laparoscopic gastrectomy is likely to be the choice of surgery in obese patients with growing experience.

2.6. Elderly patients

In parallel to increasing age, functional capacity decreases at some point and this situation creates risk for surgery. Considering advantages, elderly may benefit from laparoscopic surgery. In an updated pooled meta-analysis, laparoscopic gastrectomy was found to reduce surgery-related cardiopulmonary disease and also better cognitive outcomes were observed compared to open surgery [24]. But, lack of randomized controlled studies in the literature prevent from making precise conclusions.

3. Technical considerations

3.1. The importance of lymphadenectomy in gastric cancer

Lymph node metastasis (LNM) is the most common pattern of metastatic spread in gastric cancer [25]. The reported frequency of LNM in gastric cancer can be seen up to 80%. Lymphatic networks are plenty in the layer of the gastric wall, particularly in the submucosa and serosa, which simplify metastasis. Oncological outcomes will not be reached if gastrectomy alone

is performed for gastric cancer. Therefore, lymphatic flow of the stomach and characteristics of metastasis have been continuously examined by researchers. In the Japanese gastric cancer treatment guidelines based on the third English edition of the Japanese Classification of Gastric Carcinoma and the Japanese Gastric Cancer Association defined the extent of systematic lymphadenectomy according to the type of gastrectomy indicated [26]. Lymph node metastasis in gastric cancer is usually associated with the location of the tumor, and metastasis follows the lymphatic drainage routes from the superficial to the profoundus. For this reason, lymph nodes are numbered and dissection for functional lymph node resection was defined. Laparoscopic gastrectomy, which begins with D1 dissection in early gastric cancer treatment, can now be done easily with the aid of technology (laparoscopy, robotic surgery) and D2 dissection technique is routinely performed in the treatment of advanced GC [27] (**Tables 1** and **2**).

3.2. Surgical technique of laparoscopic gastrectomy with D2 lymphadenectomy

3.2.1. Patient's position and location of trocars

The patient is placed in the modified lithotomy position. The surgical table is adjusted 20–30° into the reverse Trendelenburg position. The surgeon stands on the patient's leg, the assistant is on the right side, and the camera operator is between the patient's left side. Besides routine laparoscopic devices, advance vessel sealing systems, all types of intestinal Endo-GIA and circular staplers must be available on the operating table. The intervention generally performed by using five ports. Additionally, subxiphoid sixth port can be required during the splenic hilar lymph node dissection. 10-mm optic port is placed 1 cm above the umbilicus. 15-mm trocar left preaxillary and 5 mm trocar right preaxillary is inserted in the line 2 cm below the costal margin. Two 5-mm ports are placed bilaterally in each hypochondrium for assisting and dissection purposes (**Figure 1**).

3.2.2. Surgical procedure

Laparoscopic exploration is used for preoperative staging, liver and peritoneal metastasis which can reduce unnecessary laparotomies. Once it is determined that it is suitable for surgery, the procedure continues in four steps as left part region, right part region, cardiac region, and reconstruction (**Table 3**).

3.2.2.1. Left part region (4sa, 4sv, 10, 11d)

The approach for removing the greater omentum begins from the superior border of the transverse colon. After that, the division is extended toward the flexura of left and the right colon. In the continuation of the dissection, splenic ligaments must be separated due to prevent of iatrogenic splenic injury which may be caused by traction. Gastrosplenic, splenocolic, splenorenal, and splenophrenic ligaments need to be separated in this stage. The omentectomy helps to achieve a lymphadenectomy corresponding to lymph node stations 4sa and 4sv according to the Japanese classification. The left gastro-omental vessels are perfectly identified clipped and divided. After this dissection, the short gastric vessels will be divided using the sealing

Regional lymph nodes of stomach

1. Right cardia lymph nodes
2. Left cardia lymph nodes
3. Lymph nodes along the lesser curvature
4. Lymph nodes along the greater curvature
   - Station **4sa:** lymph nodes along the short gastric vessels
   - Station **4sb:** lymph nodes along the left gastroepiploic vessels
   - Station **4d:** lymph nodes along the right gastroepiploic vessel
5. Suprapyloric group of lymph nodes or nodes along the right gastric artery
6. Infrapyloric groups of lymph nodes
7. Lymph nodes along the left gastric artery
8. Lymph nodes along the common hepatic artery
   - Station **8a:** anterosuperior group
   - Station **8b:** posterior group
9. Lymph nodes around the celiac artery
10. Lymph nodes at the splenic hilum
11. Lymph nodes along the splenic artery
    - Station **11p:** along the proximal splenic artery
    - Station **11d:** along the distal splenic artery
12. Lymph nodes in the hepatoduodenal ligament
    - Station **12a:** along the hepatic artery
    - Station **12b:** along the bile duct
    - Station **12p**: behind the portal vein
13. Lymph nodes behind the pancreatic head
14. Lymph nodes at the root of the mesentery or the SMA
15. Lymph nodes along the middle colic artery
16. Para-aortic group of lymph nodes
    - Station **16a1:** lymph node in the aortic hiatus
    - Station **16a2:** lymph node around the abdominal aorta (from the upper margin of the celiac trunk to the lower margin of the left renal vein)
    - Station **16b1:** lymph node around the abdominal aorta (from the lower margin of the left renal vein to the upper margin of the inferior mesenteric artery)
    - Station **16b2:** lymph node around the abdominal aorta (from the upper margin of the inferior mesenteric artery to the aortic bifurcation)

Table 1. Numbering lymph nodes according to the Japanese Research Society for Gastric Cancer.

D0	No dissection or incomplete dissection of the Group 1 nodes
D1	Dissection of all the Group 1 nodes (No.1–6 lymph nodes)
D2	Dissection of all the Group 1 and Group 2 nodes (D1 station + No.7–11 lymph nodes)
D3	Dissection of all the Group 1, Group 2 and Group 3 nodes (D2+ No. 12–16 lymph nodes)

Table 2. Definitions of lymphadenectomy in gastric cancer.

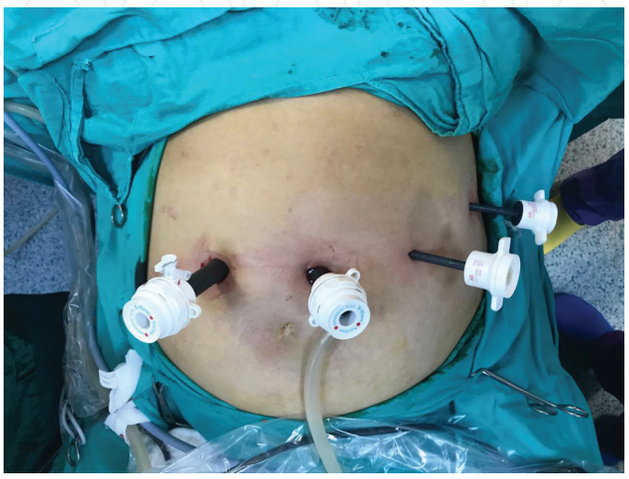

Figure 1. Patient's position and location of trocars.

1	Left part region (4sa, 4sv, 10, 11d)
2	Right part region (4d, 5, 6, 7, 8a, 8p, 9, 11p, 12a, 12b, 12p)
3	Cardiac region [1–3]
4	Gastric resection and reconstruction

Table 3. Steps of laparoscopic gastrectomy for gastric cancer.

systems. This dissection should be continued until the left crus of the diaphragm clearly seen. At this time, the lymph node 10 and 11d in the splenic hilus is gently excised (**Figures 2** and **3**).

3.2.2.2. Right part region (4d, 5, 6, 7, 8a, 8p, 9, 11p, 12a, 12b, 12p)

The dissection is then continued toward the right part of the abdomen. Dissection of the gastro-omental ligament is pursued in this area. This dissection allows to drop the right colon and to access the duodenum. This maneuver also allows to expose the anterior aspect of the pancreatic head and to access the right gastro-omental pedicle, where a lymphadenectomy should be performed in order to control lymph node station 6 (**Figure 4**).

Right gastro-omental vessels are dissected, isolated, and divided. Once this first mobilization and 6-station of lymphadenectomy step has been performed, the first portion of the duodenum will be dissected and isolated, prior to moving on to the supragastric compartment. The common bile duct, hepatic artery, and portal vein, which form the hepatoduodenal ligament,

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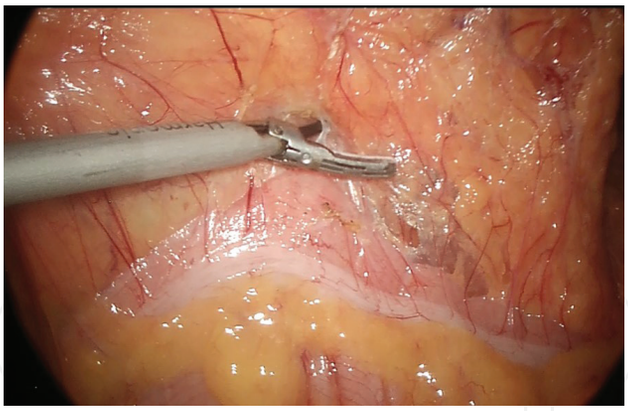

Figure 2. Lift of transvers colon and dissection of anterior transvers mesocolon fascia.

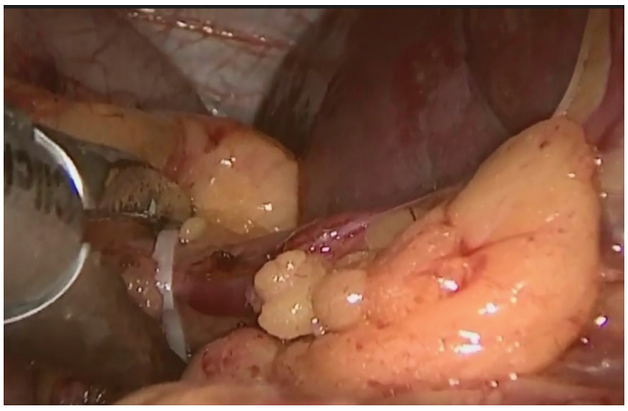

Figure 3. The left gastro-omental vessel is clipped and divided.

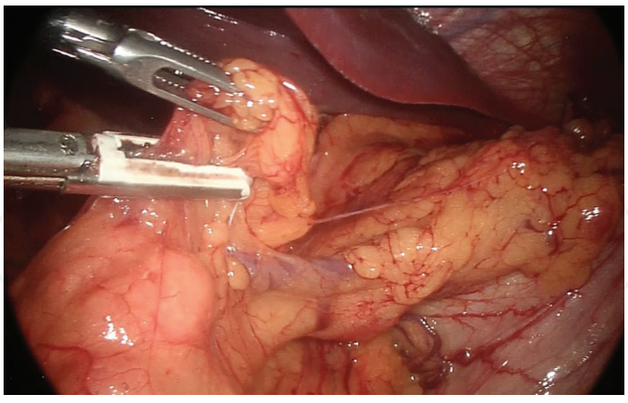

Figure 4. Dissection of number 6 lymphatic area.

are identified. The right gastric artery will also be identified and divided along with lymph node dissection at the level of lymph node station 5. The 12a, 12b, and 12p lymph node stations in the hepatoduodenal ligament are excised with vessel sealing devices (**Figure 5**).

Duodenal division is then performed approximately 2 cm distally from the pylorus by Endo-GIA blue cartridge. After dissection of the hepatic proper artery, resection will be carried on at the superior border of the pancreas at the level of the common hepatic artery, namely lymph node

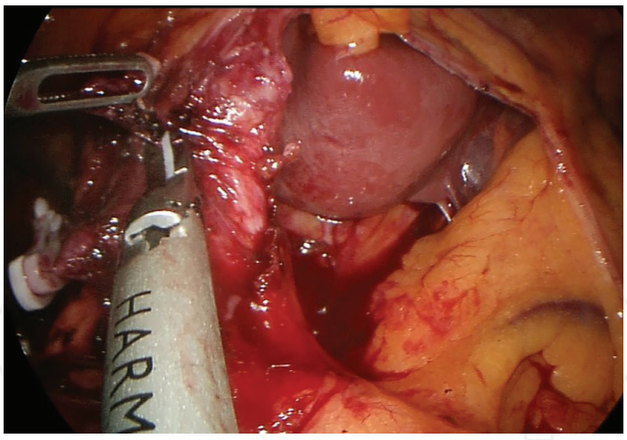

Figure 5. Dissection of hepatoduodenal lymphatic area.

stations 8 and 9. The left coronary vein is also identified, clipped, and divided. Dissection is pursued toward the coeliac trunk with lymph node dissection of stations 9. Dissection of the left gastric artery is begun along with lymph node dissection of station 7. The left gastric artery is clipped and divided. After that 11p lymph node stations along the splenic artery are excised. Care should be taken during dissection due to the tortuous structure of splenic artery (**Figures 6** and **7**).

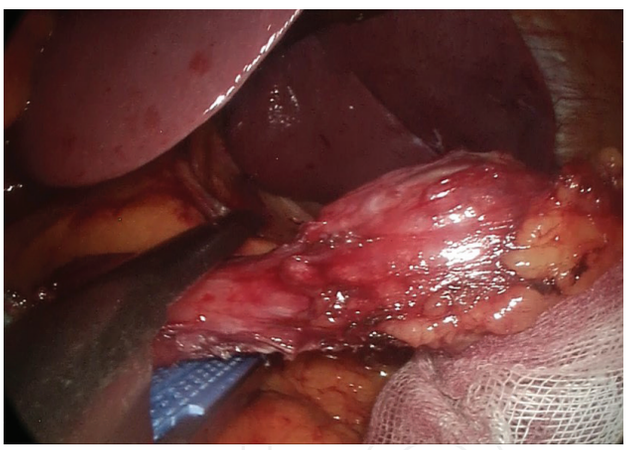

Figure 6. Transection of duodenum.

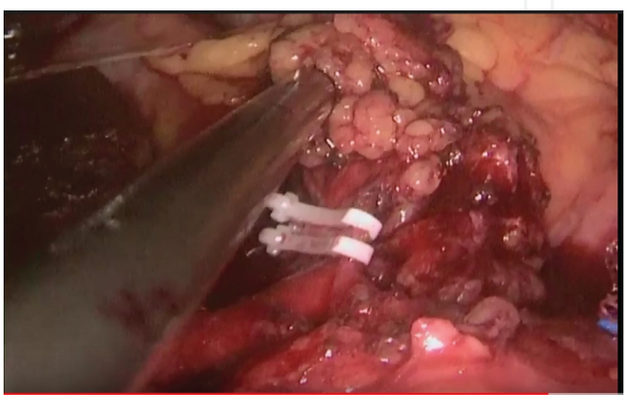

Figure 7. Dissection of number 7, 8, and 9 lymphatic area.

3.2.2.3. Cardiac region

The lymph nodes in the cardiac region are located on both sides of the cardia and along the lesser curvature [1–3]. Hepatogastric ligament is opened by vessel sealing devices in the avascular area at the posterior wall of the gastric lesser curvature. Thus, the gastric lesser curvature is fully bared and dissection of the No. 3 lymph nodes is done. The left and right diaphragm crus are identified and the phrenoesophageal membrane is dissected. Lymph nodes No:1 and No:2 are excised. The abdominal part of the esophagus is bared 5 cm in the abdomen. Left and right vagal nerves divided (**Figure 8**).

3.2.2.4. Gastric resection and reconstruction

The reconstruction should be in different forms according to the extent of the resection. Proximal resection was performed with Endo GIA blue cartridge which is placed from 15 mm trocar. Trans oral OrVil™ (Covidien Mansfield, USA) is propagated from the esophagus and anvil is placed in the esophageal stump. Transvers mesocolon lifted and the small window open from the avascular area. Jejunal ans is divided at 20 cm from the Treitz ligament by Endo GIA blue cartridge. Esophagojejunostomy is done with 25 mm circular stapler if totally gastrectomy planned or gastrojejunostomy is performed with EndoGIA if subtotal gastrectomy intended. Jejunal stump is closed with Endo GIA blue cartridge. Laparoscopic reinforcement

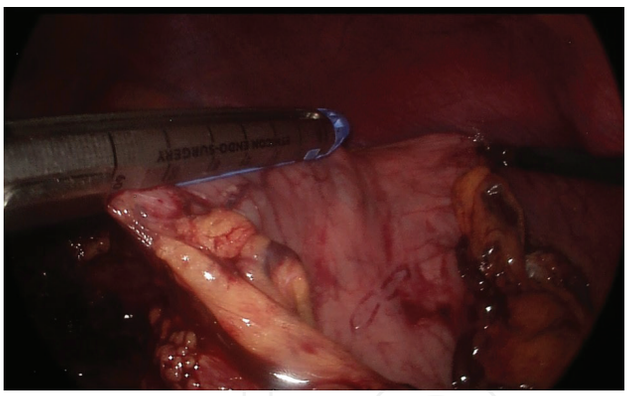

Figure 8. Dissection of cardiac lymphatic area.

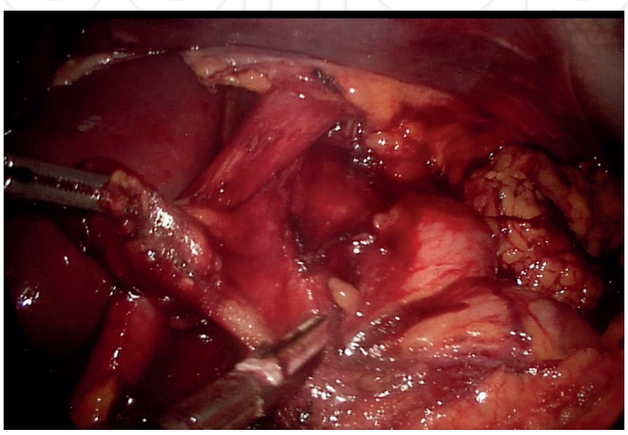

Figure 9. Proximal resection of stomach with EndoGIA.

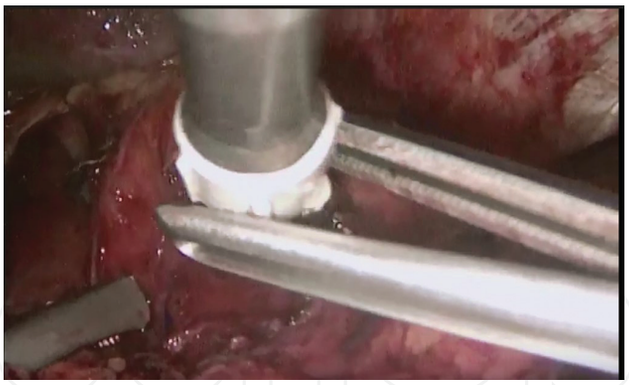

Figure 10. OrVil™ placement in the esophageal stump.

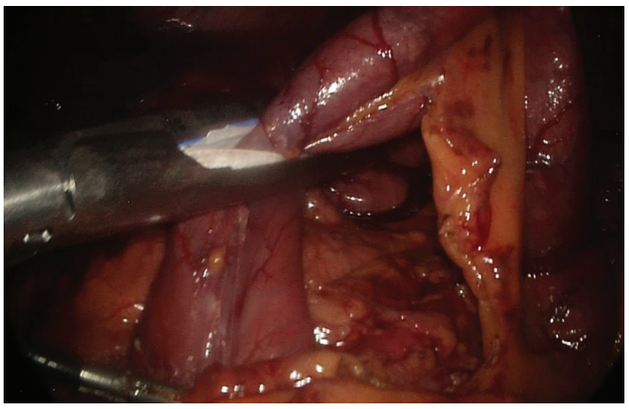

Figure 11. Division of jejunal ans 20 cm distal to the Treitz ligament.

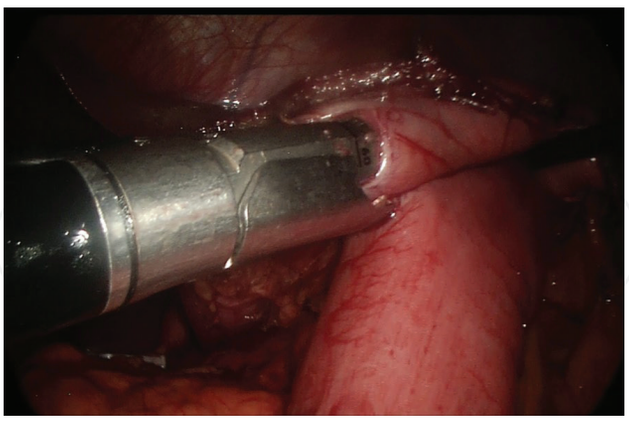

Figure 12. Gastrojejunostomy with EndoGIA.

sutures can be added if needed. Jejunum is fixed to the diaphragm crus. The jejunojejunostomy is also performed by means of a side to side Endo GIA blue cartridge stapler. Placement of the gastric tube is controlled laparoscopically. This tube is lowered until the distal part of the alimentary limb. A wound protector is placed into the defect, hence allowing for the extraction of the entire specimen, including the whole stomach and the omentum (**Figures 9–13**, **Table 4**).

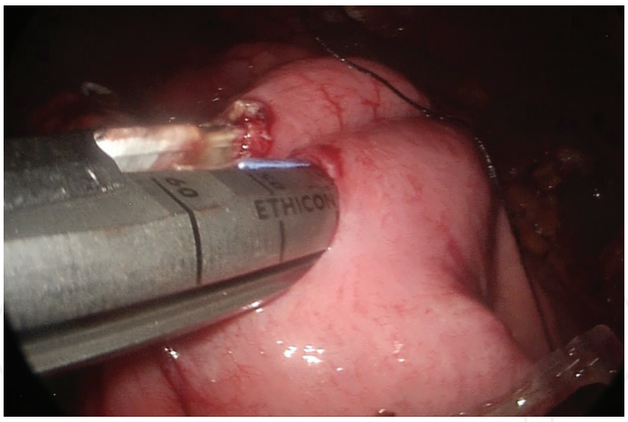

Figure 13. Jejunojejunostomy with EndoGIA.

Subtotal gastrectomy	Total gastrectomy

• Totally laparoscopic gastroduodenostomy (Billroth 1)
• Billroth 1 through mini laparotomy
• Billroth 1 with hand port
• Roux-en-Y Gastrojejunostomy
	• Roux-en-Y esophagojejunostomy
	• Hand-sewn anastomosis
	  • Laparoscopic
	  • Mini-laparotomy
	• Mechanical anastomosis
	  • Circular stapler
	  • Manually loaded anvil
	  • Transoral (OrVil™)

Table 4. Different reconstruction forms according to the resection types.

4. Post-operative outcomes

4.1. Early post-operative outcomes

Initial studies with laparoscopic gastrectomy consisted of mostly early GC and with growing experience it has been started to apply to later stages of the disease. Laparoscopic gastrectomy whether performed for early or advanced GC has advantages such as less blood loss, early ambulation, rapid recovery of bowel movement, and shorter hospitalization compared to open surgery [28–31]. Complication rates of laparoscopic gastrectomy for early GC ranged from 4.2 to 23.3% and these results did not differ from open surgery [29, 32–34]. In the latest ongoing clinical trials, short-term results have been shared. While, laparoscopic surgery for advanced GC has a complication rate of 16.4%, it is 24.3% for open surgery [35–37]. These studies will be finalized in 2018. In an ongoing study in Japan, short-term results have revealed incidence of anastomotic leakage rate as 4.7% for laparoscopic surgery in advanced stage [37]. In the retrospective studies, anastomotic leakage rate during LS for advanced GC was reported to range from 1.1 to 2.7% [30, 38–40]. But this risk should be evaluated appropriately.

4.2. Late post-operative outcomes

According to single-center studies, after laparoscopic gastrectomy for early GC, the morbidity rates ranged from 10 to 14.8% and mortality rates from 0 to 1.1% [6, 41, 42]. Regarding laparoscopic gastrectomy for AGC, the morbidity rates ranged from 8.0 to 24.2% but there was no significant difference compared to open surgery [30, 39, 40]. There are ongoing randomized phase-II and III studies in Asian Countries. They are expected to give scientifically more reliable results [30, 35]. Initial results indicate that LS for advanced GC is feasible and safe but surgeon experience and institution volume play important role on patient outcome. Long-term outcomes should be clarified with well-established studies.

Author details

Talha Sarigoz[1]*, Inanc Samil Sarici[2], Ozgul Duzgun[3] and Mustafa Uygar Kalayci[4]

*Address all correspondence to: sarigozt.md@gmail.com

1 Department of General Surgery, Sason State Hospital, Batman, Turkey

2 Department of General Surgery, Kanuni Sultan Suleyman Training and Research Hospital, Istanbul, Turkey

3 Division of Surgical Oncology, Department of General Surgery, Umraniye Training and Research Hospital, Istanbul, Turkey

4 Department of General Surgery, Kanuni Sultan Suleyman Training and Research Hospital, Istanbul, Turkey

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