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Original Article

Laparoscopic Gastrectomy Performed by an Expert in Open Gastrectomy

Kyong-Choun Chi, Joong-Min Park

Department of Surgery, Chung-Ang University College of Medicine, Seoul, Korea

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Correspondence to
Joong-Min Park
Department of Surgery, Chung-Ang University College of Medicine, 102 Heukseok-ro Dongjak-gu, Seoul 06973, Korea.
Tel: +82-2-6299-3124
Fax: +82-2-6299-2064
E-mail: jmpark@cau.ac.kr

ORCID iDs
Kyong-Choun Chi
https://orcid.org/0000-0001-8703-5377
Joong-Min Park
https://orcid.org/0000-0002-8582-6391

Author Contributions
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Conflict of Interest
No potential conflict of interest relevant to this article was reported.

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ABSTRACT

Purpose: Senior surgeons prefer open gastrectomy (OG), while young surgeons prefer laparoscopic gastrectomy (LG). The purpose of this study was to evaluate the surgical outcomes of LG performed by a senior surgeon who was an expert in OG during his learning period, by comparing them with LGs performed by a young surgeon.
Materials and Methods: A senior surgeon performed 50 curative gastrectomies with laparoscopy (LG-S group) from March 2015 to August 2016. A young surgeon's initial 50 LGs comprised the LG-Y group. Clinicopathological characteristics and surgical outcomes were compared between the LG-S and LG-Y groups.
Results: D2 lymphadenectomy was more frequently performed in the LG-S group than in the LG-Y group (P=0.029). The operation time and number of retrieved lymph nodes did not significantly differ between the 2 surgeons (P=0.258 and P=0.410, respectively). Postoperative hospital stay and postoperative complication rate were similar between 2 groups (P=0.234 and P=1.000, respectively). Similarly, significant decreases in operation time with increasing case numbers were observed for both surgeons, whereas the number of retrieved lymph nodes increased significantly in the LG-Y group but not in the LG-S group.
Conclusions: The LG outcomes when performed by the senior surgeon were comparable to those when performed by the young surgeon, despite performing more extended lymphadenectomies. Senior surgeons who are experts in OG should not refrain from performing LG.

Keywords: Gastrectomy; Laparoscopy; Learning curve; Stomach neoplasms

INTRODUCTION

Laparoscopic gastrectomy (LG) has now gained worldwide acceptance as a treatment for early gastric cancer. A large number of non-randomized trials, randomized trials, and meta-analyses have confirmed that LG is safe and feasible, with advantages such as less pain, early recovery, and comparable oncological outcomes with open gastrectomy (OG) [1-5].

However, LG has been considered a more complicated procedure than other laparoscopic procedures such as cholecystectomy or colectomy because LG requires the identification and ligation of several main vessels and includes resection of the intestine, lymph node

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dissection (LND), and bowel reconstruction. Therefore, its learning curve is known to be longer than that for other laparoscopic procedures [6]. In addition, whereas the surgical trends for cholecystectomy and colectomy have totally changed in favor of laparoscopic surgery, OG still plays a role in the treatment of gastric cancer, especially advanced gastric cancer. Thus, some gastric surgeons are still reluctant to perform LG, and senior surgeons tend to prefer performing OG, while young surgeons prefer performing LG. Although there are no definite reasons for this tendency, it is possible that senior surgeons have been performing only OG throughout their career and may be reluctant to introduce a new surgical procedure due to their total lack of experience. By contrast, young surgeons may be more familiar with emergent techniques such as laparoscopic surgery owing to experiences during resident training and have a higher desire to perform novel surgical procedures.

The purpose of this study was to evaluate the technical feasibility and short-term surgical outcomes of LG performed by a senior gastric surgeon who was an expert in OG but who had no previous experience with laparoscopic surgery. We compared the outcomes during his learning period with those of the initial LGs performed a young surgeon who had little experience with OG before learning LG in order to verify the impact of expertise in OG on the outcomes of LG in the learning period. We also compared the LG outcomes with those of the OGs performed by the senior surgeon during the same period.

MATERIALS AND METHODS

Chung-Ang University Hospital has had 2 specialized surgeons for gastric cancer since 2008. One is a senior surgeon (Chi KC) and the other is a young surgeon (Park JM). From 2008 to 2014, the senior surgeon performed OG, whereas the young surgeon performed LG. Patients with gastric cancer were assigned to a surgeon according to the preoperative stage and indication for minimal invasive surgery. The senior surgeon decided to perform LG because of a temporary absence of the young surgeon who had been performing the LG procedures. Before beginning LG, the senior surgeon had extensive experience in OG for gastric cancer but only limited laparoscopic training during residency. He was unfamiliar with most types of laparoscopic surgery except for laparoscopic cholecystectomy. To prepare for laparoscopic surgery, he reviewed a surgical video and had a discussion with the young surgeon. He practiced the laparoscopic procedure using an animal training model and participated more than 10 times as an assistant surgeon in LG procedures performed by the young surgeon.

The choice of surgical procedure (LG or OG) was based strictly on the clinical stage as determined by gastroscopy and computed tomography scan of the abdomen. The indication for LG was clinical stage I gastric cancer (cT1 N0, cT1 N1, and cT2 N0), which differed from the indication for endoscopic resection (<2-cm differentiated mucosal cancer without ulcer). Candidates for total gastrectomy were also included in the indications for laparoscopic surgery.

The senior surgeon (Chi KC) began performing LG in March 2015. Since his first LG procedure, 50 patients with gastric adenocarcinoma underwent LG performed by the senior surgeon from March 2015 to August 2016 (LG-S group). During the same period, 41 patients with gastric adenocarcinoma underwent OG performed by the senior surgeon (OG-S group).

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The young surgeon (Park JM) began performing LG early in his career in July 2006, and his initial 50 LGs from July 2006 to February 2011 comprised the LG-Y group. Prior to his experience with LG, he had little experience with OG and limited laparoscopic training (cholecystectomy only) during his residency. He learned the technique of LG through active participation in numerous video conferences, workshops, and animal laboratories. He also practiced the basic skill by performing laparoscopic appendectomies. He performed the first LG ever in the hospital without an experienced supervisor.

The LG technique used by the 2 surgeons in this study was basically the same, including the identical operative device and trocar positions. However, because of the different time periods during which the surgeries were performed, procedural details such as the extent of LND and anastomosis method differed between the 2 surgeons.

Clinicopathological characteristics and short-term surgical outcomes were compared between the LG-S and LG-Y groups. We also compared them between the LG-S and OG-S groups. Surgical outcomes included operation time; extent of gastrectomy, laparotomy, and lymphadenectomy; use of surgical drain; postoperative hospital stay; and postoperative complication and mortality. Postoperative complications were classified in accordance with the Clavien-Dindo classification [7].

To determine the learning curve for LG, the operation time and the number of retrieved lymph nodes were plotted in chronological order according to when the respective surgeons performed LG in each patient. Exponential regression analysis was used to evaluate the significance of the differences in operation time and the number of retrieved lymph nodes according to the consecutive case number. Operation time was defined as the time from umbilical incision for a trocar to the time of closure of all abdominal wounds.

The χ^2 test was used to compare categorical variables between the groups. Independent t-test was used to compare non-categorical variables. A P-value <0.05 was defined as statistically significant. Statistical analyses were conducted using the Statistical Package for Social Science version 19.0 (IBM Corp., Armonk, NY, USA).

RESULTS

Comparison between LG-S and LG-Y groups

The details of patient demographics and surgical outcomes are summarized in **Table 1**. The male-to-female ratio and age were not different between the groups. The extent of gastrectomy (total gastrectomy rate) was similar between the groups, whereas the extent of LND (D2 dissection rate) was different. D2 lymphadenectomy was more frequently performed in the LG-S group (23/50) than in the LG-Y group (10/50; P=0.029), though the number of retrieved lymph nodes was similar in the 2 groups (P=0.410). Forty-three patients in the LG-S group underwent totally laparoscopic surgery, whereas all 50 patients in the LG-Y group underwent extracorporeal reconstruction with mini laparotomy. Surgical drain was used more frequently in the LG-Y group (49/50) than in the LG-S group (23/50; P<0.001). Pathological stage did not significantly differ between the 2 groups (P=0.331). No significant difference in operation time was found between the LG-S and LG-Y groups (P=0.258). Hospital stay after surgery in the LG-S group was similar to that in the LG-Y group (P=0.234).

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Table 1. Clinicopathological characteristics and surgical outcomes of initial LG by the senior surgeon and the young surgeon

Characteristics	LG-S (n=50)	LG-Y (n=50)	P-value
Age (yr)	60.8±13.5	58.9±9.6	0.434
Sex			0.826
Male	35	36	
Female	15	14	
Extent of gastrectomy			0.538
Total	7	5	
Distal	43	45	
Extent of lymphadenectomy			0.029
D1/D1+	30	40	
D2	20	10	
Operation time (min)	260.0±79.7	244.2±58.8	0.258
Extent of laparotomy			<0.001
Mini open	7	50	
Totally laparoscopic	43	0	
Conversion to open	0	0	1.000
Drain			<0.001
Yes	23	49	
No	27	1	
No. of retrieved lymph nodes	31.4±13.6	29.0±14.9	0.410
Pathologic stage			0.331
I	47	46	
II	3	2	
III	0	2	
Hospital stay (day)	9.6±3.2	11.0±7.6	0.234
Postoperative complication	7 (14.0)	6 (12.0)	0.766
CD classification ≥3	2 (4.0)	2 (4.0)	1.000
Mortality	0	0	1.000

Data are shown as mean ± standard deviation or number (%).
LG = laparoscopic gastrectomy; LG-S = laparoscopic gastrectomy by the senior surgeon; LG-Y = laparoscopic gastrectomy by the young surgeon; CD = Clavien-Dindo.

Of the 100 patients who underwent LG, none had conversion to OG, 13 (13.0%) had complications, and 4 (4.0%) had major complications (Clavien-Dindo classification >III). There was no postoperative death. Postoperative complications and mortality did not differ significantly between the 2 groups (P=1.000 and P=1.000, respectively; **Table 2**).

Difference in learning curves of senior surgeon and young surgeon

To determine the learning curve of the LG procedure, differences in operation time and number of retrieved lymph nodes according to consecutive case numbers were evaluated using an exponential regression analysis model. The significant decreases in operation time with increasing case number were comparable between the senior surgeon (r^2=0.213, P=0.001) and the young surgeon (r^2=0.148, P=0.006). The curves were similar between the LG-S and LG-Y groups (**Fig. 1**). The number of retrieved lymph nodes increased significantly with increasing case number in the LG-Y group (r^2=0.183, P=0.002), whereas there was no significant increase in the number of retrieved lymph nodes in the LG-S group (r^2=0.052, P=0.111; **Fig. 2**).

Comparison between LG-S and OG-S groups

The senior surgeon performed 41 OGs during the time period in which he performed 50 LGs. The male-to-female ratio was not different between 2 groups. The patients who underwent LG were younger than those who underwent OG (P=0.003). The extent of gastrectomy (total gastrectomy rate) was similar between the groups, whereas D2 lymphadenectomy was more frequently performed in the OG-S group (38/41) than in the LG-S group (23/50; P<0.001).

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Table 2. List of complications in the 141 patients with gastric cancer

Characteristics	LG-S (n=50)	OG-S (n=41)	LG-Y (n=50)
Major complications	2 (4.0)	5 (12.2)	2 (4.0)
Anastomosis leak (esophagojejunostomy)	1	0	0
Fluid collection drainage	1	1	0
Gastroduodenostomy necrosis	0	1	0
Anastomosis stricture	0	1	0
Gastric mucosal bleeding	0	1	0
Gastric ulcer perforation and intraabdominal bleeding	0	1 (mortality)	0
Anastomosis bleeding (gastroduodenostomy)	0	0	2
Minor complications	5 (10.0)	8 (19.5)	4 (8.0)
Anastomosis narrowing	1	1	0
Anastomosis bleeding	0	0	1
Atelectasis	1	2	0
Pneumonia	0	1	0
Pleural effusion	1	1	0
Delayed gastric emptying	0	0	2
Symptomatic omental infarction	1	0	0
Gastroesophageal reflux disease	1	0	0
Delirium	1	3	1
Wound infection	0	1	0
Mortality	0	1	0

Data are shown as number (%). Major complications were defined as those classified as Clavien-Dindo grade III, IV, or V, whereas minor complications were those classified as Clavien-Dindo grade I or II. The total number of minor complications exceeded the sums of the individual complications because some patients had more than 1 complication.
LG-S = laparoscopic gastrectomy by the senior surgeon; OG-S = open gastrectomy by the senior surgeon; LG-Y = laparoscopic gastrectomy by the young surgeon.

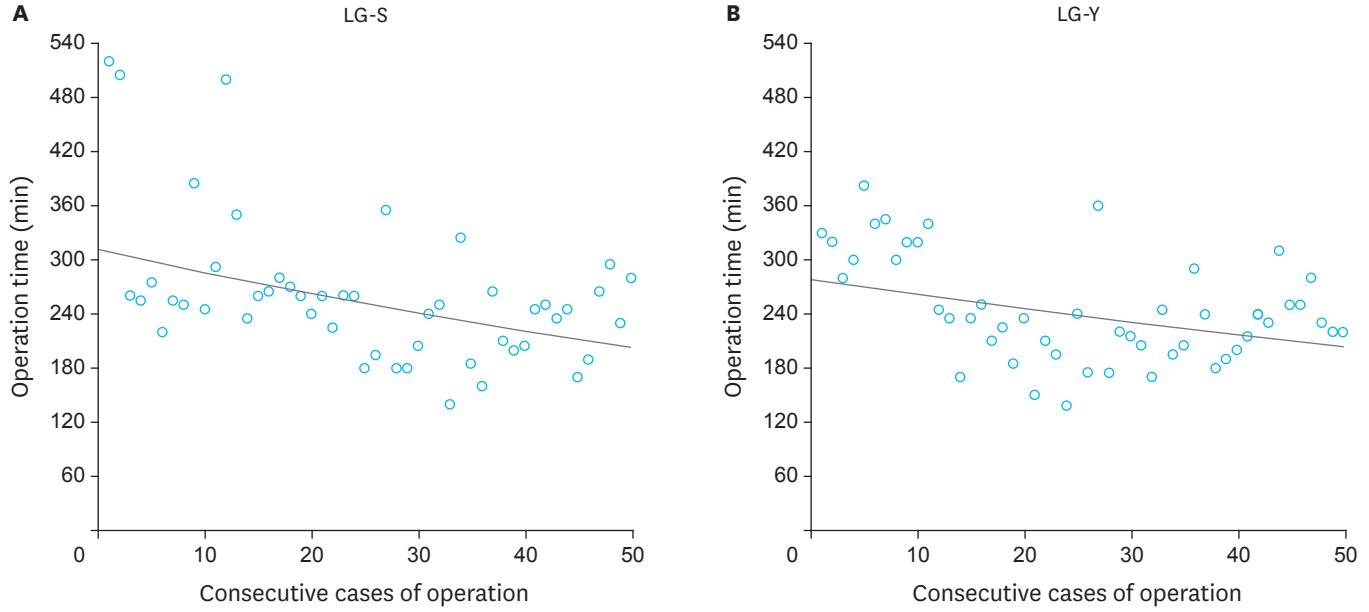

Fig. 1. Operation time is displayed as a scatter plot according to the consecutive case numbers of patients who underwent LG performed by the senior surgeon (A) and the young surgeon (B). Operation time decreased significantly with increasing case number for both the senior surgeon (r^2=0.213, P=0.001) and the young surgeon (r^2=0.148, P=0.006).
LG = laparoscopic gastrectomy; LG-S = laparoscopic gastrectomy by the senior surgeon; LG-Y = laparoscopic gastrectomy by the young surgeon.

The number of retrieved lymph nodes was in accordance with the D2 dissection rate, but it was not statistically significant (P=0.084). Pathological stage was more advanced in the OG-S group than in the LG-S group (P<0.001). Among the procedures performed by the senior surgeon, the operation times were longer for LG than for OG (P=0.046). Hospital stay after surgery in the LG-S group was shorter than that in the OG-S group (P=0.014).

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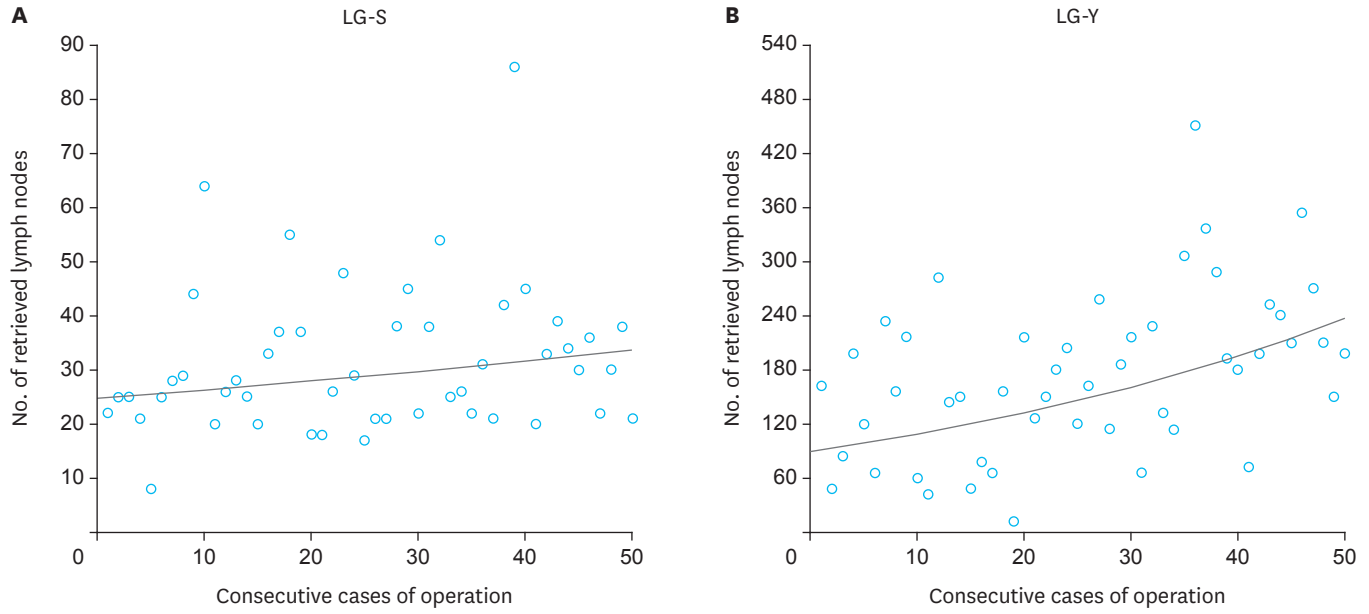

Fig. 2. The number of retrieved lymph nodes is displayed as a scatter plot according to the consecutive case numbers of patients who underwent LG performed by the senior surgeon (A) and the young surgeon (B). The number of retrieved lymph nodes increased significantly with increasing case number for the young surgeon (r^2=0.183, P=0.002), whereas there was no significant increase in the number of retrieved lymph nodes for the senior surgeon (r^2=0.052, P=0.111).
LG = laparoscopic gastrectomy; LG-S = laparoscopic gastrectomy by the senior surgeon; LG-Y = laparoscopic gastrectomy by the young surgeon.

Table 3. Clinicopathological characteristics and surgical outcomes of LG and OG performed by the senior surgeon in the same period

Characteristics	LG-S (n=50)	OG-S (n=41)	P-value
Age (yr)	60.8±13.5	68.4±10.1	0.003
Sex			0.386
Male	35	32	
Female	15	9	
Extent of gastrectomy			0.126
Total	7	11	
Distal	43	30	
Extent of lymphadenectomy			<0.001
D1/D1+	30	3	
D2	20	38	
Operation time (min)	260.0±79.7	232.0±44.6	0.046
Drain			0.467
Yes	23	22	
No	27	19	
No. of retrieved lymph nodes	31.4±13.6	36.9±16.8	0.084
Pathologic stage			<0.001
I	47	13	
II	3	14	
III	0	14	
Hospital stay (day)	9.6±3.2	11.8±5.1	0.014
Postoperative complication	7 (14.0)	13 (31.7)	0.042
CD classification ≥3	2 (4.0)	5 (12.2)	0.144
Mortality	0	1 (2.4)	0.267

Data are shown as mean ± standard deviation or number (%).
LG = laparoscopic gastrectomy; LG-S = laparoscopic gastrectomy by the senior surgeon; OG-S = open gastrectomy by the senior surgeon; CD = Clavien-Dindo.

While postoperative complications developed more frequently in OG than in LG (P=0.042), the incidences of major complications and mortality did not differ significantly among the groups, although there was one case of mortality in the OG-S group (P=0.144 and P=0.267, respectively; **Tables 2** and **3**).

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DISCUSSION

There is a trend in some hospitals for senior surgeons to typically perform OG for advanced gastric cancer, while the young surgeons perform LG for early gastric cancer. However, the role of laparoscopy in gastric cancer surgery has changed, and the indications for LG have expanded beyond those of its initial implementation to include more advanced gastric cancer [8,9]. Moreover, laparoscopy has a role in the palliative procedure for stage IV gastric cancer [10]. Thus, the laparoscopic technique is now valuable for all gastrointestinal surgeons, and laparoscopy is no longer exclusively performed by young surgeons.

Compared to senior surgeons, young surgeons are generally considered more skilled in laparoscopic procedures. Hence, better surgical outcomes are expected from young surgeons. However, contrary to our expectations, the surgical outcomes of LG performed by the senior surgeon in our study were not inferior to those of the initial LGs performed by the young surgeon. Moreover, the complication rate and recovery time from LG in the initial period were not significantly different between the two surgeons. In addition, the short-term surgical outcomes in both the LG-S and OG-S groups showed the common advantages of laparoscopic surgery, including shorter postoperative hospital stay and fewer postoperative complications, although the indications and disease stages were certainly different between LG and OG.

According to the previous experiences of many gastric surgeons, surgical safety was the primary goal at the beginning of their careers. Thus, at the beginning, many surgeons chose to perform LG for select patients with narrow stage-oriented indication (only cT1 N0), exclusion of total gastrectomy, and limited LND. However, in the present study, the senior surgeon selected candidates for LG on the basis of stage-oriented indication alone (clinical stages Ia and Ib) and performed adequate LND in accordance with the disease stage. In addition, the anastomosis method and use of drains were the same as those applied in the most current techniques, including intracorporeal anastomosis and no drain use.

To be distinct from the senior surgeon, the young surgeon has since advanced his surgical technique and patient management skills, including progressively more extended LND, intracorporeal anastomosis, and no use of drains. The senior surgeon learned and accepted the young surgeon's currently advanced LG technique. Hence, the senior surgeon performed intracorporeal anastomosis more frequently, used surgical drains less frequently, and performed more extended LND than did the young surgeon during his initial experience.

For both surgeons, the LG operation time significantly decreased according to the case number, and the rate of decrease in the operation time was similar between the senior surgeon and the young surgeon. The number of procedures required to master LG has been debated, and the amount of experience necessary to overcome the learning curve of a new procedure might vary based on the study variable, such as operation time or surgical outcomes. In terms of the operation time during the learning curve, optimal proficiency may be achieved with an experience of 40 to 60 LG cases according to previous studies [6,7,11]. However, the difference in the volume of patients in each hospital might be another cause of variability in the learning curve. Although the annual LG volume for both surgeons in this study was lower than that of large-volume hospitals, the learning curve plots were similar to those in previous reports. In several other studies, the operation time of LG increased after a

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plateau because the surgeon usually began performing more advanced procedures, enrolling unselected patients, and expanding the indications of LG as they became increasingly skilled in the laparoscopic technique [7,10,12]. However, no secondary increase in operation time was observed in the present study because the surgeon's surgical intentions, such as the extent of LND, anastomosis method, and surgical indication for LG, were unchanged during the study period.

The outcomes of the surgery performed by the senior surgeon may have been comparable to those of the young surgeon for the following reasons: First, expertise in OG might have enhanced the senior surgeon's skill in laparoscopic surgery even at the beginning. The young surgeon did not have much experience with gastric cancer surgery when he began performing LG; therefore, he tried to advance his surgical technique gradually from limited LND (D1) to extended LND (D2). In contrast, the senior surgeon was able to perform extended LND from the start, leading to an increased number of retrieved lymph nodes by case number in the LG-Y group, but not in the LG-S group. The initial learning period for the senior surgeon was focused only on LG, whereas that period for the young surgeon comprised the learning period for all kinds of gastrectomy, including LG and conventional OG. Extensive experience in OG prior to learning LG might have contributed to the stable performance of the senior surgeon in laparoscopic surgery. Second, the time gap between the LG learning period of the 2 surgeons was almost 10 years, with the senior surgeon performing LG most recently. Over the 10-year period, laparoscopic surgical skills have been well developed and popularized among surgeons, resulting in potentially superior surgical skills, a better environment for the research and learning of laparoscopic surgery, and the improved quality of the surgical residents acting as assistant surgeons in the most recent surgeries performed by the senior surgeon. Third, there was also a difference in the frequency of LG between the young surgeon and the senior surgeon. The senior surgeon performed 50 LGs over 17 months (2.94 cases/month), whereas the young surgeon performed the same number of LGs over 68 months (0.74 cases/month). Thus, the senior surgeon had the advantage of overcoming the learning curve more quickly owing to performing the surgery more frequently in comparison with the young surgeon.

In this study, the postoperative complication and mortality rates of LG (13.0% and 0%, respectively) were comparable to those reported in a large-scale Korean multicenter study (12.5% and 0.5%, respectively) [5]. Both surgeons in this study did not experience the need for open conversion of LG, whereas the previous reports demonstrated 1.5% to 5% conversion rates that typically occurred in the earlier period of the learning curve [6,10,13]. Although the number of cases was insufficient to confirm the lower conversion rate in this study, none of the patients underwent open conversion in the early period when the risk of open conversion is known to be high. Thus, the total conversion rates for the surgery performed by both surgeons in their careers so far might be lower than the average LG conversion rate.

In conclusion, the surgical outcomes of LG performed by the senior surgeon were better than those of OG, with a lower complication rate and shorter hospital stays. During the initial experience of performing LG, the senior surgeon's results were comparable to those of the younger surgeon, even though the senior surgeon performed more extended lymphadenectomies. Therefore, senior surgeons who have expertise in OG should not refrain from learning and performing LG.

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