

• RAPID COMMUNICATION •

# Learning curve of laparoscopy-assisted distal gastrectomy with systemic lymphadenectomy for early gastric cancer

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## Abstract

**AIM:** To evaluate the nature of the "learning curve" for laparoscopy-assisted distal gastrectomy (LADG) with systemic lymphadenectomy for early gastric cancer.

**METHODS:** The data of 90 consecutive patients with early gastric cancer who underwent LADG with systemic lymphadenectomy between April 2003 and November 2004 were reviewed. The 90 patients were divided into 9 sequential groups of 10 cases in each group and the average operative time of these 9 groups were determined. Other learning indicators, such as transfusion requirements, conversion rates to open surgery, postoperative complication, time to first flatus, and postoperative hospital stay, were evaluated.

**RESULTS:** After the first 10 LADGs, the operative time reached its first plateau (230-240 min/operation) and then reached a second plateau (<200 min/operation) for the final 30 cases. Although a significant improvement in the operative time was noted after the first 50 cases, there were no significant differences in transfusion requirements, conversion rates to open surgery, postoperative complications, time to first flatus, or postoperative hospital stay between the groups.

**CONCLUSION:** Based on operative time analysis, this study show that experience of 50 cases of LADG with systemic lymphadenectomy for early gastric cancer is required to achieve optimum proficiency.

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**Key words:** Laparoscopic gastrectomy; Systemic lymphadenectomy; Learning curve

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## INTRODUCTION

In Korea, an aggressive surgical approach of gastrectomy with systemic lymphadenectomy has long been the standard treatment, even for superficial cancers, because of the limitations of preoperative assessment for the depth of tumor invasion<sup>[1,2]</sup> and imaging technique for the detection of regional lymph node metastasis<sup>[3-5]</sup>. Since its introduction in 1992, laparoscopy-assisted distal gastrectomy (LADG) has become a viable treatment alternative for patients with early gastric cancer<sup>[6-8]</sup>. Many studies have been conducted on the safety, efficacy, and feasibility of this procedure<sup>[9-14]</sup>. Surgeons who are seeking to undertake, or who are currently practicing this procedure, should be aware that it is considered as an advanced laparoscopic procedure and it is associated with a significant learning curve. Although many reports have been issued on the learning curves of laparoscopic cholecystectomy<sup>[15]</sup>, laparoscopy-assisted colectomy<sup>[16]</sup>, and laparoscopic urologic procedures<sup>[17]</sup>, no report has been issued on the learning curve of LADG with systemic lymphadenectomy for early gastric cancer.

We hypothesized that the point at which proficiency is reached (as defined as the learning curve plateau) would be associated with improvements in perioperative outcomes, including transfusion requirement, conversion rates to open surgery, postoperative complications, time to first flatus, and postoperative hospital stay. The purpose of this study was to define the nature of the "learning curve" for LADG with systemic lymphadenectomy for early gastric cancer.

## MATERIALS AND METHODS

### Patients

The Dong-A University Medical Center's stomach cancer database and the medical records of 90 consecutive patients with early gastric cancer who underwent LADG with systemic lymphadenectomy by a single surgeon (MC Kim) between April 2003 and November 2004 were reviewed. The review board of the Dong-A University Medical Center approved the protocol used for LADG with systemic lymphadenectomy in early gastric cancer patients and written informed consent was obtained from every patient that

agreed to LADG with systemic lymphadenectomy.

Patients' characteristics, pathologic findings, and postoperative outcomes were evaluated. Cases with mucosal lesions suitable for endoscopic mucosal resection (EMR) and with a history of upper abdominal surgery were excluded. The indication for EMR at our hospital is a Tm lesion with a size of <2 cm with no ulcer.

### Surgical technique

A periumbilical trocar (10 mm) was inserted using the open surgical method, and four trocars were introduced under laparoscopic guidance. A rigid electrolaparoscope (25°, Panoview plus telescope, Richard Wolf, Germany) was then introduced through the umbilical port. Under pneumoperitoneum of 10–14 mmHg, the greater omentum was divided proximally at about 4 cm from the gastroepiploic arcade towards the lower pole of the spleen, using a new hemostatic device (The Ligasure™ Vessel Sealing System, Valleylab, Boulder, CO, USA). The roots of the left gastroepiploic vessels were then exposed using an ultrasonic dissector (Autosonix™, Tyco/US Surgical Inc., Norwalk, CT, USA) and a hook-type bovie, and divided with double Ligasure™ clamps. Their perforating branches were dissected away from the greater curvature using an ultrasonic dissector (Autosonix™, Tyco/US Surgical Inc., Norwalk, CT, USA), and the right gastroepiploic vein and artery were divided individually at their roots with double clips. The right gastric artery was then exposed and divided at its origin with double clips, thus creating room for the dissection of the suprapyloric lymph nodes (No. 5 lymph nodes). The duodenum was then transected 1 cm distal to the pylorus, using an endoscopic stapling device (Endo cutter 45 staple; Ethicon, OH, USA). After switching to an electrolaparoscope (50°, Panoview plus telescope, Richard Wolf, Germany), no. 8a (the common hepatic artery, anterosuperior group), and no. 9 (the celiac axis) lymph nodes were dissected along each artery, by using ultrasonic dissection and a hook-type bovie. In some cases, no. 11p (the proximal splenic artery), 12a (the hepatic artery), and 14v (the superior mesenteric vein) lymph nodes were dissected. The left gastric vein was then divided, and the root of the left gastric artery was exposed and divided with double clips, allowing dissection of the left gastric artery (No. 7 lymph nodes). The perigastric lymph nodes were dissected along the upper lesser curvature up to the esophagogastric junction. A 5-cm upper transverse skin incision that separated three fingers from the substernal angle, was made from the midline to the right side for the Billroth I reconstruction or to the left side for the Billroth II reconstruction. The distal two-thirds of the stomach were resected using a stapler (Proximate linear cutter 100 mm; Ethicon, OH, USA). Billroth I gastroduodenostomy was performed using a circular stapler (Proximate CDH 25; Ethicon, OH, USA), and Billroth II gastrojejunostomy with side to side jejunojunction using two endoscopic stapling devices (Endo cutter 45 staple; Ethicon, OH, USA) or by hand sewing. Irrigation and observation of the operative field were achieved under pneumoperitoneum after closing the 5-cm minilaparotomy wound. Each trocar wound was

**Table 1** Characteristics and pathologic results of patients

	Total	1–50 cases	51–90 cases	P
Total number of patients	90	50	40	
Age (yr, mean±SD)	55.7±12.0	56.3±11.3	54.9±12.9	0.6907
Sex ratio (male:female)	50:40	26:24	24:16	0.5854
Body mass index (kg/m <sup>2</sup> , mean±SD)	22.8±2.7	23.1±2.5	22.5±2.9	0.1700
Comorbidity (%)	29 (32.2)	13 (26.0)	16 (40.0)	0.2359
Method of reconstruction				0.5343
B–I	67	39	28	
B–II	23	11	12	
T stage				0.1758
Tis	2	1	1	
Tm	66	33	33	
Tsm	22	16	6	
N stage				0.8439
N0	87	49	38	
N1	3	1	2	
Extent of lymphadenectomy				0.4709
D1+α	11	8	3	
D1+β	68	36	32	
D2	11	6	5	
Retrieved LN number (mean±SD)	27.0±9.7	25.4±10.0	28.9±8.9	0.1330
Resection margin (cm, mean±SD)				
Proximal	4.2±2.6	3.8±2.4	4.7±2.7	0.1472
Distal	5.1±3.1	5.0±3.1	5.3±3.0	0.5752

LN, lymph node; D1+α: D1+no. 7 LN; D1+β: D1+no. 7, 8a, 9 LN; D2: D1+β+no. 11p, 12a, 14v LN.

closed after a closed suction drain had been placed around the anastomosis.

### Perioperative management

All patients were managed routinely using a standardized postoperative protocol as follows: (1) No nasogastric intubation or preoperative mechanical bowel preparation; (2) the use of one closed suction drain; (3) sips of water at 48 h after the operation; (4) clear liquid diet after first flatus; (5) the discharge of the patients after tolerance of a soft diet for 2 d; and (6) no postoperative transfusion unless the hemoglobin level fell to or below 80 g/L and the patient complains of anemic symptoms. All patients received a continuous intravenous infusion of mixed analgesics (butorphanol 20 mg, ketorolac 300 mg, metoclopramide 30 mg, saline 100 mL) at 1 mL/h for 3–4 d after surgery.

### Calculation of the learning curve

To define the learning curve, the 90 patients were divided into 9 sequential groups of 10 cases in each group and the average operative time of these 9 groups were determined. Other learning indicators, such as transfusion requirements, conversion rates to open surgery, postoperative complication, time to first flatus, and postoperative hospital stay, were evaluated for statistical significance. Statistical analysis was performed using the unpaired Student's *t*-test and the Mann-Whitney *U*-test for continuous variables, and the  $\chi^2$  and ANOVA tests for categorical variables. For all the three tests,  $P < 0.05$  was considered statistically significant. Data were expressed as mean±SD.

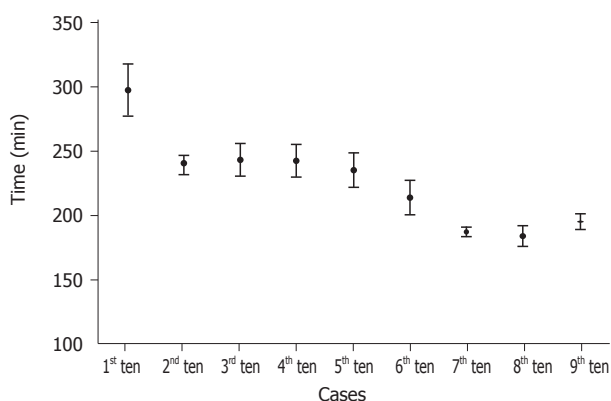
**Table 2** Overall postoperative outcomes

	Total	1-50 cases	51-90 cases	P
Operative time (min, mean±SD)	227.2±48.0	251.3±47.3	227.2±48.0	<0.0001
No. of transfused patients (%)	5 (5.6)	3 (6.0)	2 (5.0)	0.837
Time to first flatus (d, mean±SD)	3.1±0.8	3.1±0.9	3.1±0.6	0.805
Postoperative hospital stay (d, mean±SD)	7.5±1.2	7.6±1.4	7.4±1.0	0.610
Postoperative complication (%)	13 (14.4)	6 (12.0)	7 (17.5)	0.663

**Table 3** Comparison of postoperative outcomes (first 50 patients vs last 40 patients)

	Operative time (min)	Open conversion	Transfusion requirement	Time to first flatus (d)	Hospital stay (d)	Complication (patients)
First 50 patients	251.3±47.3	1	3	3.1±0.9	7.6±1.4	7
Last 40 patients	197.0±27.7	1	2	3.1±0.6	7.4±1.0	6

$P < 0.0001$

**Figure 1** LADG with systemic lymphadenectomy (operative time vs number of cases experienced).

## RESULTS

Patients' characteristics and pathologic findings are summarized in Table 1. The mean patient body mass index was 22.8 kg/m<sup>2</sup>. Of the 22 patients with a submucosal lesion, two patients had one metastatic lymph node. There were no significant differences in patients' characteristics, oncological radicality, and pathology between the two groups.

Mean operative time was 227.2 min (Table 2). Open conversion was required intraoperatively in two cases due to excessive intra-abdominal fat ( $n = 1$ ) or intra-abdominal adhesion ( $n = 1$ ). The body mass index of the patient with excessive intra-abdominal fat was 29.3 kg/m<sup>2</sup>. Fifteen complications occurred in 13 patients. These complications included wound complications, intra-abdominal bleeding, anastomotic bleeding, dumping syndrome, subcutaneous emphysema, intra-abdominal abscess, and anastomotic stricture. All these complications were treated by conservative management without reoperation. No deaths occurred in this series.

### Defining the learning curve

Figure 1 shows two plateaus in operative time vs cumulative case number plot for LADG with systemic lymphadenectomy. After the first 10 LADGs, the operative time

reached its first plateau (230-240 min/operation) and then reached a second plateau (<200 min/operation) for the final 30 cases, which was between 30 and 40 min/operation faster than that for the first 10-50 cases. We considered that learning was complete at the second plateau, and not at the first. When we compared the postoperative outcomes of the first 50 cases with the last 40 cases, no significant difference was observed despite the fact that mean operative time had been obviously reduced for the last 40 cases (Table 3).

## DISCUSSION

The proportion of cancers invading the mucosa or submucosa represents about a half of surgical gastric cancer cases in Korea. Recently, many gastric surgeons have expressed a high level of interest in laparoscopic surgery for early gastric cancer, because laparoscopic surgery has been proven to have substantial advantages over conventional open surgery<sup>[14,18-20]</sup>. However, LADG with systemic lymphadenectomy is considered technically more complicated than other laparoscopic procedures (e.g., cholecystectomy, Nissen fundoplication, colon resection, or splenectomy) because many great vessels must be identified and extensive lymph node dissection is necessary for radical gastrectomy.

The definition of the completion of learning is clearly arbitrary. To determine that learning has occurred, some have used the minimization of operative complications or the reaching of a steady mean operative time as measures. According to the learning curves of other laparoscopic procedures, surgeons who have performed more than 20 laparoscopic cholecystectomies<sup>[15]</sup> or 8 laparoscopic urologic procedures<sup>[17]</sup> have lower complication rates. As for colorectal surgery, approximately 11-15 completed laparoscopic colectomies were found to be needed to comfortably learn this procedure<sup>[21]</sup>. We hypothesized that the point at which learning has been achieved (as defined by the operative time plateau) would be associated with an improved postoperative outcome. However, though a significant improvement in operative time was noted after the first 50

cases, this did not correspond with a significant reduction in other postoperative outcomes, including transfusion requirements, conversion rates to open surgery, postoperative complications, time to first flatus, or postoperative hospital stay. This finding may be attributed to, firstly, regardless of operative time, transfusion requirement or conversion to open surgery which was rare, and postoperative complications occurred evenly in each of the nine groups. Second, time to first flatus was not proportioned to operative time. The mean time to first flatus in the present study was 3.1 d, although flatus has been reported to return at a mean 2.5 d after laparoscopic gastrectomy and 3.5 d after conventional open gastrectomy<sup>[22,23]</sup>. However, the previous result of 2.6 d may have been caused by less extensive lymphadenectomy (D1+ $\alpha$ ).

Although Kitano *et al.*<sup>[11]</sup> reported that the mean operative time of 116 cases for LADG with D1+ $\alpha$  lymphadenectomy (perigastric and no. 7 lymph nodes dissection) was 234 min, Noshiro *et al.*<sup>[13]</sup> found a mean operative time for 79 cases of LADG with D1+ $\beta$  lymphadenectomy of over 300 min. In another study of 43 LADGs was performed for 2 years, the mean operative time was 225 min despite LADG with D1+ $\beta$  lymphadenectomy<sup>[24]</sup>. We performed 90 LADGs with D1+ $\beta$  lymphadenectomy for 20 mo, and mean operative time of the present study was 227.2 min. We believe that the operative time required for LADG in gastric cancer is related to the extent of the lymphadenectomy, constant LADG practice, the experience of open radical gastrectomy, information and familiarity with the laparoscopic system and instruments, and the skill of the operative team.

In conclusion, based on operative time analysis, our study shows that experience of 50 cases of LADG with systemic lymphadenectomy for early gastric cancer is required to achieve optimum proficiency.

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