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Comparison of the outcomes for laparoscopic gastrectomy performed by the same surgeon between a low-volume hospital and a high-volume center

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Abstract
Background The volume–outcome relationship in laparoscopic surgery is controversial. This study was designed to identify differences in laparoscopic gastrectomy outcomes between a low-volume hospital and a high-volume center and to provide guidelines for overcoming the problems associated with a low-volume hospital.
Methods From April 2009 to November 2012, one surgeon performed 134 totally laparoscopic distal gastrectomies (TLDGs) at a high-volume center (HVC; ASAN Medical Center) and at a low-volume hospital (LVH; Hanyang University Guri Hospital). All laparoscopically assisted gastrectomies were excluded from this study. During the early period of laparoscopic gastrectomy at the low-volume hospital, TLDG with Roux-en-Y gastrojejunostomy (RYGJ) was performed according to the surgeon's choice. The reconstruction method was classified as gastroduodenostomy (GD) or RYGJ. Early surgical outcomes achieved at the LVH were investigated and compared with those obtained at the HVC.
Results The early surgical outcomes differed significantly between the two hospitals. In particular, the postoperative complication rate for the patients who underwent TLDG RYGJ at the LVH was higher than at the HVC (LVH 15.4 % vs. HVC 0 %; $p = 0.037$). Furthermore, significant differences were observed in the mean operation time (TLDG GD: LVH 141.0 min vs. HVC 117.4 min, $p = 0.001$; TLDG RYGJ: LVH 186.3 min vs. HVC 134.6 min, $p = 0.009$) and length of hospital stay (TLDG GD: LVH 8.1 days vs. HVC 7.2 days, $p = 0.044$; TLDG RYGJ: LVH 11.5 day vs. HVC 6.8 day, $p = 0.009$).
Conclusions Although all the operations were performed by one experienced surgeon, the early surgical outcomes differed significantly between the low- and high-volume hospitals. Low-volume hospitals often lack well-trained surgical professionals such as first assistants and scrub nurses. Therefore, the authors recommend that a surgeon who works at an LVH should assess potential personnel shortages and find a solution before operating.

Keywords Gastric cancer · Laparoscopic gastrectomy · Surgical outcomes · Low-volume hospital · High-volume center

Laparoscopic gastrectomy has become a popular surgical treatment for gastric cancer worldwide. Many investigators have demonstrated that laparoscopic gastrectomy results in less pain, faster bowel recovery, a shorter hospital stay, and a better quality of life than open gastrectomy [1, 6, 12, 14, 21]. In Korea, many patients and their caretakers specifically request laparoscopic gastrectomy.

However, not all surgeons have the requisite skills to perform laparoscopic surgery. Experts have suggested that a surgeons need to perform ~30–90 operations before they become competent [8, 9, 11, 29, 32]. In practice, however, it is difficult for surgeons to obtain sufficient experience at most low- and medium-volume hospitals in contrast to high-volume centers (HVCs). Little attention has therefore

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been paid to problems associated with laparoscopic gastrectomy at low-volume hospitals (LVHs).

Several studies have reported that laparoscopic gastrectomy is technically feasible at low-volume hospitals [5, 31]. However, they did not determine what the fundamental problems associated with LVHs were or propose solutions. In this study, patients at both an LVH and an HVC underwent surgery performed by a same surgeon who had overcome the learning curve required for competence performing laparoscopic gastrectomy before this study [13].

Materials and methods

Patients

We retrospectively reviewed data collected prospectively for 134 patients who underwent totally laparoscopic distal gastrectomy (TLDG) for gastric cancer between April 2009 and November 2012 at Hanyang University Guri Hospital (LVH) and ASAN Medical Center (HVC). Our patient population consisted of 67 patients who had TLDG with Roux-En-Y gastrojejunostomy (RYGJ) and 67 patients who had TLDG with gastroduodenostomy (GD). Based on hospital volume, the patients were classified as belonging to the LVH group or the HVC group.

More than 1,000 laparoscopic gastrectomies are performed at the HVC every year. In contrast, not a single laparoscopic gastrectomy for gastric cancer had been performed at the LVH before this study.

Surgical techniques for TLDG

All laparoscopic gastrectomies were performed using the same method at both hospitals. Each patient was placed in the reverse Trendelenburg position. After creation of a carbon dioxide pneumoperitoneum, five trocars were placed in a U shape. Dissection was begun by division of the greater omentum from the mid-portion of the gastroepiploic arcade to the left gastroepiploic vessel. Total omentectomy was performed if advanced gastric cancer was suspected.

Lymph nodes around the left gastroepiploic vessels were dissected depending on the location of the primary tumor. After dissection of the lymph nodes around the right gastroepiploic area, the infrapyloric area was dissected. In some patients, dissection was advanced to the superior mesenteric vein to include enlarged 14v lymph nodes. Lymph nodes were dissected in the following order: around the suprapyloric area, the hepatoduodenal ligament (along the hepatic artery), and the common hepatic, proximal splenic, celiac, and left gastric arteries, then around the right paracardial and lesser curvature areas.

When a gastroduodenostomy was performed, a duodenal stump was made after the number 5 lymph nodes had been cleared and the duodenum mobilized. The duodenum was transected just below the duodenal bulb using an endoscopic linear stapler (Echelon Flex Endopath Stapler 60, Cincinnati, OH). The transection line was positioned in the ventrodorsal direction.

After clearing of all lymph nodes, the remnant stomach was transected using the endoscopic linear stapler, and the specimen was removed through the umbilical port by extending the incision in an I shape. After remaking of the pneumoperitoneum, a small opening in the greater curvature side of the remnant stomach and the posterior side of the duodenal stump was made using endoscopic scissors.

To make a V-shaped anastomosis of the posterior walls, the first assistant inserted the stapler (Echelon Flex Endopath Stapler 45) into the small opening of the remnant stomach and pulled the stapler line of the remnant stomach at an angle of 45°. The operator then guided the first assistant to insert the stapler through the duodenal opening. Before firing, the operator pulled the stapler line of the duodenal stump at an angle of 45°. Finally, the anterior hole was closed with a stapler (Echelon Flex Endopath Stapler 60) [12].

In RYGJ cases, the jejunum was divided using an endoscopic linear stapler. After division of the jejunum, the efferent loop was turned in a counterclockwise direction for reconstruction of the gastrojejunostomy. Small holes for an endoscopic linear stapler (Echelon Flex Endopath Stapler 60) were made in the greater curvature side of the remnant stomach and the antimesenteric side of the jejuna limb.

After a common channel had been made between the remnant stomach and the jejunum, the anterior hole was closed with an endoscopic linear stapler (Echelon Flex Endopath Stapler 60) by the operator. To reconstruct the jejunojejunostomy, small holes were made on the antimesenteric side of the jejunum below the gastrojejunostomy (35–40 cm) and the antimesecteric side of the afferent loop. The operator inserted the stapler (Echelon Flex Endopath Stapler 45) into these holes to make a common channel. Finally, the anterior hole of the common channel was closed with a stapler (Echelon Flex Endopath Stapler 60).

Operating system differences between LVH and HVC

In addition to factors associated with operator and patient volume, there are several other differences between HVCs and LVHs. First, assistants and scrub nurses at LVHs generally are not specialists, in contrast to HVCs. However, the combined efforts of the operator and others contribute to the success of a specialized laparoscopic

team. For this reason, the choice of surgical method used by the surgeon at the LVH was restricted during the period of training for the LVH surgical team. Throughout the training period (up to case 30), intracoropreal RYGJ was used as a reconstruction method for distal gastrectomy, and extracorporeal esophagojejunostomy via a circular stapler was used for total gastrectomy. Roux-En-Y gastrojejunostomy would have enabled the operator to complete the laparoscopic gastrectomy without assistance. The surgeon who performed all the operations did not perform intracorporeal esophagojejunostomy because this method requires both a high level of surgical skill and competent assistants.

The second major difference between HVCs and LVHs is the shortage of manpower in postoperative care at LVHs. Generally, HVCs have a surgical ward for patients after gastric surgery, in contrast to LVHs.

Third, surgeons at LVHs may be hesitant to perform operations that require a high degree of surgical skill. For example, high-level surgical skills are needed to complete a safe intracorporeal esophagojejunostomy. Although the surgeon in this study was experienced and had managed numerous TLTG cases at an HVC, he was reluctant to use this surgical method at the LVH due mainly to the high morbidity rate in the early period [10].

Clinical analysis

The clinical data obtained from medical records included patient age, gender, body mass index (BMI), history of previous abdominal surgery, American Society of Anesthesiologists (ASA) score, omentectomy, and combined resection. Early surgical outcomes included operation time, postoperative complications, days until soft diet commencement, and postoperative hospital stay. Pathologic results were analyzed for tumor size, number of retrieved lymph nodes, and Union for International Cancer Control (UICC)/American Joint Committee on Cancer (AJCC) stage 6.

In this study, real operation time was defined as the mean operation time for patients except for those who had a history of major abdominal surgery, obese patients (BMI$>$ 30 kg/m^2), patients with combined omentectomy, and those with combined resection of another organ. To evaluate the learning period of the surgical team at the LVH, the patients who underwent TLDG GD and RYGJ were divided into sequential groups of five patients according to time.

Postoperative complications were defined as any conditions requiring conservative or surgical treatment. Severe postoperative complications were defined as those that required management by an endoscopic or interventional procedure or by a reoperation (expanded classification, exceeding level 3) [28].

In this study, a liquid diet was started after confirmation of the first flatus. A soft diet was started when patients felt comfortable enough to consume a liquid diet twice consecutively. Patients were discharged if they had no problems eating a soft diet; showed an absence of inflammatory conditions including leukocytosis, unstable vital signs, or abrupt onset abdominal pain; and generally were comfortable. The final decision regarding discharge was left up to each patient.

Statistical analysis

Statistical analyses were performed using SPSS version 18.0 for Windows (SPSS, Inc., Chicago, IL, USA). All values are expressed as means ±standard deviations. Categorical variables were analyzed by the χ^2 test, and continuous variables were analyzed by Student's t-test. A p value lower than 0.05 was considered statistically significant.

Results

Patient characteristics

Differences in patient characteristics between the LVH and the HVC according to the reconstruction method are shown in Table 1. The mean age of the TLDG GD patients was significantly higher at the LVH than at the HVC ($p = 0.007$). Furthermore, the distributions of ASA scores ($p = 0.014$) and combined omentectomies ($p < 0.001$) differed significantly between the LVH and the HVC. The TLDG RYGJ patients differed significantly in combined omentectomy scores between the LVH and the HVC ($p < 0.001$).

Early surgical outcomes

Table 2 shows the early surgical outcomes and pathologic results for the patients who underwent TLDG GD. None of these patients required conversion to open surgery or died. The LVH and HVC groups differed significantly in terms of operation time (153.4 vs. 116.9 min; $p < 0.001$), other operation time (141.0 vs. 117.4 min; $p = 0.001$), and postoperative hospital stay (8.1 vs. 7.2 days; $p = 0.044$).

Table 3 shows early surgical outcomes and pathologic results for the patients who underwent TLDG RYGJ at the LVH and the HVC. The two types of hospital differed significantly in terms of other operation time (186.3 vs. 134.6 min; $p = 0.009$), days until soft diet commencement (5.2 vs. 3.8 days; $p = 0.010$), and postoperative hospital stay (11.5 vs. 6.8 days; $p = 0.033$). In particular, the postoperative complication rate was significantly higher for the LVH patients than for the HVC patients ($p = 0.037$).

Table 1 Clinical characteristics of gastric cancer patients who underwent TLDG

Variables	TLDG GD			TLDG RYGJ		
	LVH ($n = 36$)	HVC ($n = 31$)	p Value	LVH ($n = 52$)	HVC ($n = 15$)	p value
Mean age (years)	67.6 ± 11.8	59.5 ± 11.7	0.007	59.9 ± 11.5	53.8 ± 15.4	0.097
Median age: years (range)	70.0 (42–88)	59 (35–82)		59 (35–81)	54 (32–81)	
Elderly patients (age > 70 years): n (%)	19 (52.8)	7 (22.6)	0.011	11 (21.2)	2 (13.3)	0.716
Sex			0.856			0.267
Male	26	23		39	9	
Female	10	8		13	6	
Mean BMI (kg/m^2)	24.5 ± 3.6	24.0 ± 3.4	0.589	24.3 ± 3.6	24.5 ± 3.5	0.807
Median BMI: kg/m^2 (range)	24.6 (17.7–34.5)	24.1 (18.2–33.5)		24.1 (15.8–32.0)	23.8 (19.4–3.03)	
Obese patient (BMI > 25 kg/m^2): n (%)	15 (41.7)	10 (32.3)	0.427	21 (40.4)	7 (46.7)	0.664
History of abdominal operation: n (%)	8 (22.2)	4 (12.9)	0.321	11 (21.2)	2 (13.3)	0.716
Open distal gastrectomy				1		
Open right hemicolectomy						
Open low anterior resection	1					
Open small bowel surgery				2		
Open cholecystectomy	1			1	1	
Laparoscopic cholecystectomy	1					
Appendectomy and others	5	4		7	1	
ASA score: n (%)			0.014			0.227
1	9 (25.0)	17 (54.8)		22 (42.3)	11 (73.3)	
2	20 (55.6)	7 (22.6)		23 (44.2)	3 (20.0)	
3	6 (16.7)	7 (22.6)		6 (11.5)	1 (6.7)	
4	1 (2.8)			1 (1.9)		
Combined omentectomy	9 (25.0)	0	<0.001	20 (38.5)	0	<0.001
Combined other organ resection	2 (5.6)	0	0.111	7 (13.5)	0	0.335

TLDG totally laparoscopic distal gastrectomy, *GD* gastroduodenostomy, *RYGJ* Roux-en-Y gastrojejunostomy, *LVH* low-volume hospital, *HVC* high-volume center, *BMI* body mass index, *ASA* American Society of Anesthesiology

Table 4 shows the postoperative complications that occurred for the patients who underwent a total laparoscopic gastrectomy. Postoperative complications occurred for 11 patients, 2 of whom had severe postoperative complications.

The mean operation times for sequential groups of five patients who underwent TLDG GD and TLDG RYGJ at the LVH are shown in Table 5. These sequential groups differed significantly in terms of mean operation times.

Discussion

Many investigators have shown that laparoscopic gastrectomy is both safe and feasible [1, 6, 12, 14, 21]. Advanced surgical techniques and improved surgical outcomes due to these innovative surgical techniques also have been reported recently [10, 18, 19, 27]. Yet laparoscopic gastrectomy, despite advancing surgical techniques, is not commonly performed at low-volume hospitals. Most advanced technological procedures are performed at high- or medium-volume centers for gastric cancer.

Some investigators have suggested that ~30–90 laparoscopic gastrectomies are required for a surgeon to acquire competence [8, 9, 11, 29, 32]. Regarding complex laparoscopic procedures such as laparoscopic colectomy, laparoscopic bariatric surgery, and others, several investigators have suggested that the hospital or surgeon volume has a role in promoting the quality of laparoscopic surgery [7, 15–17, 26, 30]. Some reports also state that the high volume can improve surgical outcomes, including quality, during the peri- or postoperative periods for other open procedures [2–4, 20, 23–25]. However, in these studies, hospital volume was not considered in the determination of this learning period. We therefore evaluated the volume–outcome relationship. To the best of our knowledge, this is

Table 2 Early surgical outcomes for gastric cancer patients who underwent TLDG GD

Variable	According to hospital volume		
	LVH ($n = 36$)	HVC ($n = 31$)	p value
Conversions to open surgery	0	0	
Mean operation time (min)	153.4 ± 35.5	116.9 ± 23.0	<0.001
Real operation time[a] (no. of patients, 23 vs. 29) (min)	141.0 ± 24.6	117.4 ± 23.6	0.001
Overall postoperative complications: *n* (%)	1 (2.8)	1 (3.2)	0.915
Severe postoperative complications	0	0	
Postoperative mortalities (within 30 days)	0	0	
Days until soft diet commencement	4.2 ± 0.8	4.1 ± 0.7	0.759
Mean postoperative hospital stay (days)	8.1 ± 1.6	7.2 ± 2.1	0.044
T classification (6th AJCC): *n* (%)			0.005
T1	27 (75.0)	31 (100)	
T2	7 (19.4)	0	
T3	2 (5.6)	0	
N classification (6th AJCC): *n* (%)			0.597
N0	29 (80.6)	26 (83.9)	
N1	4 (11.1)	5 (16.1)	
N2	2 (5.6)		
N3	1 (2.8)		
Mean tumor size (cm)	3.2 ± 1.8	3.2 ± 1.6	0.921
Mean no. of retrieved lymph nodes	36.8 ± 12.2	32.4 ± 13.2	0.164
No. of retrieved lymph nodes: *n* (%)			
<15	0 (0)	0 (0)	
≥15	36 (100)	31 (100)	
Mean proximal resection margin (cm)	3.9 ± 2.0	3.6 ± 1.7	0.635
Mean distal resection margin (cm)	4.9 ± 3.0	5.3 ± 2.5	0.569

TLDG totally laparoscopic distal gastrectomy, *GD* gastroduodenostomy, *LVH* low-volume hospital, *HVC* high-volume center, *AJCC* American Joint Committee on Cancer staging

[a] Real operation time is the mean operation time except for patients with a previous major operation, combined omentectomy, obesity (BMI > 30 kg/m^2), or combined other organ resection

Table 3 Early surgical outcomes of gastric cancer patients who underwent TLDG RYGJ

Variable	According to hospital volune		
	LVH ($n = 52$)	HVC ($n = 15$)	p value
Conversions to open surgery	0	0	
Mean operation time (min)	204.4 ± 36.4	161.3 ± 96.0	0.109
Real operation time[a] (no. of patients, 26 vs. 13) (min)	186.3 ± 25.3	134.6 ± 58.8	0.009
Overall postoperative complications: *n* (%)	8 (15.4)	0	0.037
Severe postoperative complications: *n* (%)	2 (3.8)	0	0.310
Postoperative mortality (within 30 days)	0	0	
Days until soft diet commencement	5.2 ± 2.0	3.8 ± 0.8	0.010
Mean postoperative hospital stay (days)	11.5 ± 8.3	6.8 ± 0.9	0.033
T classification (6th AJCC): *n* (%)			0.358
T1	40 (76.9)	14 (93.3)	
T2	5 (9.6)	1 (6.7)	
T3	7 (13.5)	0 (0)	
N classification (6th AJCC): *n* (%)			0.892
N0	40 (76.9)	13 (86.7)	
N1	7 (13.5)	1 (6.7)	
N2	1 (1.9)	0 (0)	
N3	4 (7.7)	1 (6.7)	
Mean tumor size (cm)	3.3 ± 1.8	4.1 ± 2.8	0.220
Mean no. of retrieved lymph nodes	41.2 ± 17.6	34.6 ± 12.6	0.181
No. of retrieved lymph nodes: *n* (%)			0.475
<15	1 (1.9)	0 (0)	
≥15	51 (98.1)	15 (100)	
Mean proximal resection margin (cm)	4.2 ± 2.5	4.4 ± 2.3	0.746
Mean distal resection margin (cm)	6.2 ± 3.1	7.4 ± 3.8	0.220

TLDG totally laparoscopic distal gastrectomy, *GD* gastroduodenostomy, *RYGJ* Roux-en-Y gastrojejunostomy, *LVH* low-volume hospital, *HVC* high-volume center, *AJCC* American Joint Committee on Cancer staging

[a] Real operation time is the mean operation time except for patients with previous major operation, combined omentectomy, obesity (BMI > 30 kg/m^2), or combined other organ resection

the first study to compare laparoscopic gastrectomy outcomes performed by the same surgeon between an LVH and an HVC.

Although the same surgeon performed all the laparoscopic gastrectomies, the surgical outcomes differed significantly between the two types of hospitals. In particular, the postoperative complication rate was significantly higher for the patients who received TLDG RYGJ at the LVH than for those who underwent this procedure at

Table 4 Details of postoperative complications

Variable	TLDG GD		TLDG RYGJ	
	LVH ($n = 36$)	HVC ($n = 31$)	LVH ($n = 52$)	HVC ($n = 15$)
Overall postoperative complications	1	1	8	0
Postoperative ileus			4	
Luminal bleeding			2	
Extraluminal bleeding		1		
Gallbladder empyema			1	
Intraabdominal abscess				
Internal herniation			1	
Duodenal stump leakage				
Anastomosis stricture				
Wound complication	1			

TLDG totally laparoscopic distal gastrectomy, *GD* gastroduodenostomy, *RYGJ* Roux-en-Y gastrojejunostomy, *LVH* low-volume hospital, *HVC* high-volume center

Table 5 Mean operation times for each set of five patients with TLDG GD and TLDG RYGJ at a low-volume hospital

Variables	TLDG GD ($n = 23$) Real operation time[a] (min)	p value	TLDG RYGJ ($n = 26$) Real operation time[a] (min)	p value
Set of five patients over time				
1–5	160.0 ± 32.5	0.179	208.0 ± 15.2	0.002
6–10	141.0 ± 11.9		204.0 ± 17.8	
11–15	126.0 ± 17.8		193.0 ± 28.6	
16–20 (GD 16–23)	138.7 ± 24.7		168.0 ± 17.8	
21–26	145.7 ± 32.9		163.3 ± 13.2	

TLDG totally laparoscopic distal gastrectomy, *GD* gastroduodenostomy, *RYGJ* Roux-en-Y gastrojejunostomy

[a] Real operation time is the mean operation time except for patients with previous major operation, combined omentectomy, obesity (over BMI 30), and combined other organ resection

the HVC. Also, the LVH and HVC patients differed significantly in terms of mean operation time, days until soft diet commencement, and postoperative hospital stay.

A surgeon's innate ability, the number of cases, the training system, the specialized or experienced surgical team, and advanced equipment all can influence the surgical outcomes of laparoscopic surgeries [9, 13, 15, 22, 26]. The current comparative study examined a single surgeon who had mastered the learning curve for laparoscopic gastrectomy at an HVC. Therefore, the study design was suitable for allowing evaluation of differences between LVHs and HVCs because key confounding factors, such as the surgeon's ability, were excluded.

The early surgical outcomes differed significantly between the LVH and the HVC (Tables 3, 5, 6). The surgery of choice was TLDG RYGJ during the early operating period at the LVH because a surgeon can complete this procedure without great help from an assistant. Despite a competent surgical team at the LVH, more learning period–related problems were encountered at the LVH than at the HVC. The longer operation times and higher postoperative complication rates for the LVH than for the HVC indicate that surgical assistants and scrub nurses who participate in laparoscopic surgery also have a learning curve.

Regarding the postoperative clinical course, progress in starting the diet and the hospital discharge were slower than expected at the LVH compared with the HVC, although the patients had their surgery performed by the same surgeon and had the same critical pathway for their treatment.

In the HVC, the surgeon performed laparoscopic gastrectomy without any difficulty with a specialized surgical team. A specialized surgical team is composed of specialized first assistants, skilled scopists, and scrub nurses. The first assistant is a surgical specialist who is learning stomach surgery.

The scopists and scrub nurses in this study had participated in laparoscopic gastrectomy after intensive training. Especially, their procedures were standardized due to the repetition of the same laparoscopic gastrectomy. In the HVC, they had experienced more than two cases of laparoscopic gastrectomy every day. These repetitive surgeries would have enabled the surgical team to maintain quality in laparoscopic gastrectomy. Also, postoperative care was conducted by fixed nurses responsible for the gastric cancer patient in one ward. Therefore, the critical pathway system had worked well with the same nursing unit.

On the other hand, several issues associated with laparoscopic gastrectomy at an LVH need to be overcome. The surgeon's ability is the most important determinant of a safe laparoscopic gastrectomy. Although this problem can be overcome by employing only experienced surgeons, it is not realistic for an LVH to recruit specialized assistants, scopists, scrub nurses, and nursing units.

For LVHs, we recommend training one assistant to perform multiple functions during the laparoscopic gastrectomy so that highly trained professional assistants, scopists, and scrub nurses are not required. A competent assistant's role may change from that of a scopist to that of a first assistant according to the procedure's level of difficulty. The assistant can function as a scopist until lymph node dissection is complete and then can function as a first assistant during reconstruction. This allows the problem of a manpower shortage to be overcome.

Table 6 Clinical characteristics of TLDG RYGJ patients except for those with other operation time at a low-volume hospital

Variables	Initial 30 ($n = 30$)	After 30 ($n = 22$)	p Value
Mean age (years)	61 ± 11.5	58.4 ± 11.7	0.426
Sex (male:female)	24:6	15:7	0.331
Mean BMI (kg/m^2)	24.7 ± 3.4	23.7 ± 3.9	0.381
ASA score: n (%)			0.377
1	13 (43.3)	9 (40.9)	
2	11 (36.7)	12 (54.5)	
3	5 (16.7)	1 (4.5)	
4	1 (3.3)		
Combined omentectomy: n (%)	7 (23.3)	13 (59.1)	0.009
Combined other organ resection: n (%)	3 (10.0)	4 (18.2)	0.396
Mean operation time (min)	204.6 ± 33.1	204 ± 41.2	0.957
Real operation time[a] (min)	200.6 ± 26.5	171.6 ± 24.8	0.008
Overall postoperative complications: n (%)	7 (23.3)	1 (4.5)	0.048
Mean days until soft diet commencement	5.5 ± 2.3	4.7 ± 1.2	0.108
Mean postoperative hospital (days)	12.3 ± 9.9	10.4 ± 5.4	0.436

[a] Real operation time is the mean operation time except for patients with combined omentectomy

In this study, despite the surgeon's best efforts to overcome the problems associated with performing a laparoscopic gastrectomy at an LVH, there were distinct differences in surgical outcomes between the LVH and the HVC, such as mean operation time. In addition, the surgeon abandoned his attempt to perform TLTG at the LVH because this procedure requires high-level technical skills from the surgical team. It is almost impossible to overcome the learning curve required for TLDG at an LVH because total gastrectomy is only rarely performed at an LVH. Therefore, the surgeon performed laparoscopically assisted total gastrectomy in a fashion similar to that for open total gastrectomy.

Conclusions

It is clear that a surgeon's ability is an absolutely crucial determinant of surgical outcome. Based on our experiences, a low volume of patients also can result in a shortage of skilled manpower on the surgical team and a poorly equipped training system. These differences have a decisive effect on the surgical outcomes obtained at an HVC versus an LVH. Therefore, surgeons who work at an LVH should assess the problems associated with their hospital and find a solution to these problems.

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