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A practical way to overcome the learning period of laparoscopic gastrectomy for gastric cancer

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Abstract
Background Although laparoscopic gastrectomy is widely performed in patients with gastric cancer, it requires a learning period for surgeons. Few methods are known to reduce or overcome this learning period. We tested a method to reduce or overcome this learning period in the beginner surgeon.
Methods Between April 2009 and March 2010, a total of 139 patients underwent laparoscopic gastrectomy by a beginner surgeon. During their training period of 6 months, the beginner had been the first assistant during 200 laparoscopic gastrectomies. To evaluate surgical outcomes as the surgeon started to perform laparoscopic gastrectomy, outcomes were assessed in 79 patients who underwent laparoscopic-assisted distal gastrectomy with extracorporeal gastroduodenostomy (LADG); the first 30 were performed by the surgeon and 49 were performed subsequently. Outcomes of LADG and totally laparoscopic distal gastrectomy with intracorporeal gastroduodenostomy (TLDG) were compared to evaluate the beginner's ability to adapt to intracorporeal reconstruction. The learning period was assessed by dividing patients who underwent LADG and TLDG into sequential groups of five each by time.
Results No patient was converted to open surgery and none died. There were no significant differences between the first 30 patients and the next 49 who underwent LADG in surgical outcomes. The only significantly different outcome between LADG and TLDG was in operation time (95.9 min vs. 115.6 min, $P < 0.001$). There were no significant differences in mean operation times of sequential groups (LADG, $P = 0.069$; TLDG, $P = 0.212$).
Conclusions The beginning surgeon examined in this work obtained satisfactory surgical outcomes during the early period of performing laparoscopic gastrectomy. We speculate that participation in laparoscopic gastrectomy team of experts improved the beginner's surgical outcomes, suggesting that such participation may reduce or overcome the learning period of beginners.

Keywords Laparoscopic gastrectomy · Learning period

Laparoscopic gastrectomy has been shown to be feasible and safe in patients with early gastric cancer and is frequently performed in Korea due to advances in surgical techniques and equipment [1–9]. We recently reported that totally laparoscopic gastrectomy using intracorporeal reconstruction is superior to laparoscopic-assisted gastrectomy using extracorporeal reconstruction, resulting in improved outcomes, such as better cosmetic effect, earlier bowel movement, less pain, and shorter hospital stay [10].

Optimal results of laparoscopic gastrectomy require proper surgical technique. Surgeons need to learn these new methods, with approximately 30–90 such operations required for optimal results [11–14]. In actual clinical practice, however, beginners have difficulty performing 30–90 such operations in a short time.

Methods of reducing or overcoming the period required to learn surgical techniques of laparoscopic gastrectomy

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for gastric cancer have not been assessed. We sought to develop a practical method to reduce or overcome this learning period in beginners. Specifically, we examined whether previous participation in laparoscopic gastrectomy as a first assistant under the guidance of experienced surgeons improved the outcomes of a beginner surgeon.

Materials and methods

Patients

Between April 2009 and March 2010, 139 consecutive patients who underwent laparoscopic gastrectomy performed by the same beginner surgeon for gastric cancer were enrolled in this study. Beginner surgeon had experienced 80 cases of open gastrectomy, including 31 total gastrectomy, 24 distal gastrectomy with gastroduodenostomy, 20 distal gastrectomy with Roux-en-Y gastrojejunostomy, and others, before performing laparoscopic gastrectomy as an operator. We retrospectively reviewed prospectively collected data of patients diagnosed preoperatively with early gastric cancer. Lymph node dissections were performed more than D1 + β lymphadenectomy in all patients. Of the 139 patients, 79 underwent laparoscopic-assisted distal gastrectomy with gastroduodenostomy (LADG), 31 underwent totally laparoscopic distal gastrectomy with delta-shaped anastomosis (TLDG), 15 underwent TLDG with Rou-en-Y gastrojejunostomy (TLDG RYGJ), 11 underwent laparoscopic-assisted total gastrectomy (LATG), and 3 underwent LADG RYGJ.

Surgical techniques

Each patient was placed in the reverse Trendelenburg position. After creating carbon dioxide pneumoperitoneum, five trocars were placed in a U-shape.

Dissection was begun by dividing the greater omentum, from the midportion of the gastroepiploic arcade to the left gastroepiploic vessel. The lymph nodes around the left gastroepiploic vessels were dissected, depending on the location of the primary tumor. After dissecting the lymph nodes around the right gastroepiploic area, the infrapyloric area was dissected. In some patients with enlarged lymph nodes, dissection was advanced to the superior mesenteric vein to include enlarged 14 lymph nodes. Lymph nodes around the suprapyloric area, hepatoduodenal ligament (along the hepatic artery), common hepatic, proximal or distal splenic, celiac, and left gastric arteries, and right paracardial and lesser curvature areas were dissected in that order.

After clearing the lymph nodes, laparoscopic-assisted gastrectomy was initiated by making a 4- to 5-cm midline incision from the epigastric trocar site. Gastroduodenostomy and gastrojejunostomy were reconstructed extracorporeally using a circular stapler (PROXIMATE®ILS; DST Series™ EEA™), and the jejunojejunostomy was reconstructed by extracorporeal end-to-side handsewn anastomosis.

For totally laparoscopic gastrectomy, a duodenal stump was made after clearing five lymph nodes and mobilization of the duodenum. The duodenum was transected just below the duodenal bulb by using an endoscopic linear stapler (ENDOPATH®ETS60). After clearing all lymph nodes, the remnant stomach was transected by the endoscopic linear stapler, and the specimen was removed through the umbilical port by extending the incision in an I-shape. After remaking the pneumoperitoneum, intracorporeal reconstruction was performed using endoscopic linear staplers for gastroduodenostomy (ENDOPATH®ETS45), gastrojejunostomy (ENDOPATH®ETS60), and jejunojejunostomy (ENDOPATH®ETS45).

Laparoscopic gastrectomy training course for beginners

The courses for beginners are as followings. The beginning surgeon described had participated in laparoscopic gastrectomy as a first assistant for 6–9 months. During this period, the surgeon participated in approximately 200 laparoscopic gastrectomy procedures, including 100 totally laparoscopic gastrectomy procedures, performed by experienced surgeons. Subsequently, the beginner had the opportunity to perform some laparoscopic procedures, and, later, reconstructions, under the guidance of expert surgeons. Beginner surgeons could learn how to make effective operation field and handle devices, such as harmonic scalpel, grasper, laparoscopic suturing device, and endoscopic linear stapler.

Clinical analysis of surgical outcomes of laparoscopic gastrectomy

Clinical data obtained from medical records included patient age, gender, body mass index (BMI), and American Society of Anesthesiologist (ASA) score. Early surgical outcomes included operation time, overall postoperative complications, estimated blood loss, time to first flatus, day of commencement of soft diet, number of analgesics administered, and postoperative hospital stay. Pathologic results analyzed included tumor size, number of retrieved lymph nodes, resection margins, and American Joint Committee on Cancer (AJCC)/International Union for Cancer Control (UICC) staging 6th edition. To evaluate learning by the beginner surgeon, patients who underwent LADG and TLDG were divided into sequential groups of five patients each by time.

A postoperative complication was defined as any that required conservative or surgical treatment. Severe postoperative complications were defined as those that required management by an endoscopic or interventional procedure or a reoperation without general anesthesia [15]. Intraoperative blood loss was estimated by the attending anesthesiologist, based on the number of surgical sponges used, the amount of fluid in the suction device, and the amount of irrigation fluid used during the operation.

Postoperative pain control consisted of intravenous, patient-controlled analgesia (IV PCA: fentanyl 2500 μg, ketorolac tromethamine 180 mg, ondansetron HCl 16 mg). The amount of postoperative pain was estimated by the number of additional doses of analgesics until discharge from the hospital.

The day of commencement of soft diet was the day on which a patient felt comfortable enough to eat soft foods. Patients were discharged if they had no problems eating a soft diet, showed an absence of inflammatory conditions, including leukocytosis, unstable vital signs, and abrupt onset abdominal pain, and were generally comfortable. The final decision about discharge was made by each patient.

Statistical analysis

Statistical analysis was performed using SPSS® version 17.0 for Windows (SPSS, Inc, Chicago, IL). All values are expressed as means ± standard deviations (SD). Categorical variables were analyzed by the chi-square test and Fisher's exact test, and continuous variables were analyzed by Student's *t* test. A P value <0.05 was considered to be statistically significant.

Results

Patient characteristics

The clinical characteristics of the 139 patients are presented in Table 1. There were no significant differences between the first 30 patients and the following 49 who underwent LADG. A comparison of patients who underwent LADG and TLDG showed significant differences in gender and ASA distribution.

Early surgical outcomes

Table 2 shows early surgical outcomes in patients who underwent LADG and TLDG. None of these patients required conversion to open surgery and none died. A subanalysis of patients who underwent LADG showed that the mean operation time was significantly longer in the first 30 patients than in the next 49 (104.3 vs. 88.6 min, $P < 0.001$) but no significant difference in postoperative complication rate ($P = 1.000$), estimated blood loss ($P = 0.346$), time to first flatus ($P = 0.495$), day of commencement of soft diet ($P = 0.234$), number of analgesics administered ($P = 0.23$), or postoperative hospital stay

Table 1 Clinical characteristics of patients who underwent laparoscopic gastrectomy

Variables	Total ($n = 139$)	LADG ($n = 79$)		P value	LADG ($n = 79$)	TLDG ($n = 31$)	P value
		Initial 30	After 30				
Age (years)				0.179			0.09
Mean (±SD)	56 (± 12)	57.6 (±10.5)	54.1 (±11.4)		55.4 (±11.1)	59.5 (±11.7)	
Median (range)	56 (25–82)	60 (30–76)	52 (26–78)		55 (26–78)	59 (35–82)	
Gender (M:F)	83:56	16:14	26:23	0.981	42:37	23:8	0.044
Body mass index (kg/m^2, ±SD)				0.372			0.138
Mean (±SD)	23.3 (±2.5)	23.3 (±1.6)	22.9 (±1.8)		23.0 (±1.7)	24.0 (±3.4)	
Median (range)	23.2 (18.1–33.4)	23.2 (19.4–26.4)	23.1 (18.2–26.2)		23.1 (18.2–26.4)	24 (18.1–33.4)	
ASA score				0.346			0.005
1	93 (66.9%)	21 (70.0%)	35 (71.4%)		56 (70.9%)	17 (54.8%)	
2	33 (23.7%)	9 (30%)	12 (24.5%)		21 (26.6%)	7 (22.6%)	
3	13 (9.4%)	0 (0%)	2 (4.1%)		2 (2.5%)	7 (22.6%)	
Methods of laparoscopic gastrectomy							
LADG	79						
LADG RYGJ	3						
LATG	11						
TLDG	31						
TLDG RYGJ	15						

Table 2 Early surgical outcomes of patients who underwent LADG and TLDG

Variables	LADG ($n = 79$)		P value	LADG ($n = 79$)	TLDG ($n = 31$)	P value
	Initial 30	After 30				
Conversion case to open surgery	0	0		0	0	
Operation time, mean (±SD)	107.9 (±10.5)	88.6 (±14.5)	<0.001	95.9 (±18.5)	115.6 (±20.3)	<0.001
Overall postoperative complications (no. of patients, %)	1 (3.3%)	1 (2.0%)	1.000	2 (2.5%)	1 (3.2%)	1.000
Postoperative mortality	0	0		0	0	
Estimated blood loss (ml, ±SD)	129.3 (±97.5)	107.5 (±100)	0.346	118.3 (±110.8)	152.2 (±85.4)	0.128
Time to first flatus (days ± SD)	3.2 (±0.7)	3.3 (±0.9)	0.495	3.3 (±0.8)	3.0 (±0.7)	0.284
Time to commencement of soft diet (days ± SD)	4 (±1.3)	3.7 (±0.7)	0.234	3.8 (±1)	3.7 (±0.7)	0.104
Number of administration of analgesics (mean ± SD)	2.9 (±2.8)	3.8 (±4.3)	0.23	3.5 (±3.8)	2.7 (±2.1)	0.301
Postoperative hospital stay (days ± SD)	6.9 (±1.5)	6.4 (±0.8)	0.093	6.6 (±1.1)	6.6 (±1)	0.917

($P = 0.093$). A comparison of patients who underwent LADG and TLDG showed that the mean operation time was significantly shorter in the former (94.6 vs. 115.6 min, $P < 0.001$), but there was no significant difference in postoperative complications ($P = 1.000$), estimated blood loss ($P = 0.128$), time to first flatus ($P = 0.284$), time to commencement of soft diet ($P = 0.104$), number of analgesics administered ($P = 0.301$), or postoperative hospital stay ($P = 0.917$).

Table 3 shows the postoperative complications that occurred in patients who underwent laparoscopic gastrectomy. Postoperative complications occurred in six patients, including three with wound complications, two with extraluminal bleeding, and one with an anastomotic leakage. The Accordion Severity Classification of Postoperative Complications found that only one patient, who underwent LATG, had a severe postoperative complication, namely bleeding from the splenic artery. This bleeding was treated by laparoscopic ligation using a liga clip (LIGACLIP®). The other patient with extraluminal bleeding was treated by conservative management only, consisting of transfusion of 4 pints (250 ml/pint) of blood. All wound complications were treated conservatively. One patient was diagnosed 7 days postoperatively by an upper gastrointestinal series with a minor anastomotic leakage of esophagojejunostomy and was treated by conservative management. An upper gastrointestinal series showed that the leakage disappeared 14 days postoperatively.

Table 4 presents pathology results in patients who underwent laparoscopic gastrectomy. Subgroup analyses showed no significant differences in tumor size, retrieved lymph nodes, resection margin, distribution of tumor depth, and lymph node metastasis.

Learning curve

Table 5 and Fig. 1 present mean operation times in sequential groups of five patients who underwent LADG and TLDG. There were no statistically significant differences among these groups in mean operation time.

Discussion

Gastric cancer is one of the most common malignancies in Korea, and laparoscopic gastrectomy is more widely accepted for treating early gastric cancer. Laparoscopic (assisted) gastrectomy is less invasive than open

Table 3 Details of morbidities and mortality in laparoscopic gastrectomy

Variables	LADG ($n = 79$)	LADG RYGJ ($n = 3$)	LATG ($n = 11$)	TLDG ($n = 31$)	TLDG RYGJ ($n = 15$)
Conversion to open surgery	0	0	0	0	0
Postoperative mortality	0	0	0	0	0
Overall postoperative complications	2	0	3	1	0
Wound complications	2	0	1	0	0
Anastomosis leakage	0	0	1	0	0
Extraluminal bleeding	0	0	1	1	0

Table 4 Pathologic results of patients who underwent LADG and TLDG

Variables	Total ($n = 139$)	LADG ($n = 79$)		P value	LADG ($n = 79$)	TLDG ($n = 31$)	P value
		Initial 30	After 30				
Tumor size (cm, ±SD)	3.1 (±1.7)	2.4 (±1.2)	2.7 (±1.2)	0.348	2.6 (±1.2)	3.2 (±1.6)	0.052
Retrieved lymph nodes (mean, ±SD)	34.6 (±14.8)	31.1 (±13.9)	36.2 (±13.1)	0.11	34.2 (±13.5)	32.4 (±13.2)	0.528
No. of retrieved lymph nodes							
<15	3 (2.2%)	1 (3.3%)	2 (4.1%)		3 (3.8%)	0 (0%)	
≥15	136 (97.8%)	29 (96.7%)	49 (95.9%)		76 (96.2%)	31 (100%)	
Proximal resection margin (mean, ±SD)	3.9 (±2.3)	4.2 (±2.8)	3.7 (±1.8)	0.397	3.9 (±2.2)	3.6 (±1.7)	0.516
Distal resection margin (mean, ±SD)	6.6 (±4)	5.8 (±4)	5.9 (±3.1)	0.883	5.9 (±3.5)	5.3 (±2.5)	0.382
Tumor depth				0.882			0.434
Mucosa	80 (57.6%)	18 (60.0%)	29 (59.2%)		47 (59.5%)	20 (64.5%)	
Submucosa	51 (36.7%)	11 (36.7%)	17 (34.7%)		28 (35.4%)	11 (35.5%)	
Proper muscle	4 (2.9%)	1 (3.3%)	2 (4.1%)		3 (3.8%)	0 (0%)	
Subserosa	4 (2.9%)	0 (0%)	1 (2.0%)		1 (1.3%)	0 (0%)	
Lymph node status				0.392			0.141
N0	124 (89.2%)	29 (96.7%)	45 (91.8%)		74 (93.7%)	26 (83.9%)	
N1	12 (8.6%)	1 (3.3%)	4 (8.2%)		5 (6.3%)	5 (16.1%)	
N2	1 (0.7%)						
N3	2 (1.4%)						

gastrectomy and has been found to be as safe as the open approach [2–9]. It has been suggested that surgeons who are beginning to perform this type of surgery should have experience in performing laparoscopic gastrectomy in 30–90 patients to master the techniques required [11–14]. In most hospitals, except high-volume centers, it is very difficult for beginners to have much experience of laparoscopic gastrectomy as a first assistant during their training period. In practice, beginners spend too much time and effort learning to perform laparoscopic gastrectomy after the training period. The alternative training method that we describe, whereby a surgeon only begins to perform this procedure after acting as first assistant to an expert surgeon in many operations, serves to reduce or eliminate the learning period.

Our results suggest that surgical outcomes may be improved during the early period of beginner training [2–9, 11–14]. Whereas most investigators were self-trained in laparoscopic gastrectomy by trial and error, beginners may learn many improved procedures from expert experience. Participation in a laparoscopic gastrectomy team of experts provides a beginner the chance to learn from experts.

Beginners gain various advantages by acting as assistants. First, beginners gain knowledge of laparoscopic anatomy. In addition, beginners have the opportunity to learn practical techniques from experts, including handling instruments, making operation fields, dissecting lymph nodes, and reconstructing anastomoses. Furthermore, beginners learn how to control situations through preoperative preparation and gain knowledge regarding the composition of a gastrectomy team and assignment of roles.

The beginner surgeon examined in the present study showed consistently good surgical outcomes from the outset, indicating that the surgeon did not require a learning period. The excellent outcomes of this surgeon during the beginning period, which are superior to those of beginner surgeons in previous reports [11–14], can be attributed to the surgeon's prior experience as first assistant to an expert surgeon. Table 5 shows that the beginner surgeon examined showed no evidence of a learning curve in terms of the mean operation time in sequential cases. In particular, the beginner adapted well to performing totally laparoscopic gastrectomy using intracorporeal reconstruction, better than with LADG. Even more surprisingly, the operation time required by the beginner during the beginning period was dramatically lower than the time typically required by beginners [11–14].

Outcome-related variables, including conversion to open surgery and the occurrence of severe complications, were very useful in monitoring performance [11, 16, 17]. None of the patients in the present work underwent conversion from laparoscopic gastrectomy to open surgery, and only one patient experienced severe postoperative complications. This complication, which was present in the recovery room, resulted in the bleeder being ligated with

Table 5 Operation times of each set of five patients with LADG and TLDG

Variables	LADG ($n = 79$) Operation time (mean, ±SD)	P value	TLDG ($n = 31$) Operation time (mean, ±SD)	P value
Sets of five patients over time		0.069		0.212
1–5	98 (±11.5)		124 (±24)	
6–10	107 (±13)		118.0 (±14.8)	
11–15	102 (±24.9)		128 (±21.6)	
16–20	99 (±16.7)		101 (±12.4)	
21–25	104 (±13.4)		104 (±18.1)	
26–30 (TLDG, 26–31)	116 (±16.7)		118.3 (±22.2)	
31–35	96 (±19.4)			
36–40	88 (±8.3)			
41–45	81.8 (±18.1)			
46–50	86 (±18.1)			
51–55	88 (±19.2)			
56–60	92 (±16.4)			
61–65	84 (±15.1)			
66–70	94 (±13.4)			
71–75	90 (±12.2)			
76–79	86.2 (±4.7)			

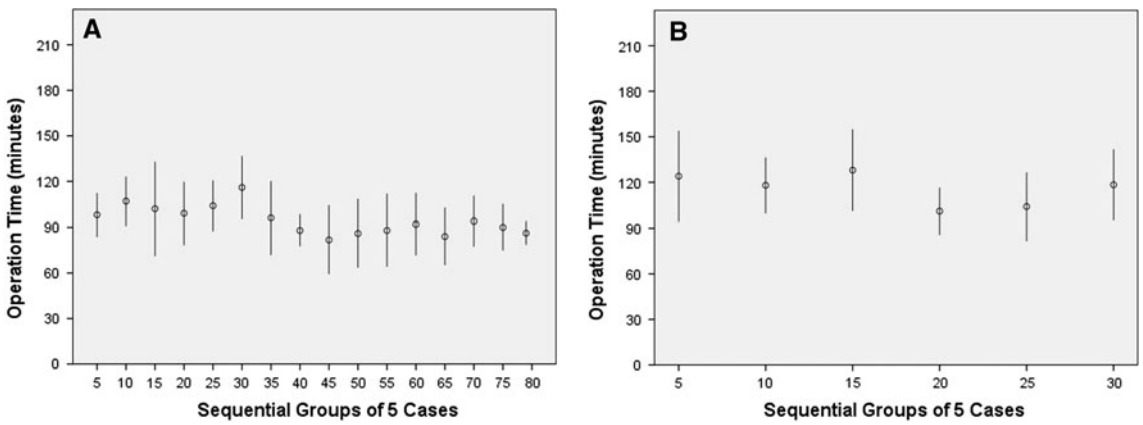

Fig. 1 Mean duration of surgery in sets of five patients who underwent **A** laparoscopic-assisted distal gastrectomy with gastroduodenostomy (LADG) and **B** totally laparoscopic distal gastrectomy with delta-shaped anastomosis (TLDG)

laparoscopic clips through previous trocar sites without laparotomy. The low complication rate and laparoscopic techniques for the management of complication suggest that the learning period for laparoscopic gastrectomy can be reduced or overcome.

Our study had several limitations, including its retrospective nature. If our study is targeted for surgical outcomes of several beginners, we could get the better results of our training method to reduce or overcome the learning period. However, there were limits, including different times of training periods by expert surgeons and different volume among beginner surgeons. Especially, in our high-volume center, beginner surgeons recently have a chance to perform many laparoscopic gastrectomy as an operator. Therefore, future studies will focus on the surgical outcomes of many beginner surgeons. Although our study has a limitation to evaluate surgical outcomes, the present findings regarding the experience of a single beginner surgeon strongly support the notion that participation in a laparoscopic gastrectomy team of experts could reduce or overcome learning period of the beginner surgeon.

In conclusion, although practical procedures have been suggested to improve the surgical outcomes of laparoscopic gastrectomy, it is very difficult for self-trained

beginners to master these procedures. Our training method may enable surgeons to learn new methods and enhance patient outcomes.

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