

Comparing the surgical outcomes of dual-port laparoscopic distal gastrectomy and three-port laparoscopic distal gastrectomy for gastric cancer

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Purpose: Many studies have demonstrated that single-incision or reduced-port laparoscopic distal gastrectomy is a feasible method compared to conventional laparoscopic distal gastrectomy. Using rigid-type laparoscope and right-side approach, we could perform dual-port laparoscopic distal gastrectomy (DPLDG) for gastric cancer. This study aimed to compare the surgical outcomes of DPLDG to those of 3-port laparoscopic distal gastrectomy (TPLDG).

Methods: From March 2017 to December 2019, this retrospective study included 218 patients with gastric cancer who underwent DPLDG (106 patients) or TPLDG (112 patients) at SMG-SNU Boramae Medical Center. Surgical outcomes were compared between 2 operation methods.

Results: Operation time was similar between DPLDG and TPLDG (158.9 ± 33.4 minutes vs. 154.0 ± 31.1 min, P = 0.787). The number of retrieved lymph nodes was similar between the 2 groups (35.3 ± 14.6 vs. 37.0 ± 13.5, P = 0.415). The complication rate in DPLDG and TPLDG groups was 10.4% and 8.9%, respectively (P = 0.894). The time to first flatus, time to first diet, and postoperative hospital stay were similar between the 2 groups. There were no reoperation or mortality cases. The cost of trocars was 359.9 US dollars (USD) in DPLDG and 291–391.4 USD in TPLDG.

Conclusion: The surgical outcomes of DPLDG and TPLDG did not differ. Regarding fewer incisions, DPLDG can be an alternative option for TPLDG.

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Key Words: Laparoscopy, Reduced port, Stomach neoplasms

INTRODUCTION

For the treatment of gastric cancer, radical gastrectomy remains the first-choice treatment for patients with resectable gastric cancer. Nowadays, laparoscopic techniques have been widely used for the surgical treatment of gastric cancer. The feasibility and long-term safety of laparoscopic gastrectomy in gastric cancer have been reported in several clinical trials [1-3].

With the development of laparoscopic technique and equipment, recent trends in laparoscopic gastrectomy have been

toward minimizing the use of trocars for lesser incision and postoperative pain [4]. Reduced-port laparoscopic gastrectomy uses lesser than 5 trocars, which were used in conventional laparoscopic surgery. Several studies demonstrated that 3-port laparoscopic gastrectomy without assistant port is a reliable form of reduced-port laparoscopic gastrectomy [5-7].

Am-channel port enables insertion of multiple instruments in a single incision. Using this port in an umbilical incision, single-incision laparoscopic gastrectomy (SILG) can be performed. Since the first report on SILG in 2011 [8], SILG

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was performed by some operators for the treatment of gastric cancer [9,10]. However, SILG requires different patient position and instruments compared to conventional and reduced-port laparoscopic gastrectomy. As such, dual-port laparoscopic gastrectomy with umbilical multichannel plus one port is an option which can be adopted by surgeons familiar with conventional or 3-port surgery. Several studies show that dual-port laparoscopic gastrectomy is feasible and safe [11-13]. This surgical procedure does not require a flexible scope or curved forceps. Surgical approach is performed at the right side of the patient with supine position (Fig. 1).

This study was conducted to compare the surgical outcomes of dual-port laparoscopic distal gastrectomy (DPLDG) and 3-port laparoscopic distal gastrectomy (TPLDG).

METHODS

Patients and data collection

A prospectively recorded gastric cancer database of SMG-SNU Boramae Medical Center was reviewed. From March 2017 to December 2019, we selected the data of 106 and 112 patients who underwent DPLDG and TPLDG, respectively. All operations were performed by 2 gastric cancer surgeons. The indication for DPLDG and TPLDG was as follows; patients with pathologically proven gastric cancer located in the lower or middle part of the stomach and clinical stage I-II without other malignancy. All included cases had received more than D1+ lymph node (LN) dissection (LN number 1, 3, 4sb, 4d, 5, 6, 7, 8a, 9). Data regarding patient demographics, clinicopathological characteristics, and short-term surgical outcomes were collected from the gastric cancer database.

The protocol of this retrospective study was approved by the Institutional Review Board of SMG-SNU Boramae Medical Center (No. 10-2020-252). Patient records were anonymized and de-identified after data collection.

Operative procedures

The patient was placed in a reverse Trendelenburg supine

position with the operator standing on the right side of the patient. The scopist usually stood on the right side of the operator. For DPLDG, a longitudinal 2.5–3 cm transumbilical skin incision was made. A multichannel port (Gelpoint mini, Applied Medical, Rancho Santa Margarita, CA, USA; or Gloveport, Nelis, Bucheon, Korea) was placed in the umbilical incision and a 5-mm trocar was inserted at the right upper quadrant (Fig. 2). For TPLDG, a 12-mm trocar was inserted at the umbilical area for laparoscopy, and 5-mm and 12-mm trocars for the operator were inserted at the right upper quadrant. In both types of surgery, no additional trocar for the assistant was used. The abdominal cavity was insufflated with carbon dioxide at a pressure of 13 mmHg. A 30° or 45° rigid-type camera was used.

Modified combined suture retraction of the falciform ligament and the left lobe of the liver was performed using polypropylene monofilament on a straight needle and hemoclip. Partial omentectomy was initiated distally approximately 3–4 cm away from the gastroepiploic vessels, which included the

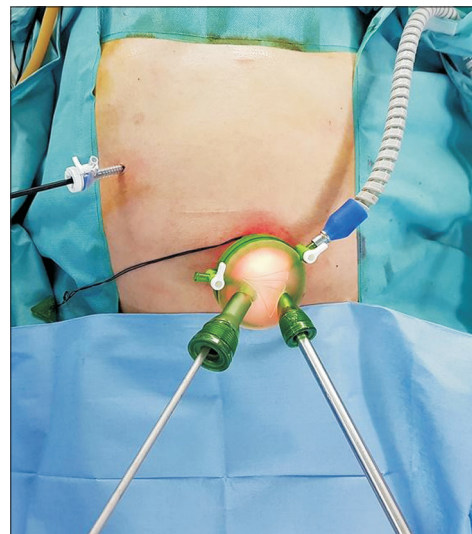


Fig. 2. It shows trocar (umbilical multichannel port + 5-mm trocar) insertion in dual-port laparoscopic distal gastrectomy.

	Port	Patient position	Assistant	Scope
Conventional laparoscopic gastrectomy	5	Supine	+	Rigid or flexible
4-port laparoscopic gastrectomy	4	Supine	+	Rigid or flexible
3-port laparoscopic gastrectomy	3	Supine	-	Rigid or flexible
Dual-port laparoscopic gastrectomy	Umbilical multichannel + RUQ 5 mm	Supine	-	Rigid or flexible
Single-incision laparoscopic gastrectomy	Umbilical multichannel	Lithotomy	-	Flexible

Fig. 1. Summarizes various types of laparoscopic gastrectomy. RUQ, right upper quadrant.

LN station 4d. The left gastroepiploic vessels were ligated distal to the omental branch (LN station 4sb). For this procedure, the operating table was tilted to the right side for traction of stomach by gravity. Then, the omentum was dissected to the head of the pancreas and the duodenum. For dissecting LN station 6, the operating table was tilted to left side for traction. The anterior side of LN station 1 and 3 was dissected before transecting the distal part of the stomach to maintain contour of stomach. This facilitates dissecting the posterior side of LN station 1 and 3 at the end of LN dissection. After transecting the distal side with a linear stapler, the right gastric artery is pulled up to the left upper side, and LN station 5 and 12 were dissected. Then LN station 8a was dissected to the left side. Between the shaft of the energy device and pancreas, gauze is placed to press the pancreas tissue and to prevent thermal damage. From LN station 8a to 11p, superficial dissection was performed initially, then dissection proceeded to a deeper area. This facilitated even traction of the suprapancreatic LN by pulling up the LN station 7 area. Then traction of LN station 11p with the left hand finalized the LN station 11p dissection, and the left sides of LN station 7 and 9 were then dissected. After ligation of the left gastric artery and vein, the right sides of LN station 9 and LN station 8a were dissected. Finally, the posterior sides of LN station 1 and 3 were dissected. After transecting the proximal stomach, the stomach is extracted via

a multichannel port in DPLDG and via a lengthened incision at the umbilical port side in TPLDG.

Intracorporeal reconstruction is conducted by Billroth I (BI-delta) or Billroth II (BII) or uncut Roux-en-Y anastomosis. For BI (delta) anastomosis in DPLDG, the linear stapler was inserted at the umbilical multichannel port; this approach is easier than using right-side port in TPLDG. A Jackson-Pratt drain was inserted into the right upper quadrant 5-mm trocar site at the end of surgery.

Statistical analyses

All statistical calculations were performed using the IBM SPSS Statistics for Windows, ver. 21 (IBM Corp., Armonk, NY, USA). Independent t-test and Pearson chi-square test were used to compare continuous and categorical variables, respectively. All P-values of <0.05 were considered as significant.

RESULTS

The patients' demographics and operative data are shown in Table 1. Age, sex, body mass index (BMI), American Society of Anesthesiologists physical status classification was not different between DPLDG and TPLDG groups. There were no open conversion cases in both groups, and combined resection was performed in 10 cases (9.4%) of DPLDG and 8 cases (7.1%) of TPLDG groups. Operation time did not differ between the 2 groups (DPLDG, 158.9 ± 33.4 minutes vs. TPLDG, 154.0

Table 1. Patients' demographics and operative data

Variable	DPLDG (n = 106)	TPLDG (n = 112)	P-value
Age (yr)	66.7 ± 10.5	68.5 ± 11.0	0.363
Sex			0.813
Male	78 (73.6)	85 (75.9)	
Female	28 (26.4)	27 (24.1)	
Body mass index (kg/m ²)	24.4 ± 3.2	23.4 ± 3.0	0.092
ASA PS classification			0.836
I	23 (21.7)	26 (23.2)	
II	78 (73.6)	79 (70.5)	
III	5 (4.7)	7 (6.2)	
Operation time (min)	158.9 ± 33.4	154.0 ± 31.1	0.787
Open conversion	0 (0)	0 (0)	-
Combined resection	10 (9.4)	8 (7.1)	0.713
LN dissection			0.407
D1+	71 (67.0)	69 (61.6)	
D2	35 (33.0)	43 (38.4)	
Reconstruction method			0.162
BI (delta)	3 (2.8)	0 (0)	
BII ± Braun anastomosis	101 (95.3)	111 (99.1)	
Uncut Roux-en-Y	2 (1.9)	1 (0.9)	

Values are presented as mean ± standard deviation or number (%). DPLDG, dual-port laparoscopic distal gastrectomy; TPLDG, 3-port laparoscopic distal gastrectomy; ASA, American Society of Anesthesiologists; PS, physical status; LN, lymph node; BI, Billroth I; BII, Billroth II.

Table 2. Pathologic data

Variable	DPLDG (n = 106)	TPLDG (n = 112)	P-value
Tumor size (cm)	2.6 ± 1.5	2.8 ± 1.7	0.786
PRM (cm)	4.0 ± 2.3	4.0 ± 1.9	0.969
DRM (cm)	4.1 ± 2.5	4.4 ± 1.8	0.579
T stage			0.645
T1a	51 (48.1)	50 (44.6)	
T1b	34 (32.1)	32 (28.6)	
T2	9 (8.5)	11 (9.8)	
T3	10 (9.4)	13 (11.6)	
T4a	2 (1.9)	6 (5.4)	
T4b	0 (0)	0 (0)	
N stage			0.917
N0	84 (79.2)	90 (80.4)	
N1	12 (11.3)	10 (8.9)	
N2	6 (5.7)	8 (7.1)	
N3a	4 (3.8)	3 (2.7)	
N3b	0 (0)	1 (0.9)	
Retrieved LN	35.3 ± 14.6	37.0 ± 13.5	0.415

Values are presented as mean ± standard deviation or number (%). DPLDG, dual-port laparoscopic distal gastrectomy; TPLDG, 3-port laparoscopic distal gastrectomy; PRM, proximal resection margin; DRM, distal resection margin; LN, lymph node.

± 31.1 minutes; $P = 0.787$). All of the combined resections were cholecystectomy cases, which were performed without additional trocars. D1+ LN dissection was performed in 67.0% of DPLDG cases and 61.6% of TPLDG cases. Regarding reconstruction method, there was no difference between the 2 groups, statistically. However, BI (delta) anastomosis was performed only in DPLDG group.

Pathologic data are shown in Table 2. Tumor size, proximal resection margin, distal resection margin, T stage, and N stage did not differ between the 2 groups. No differences were observed in the number of retrieved LNs (DPLDG, 35.3 ± 14.6 vs. TPLDG; 37.0 ± 13.5 ; $P = 0.415$).

Postoperative outcome was summarized in Table 3. The time to first flatus, time to first diet, and postoperative hospital stay were not different between the 2 groups. Postoperative complications were graded using the Clavien-Dindo classification; no significant differences were observed between the 2 groups (DPLDG, 10.4% vs. TPLDG, 8.9%; $P = 0.894$). The most common morbidity was wound complication. One case of intra-abdominal bleeding occurred in DPLDG group, and transfusion was performed in this case. Intra-abdominal fluid collection requiring percutaneous drainage insertion occurred in 3 cases of DPLDG and 2 cases of TPLDG. No anastomosis leakages were identified in both groups of operation. No reoperation case or in-hospital mortality was observed in either group.

Table 4 shows the cost of trocars. In DPLDG, 1 multichannel port and 1 trocar were needed and the sum of the cost was 359.90 US dollars (USD). When the operator uses the wound retractor with port at the beginning of TPLDG, the sum of cost is USD 291. However, when the wound retractor with port is used after stomach extraction, the sum cost is USD 391.40.

DISCUSSION

After the first successful operation by Kitano et al. [14] performing a laparoscopic distal gastrectomy, consistent efforts have been made to improve the surgical technique and instruments, and to conduct oncologically safe procedures not inferior to conventional open surgery. Through several randomized clinical trials, the feasibility and long-term safety of laparoscopic gastrectomy in gastric cancer has been reported [1-3]. Now, an increasing number of gastric surgeons have extended their indication of laparoscopic approach to include advanced cancer [15,16].

Recently, a trend in the refinement of laparoscopic procedures has been toward minimizing the number of incisions to reduce invasiveness. Conventional 5-port laparoscopic gastrectomy has evolved to reduced-port laparoscopic gastrectomy, and nowadays 3-port laparoscopic gastrectomy (TPLG) is performed widely [5-7,17-19]. Multichannel port enables insertion of multiple instruments in a single incision. Using this port in umbilical incisions, SILG can be performed. Since the first report on SILG in 2011, this operation was performed by few operators in selected institutions. SILG requires lithotomy position,

Table 4. Cost of trocars

Trocar	DPLDG	TPLDG
Multichannel port (USD)	259.5	-
Trocar (USD)	100.4 × 1	100.4 × (2 or 3)
Wound retractor with port (USD)	-	90.2
Total (USD)	359.9	291–391.4

DPLDG, dual-port laparoscopic distal gastrectomy; TPLDG, 3-port laparoscopic distal gastrectomy; USD, US dollar.

Table 3. Postoperative outcome

Variable	DPLDG (n = 106)	TPLDG (n = 112)	P-value
Time to first flatus (day)	3.1 ± 1.5	3.0 ± 1.0	0.360
Time to first diet (day)	4.1 ± 1.6	4.1 ± 0.5	0.451
Postoperative hospital stay (day)	7.5 ± 1.5	7.3 ± 1.4	0.835
Morbidity	11 (10.4)	10 (8.9)	0.894
Grade I			
Wound complication	5	3	
Grade II			
Intra-abdominal bleeding	1	0	
Intra-abdominal fluid collection	2	2	
Grade IIIa			
Intra-abdominal fluid collection	3	2	
Mortality	0	0	-
Reoperation	0	0	-

Values are presented as mean ± standard deviation, number (%), or number only.

DPLDG, dual-port laparoscopic distal gastrectomy; TPLDG, 3-port laparoscopic distal gastrectomy.

curved instrument, and flexible camera. These difficulties prevent surgeons from initiating SILG and overcoming the learning curve. Dual-port laparoscopic gastrectomy (DPLG) with umbilical multichannel plus one port can be a better option that can be adopted by surgeons familiar with conventional or 3-port laparoscopic gastrectomy. DPLG has the merit of lesser incision than TPLG, and of easier accessibility than SILG.

This study was designed to compare the short-term surgical outcomes between DPLDG and TPLDG for gastric cancer. As mentioned above, TPLDG was not inferior to conventional laparoscopic surgery in terms of short-term surgical outcome. However, there were few reports of DPLDG and the enrolled cases were very limited. So far, our study enrolled the largest number of DPLDG cases ($n = 106$) [11-13,20]. In this study, DPLDG was performed by one surgeon and TPLDG was performed by another surgeon. As a result, the patient demographics were equally distributed in each group. In this study, age, sex, and BMI were not considered for the inclusion or exclusion criteria for the 2 types of operation. Fortunately, there were no patients with a BMI over 30 kg/m^2 . In cases with a BMI under 30 kg/m^2 , we believe DPLDG and TPLDG procedures can be performed by an experienced surgeon. Each surgeon has performed over 200 cases of 4- or 5-port laparoscopic gastrectomy before DPLDG or TPLDG. The number is sufficient for overcoming the learning curve of 4- or 5-port laparoscopic gastrectomy [21,22]. Therefore, we can expect that a surgeon experienced in 4- or 5-port laparoscopic gastrectomy can perform DPLDG or TPLDG without great difficulty. Compared to TPLDG, surgical outcome of DPLDG was not inferior. In most parameters including operative data, pathologic data, postoperative outcome, there was no difference between the 2 groups. The time to first flatus did not differ between the 2 groups. In our institution, we did not adopt ERAS (Enhanced Recovery After Surgery) protocol. Patients start a semi-fluid diet on the 4th postoperative day and are discharged on the 7th postoperative day. Due to this policy, time to first diet and postoperative hospital stay did not differ between the 2 groups. Also, the retrieved LN number and overall morbidity rate were not statistically different. The difference between the 2 procedures is that DPLDG has fewer incisions and that the surgeon's right hand is closer to the laparoscopic camera. At initial experience of TPLDG, a 30° rigid scope was used, and there were some difficulties ensuring visual field. Therefore, we changed to a 45° rigid scope which enables better visual field with reduced collisions.

The potential benefit of DPLDG over TPLDG is that BI (delta) anastomosis can be conducted via umbilical multichannel port. In conventional laparoscopic distal gastrectomy, BI (delta) anastomosis was performed through a left-side trocar [23]. In TPLDG, the right-side trocar is too close to the duodenal stump site, and the approach angle for a linear stapler is inappropriate.

To overcome this difficulty, exchange of the camera and linear stapler can be considered. If the linear stapler is inserted into the umbilical port and the camera into the right-side port, then BI (delta) anastomosis technically can be performed. However, the surgeon might feel discomfort as the scopist's arm is located between the operator's 2 arms. Some operators use a right-side 5-mm trocar, umbilical 12-mm trocar, and left-side 12-mm trocar. In this trocar arrangement, delta anastomosis can be performed using an umbilical or left-side 12-mm trocar. Suh et al. [24] reported the BI (delta) anastomosis technique in single-incision distal gastrectomy, and this method can be used in DPLDG. Another potential benefit of DPLDG is that assistant devices can be inserted through the multichannel umbilical port. This facilitates LN dissection in difficult areas by traction.

In this study, the cost of trocars was USD 359.90 in DPLDG and USD 291–391.40 in TPLDG. In TPLDG, besides the 3 trocars, a wound retractor is required after lengthening of the umbilical incision for extraction of the stomach and maintaining pneumoperitoneum for anastomosis. However, if a wound retractor with a port was used at the beginning of TPLDG, the sum of cost saved could be USD 291.

This study had some limitations. We evaluated only short-term postoperative outcomes. As such, there lacks of long-term oncological data, and a study for long-term oncological outcomes regarding recurrence and survival will be conducted in the near future. Another limitation was that DPLDG and TPLDG were performed by individual surgeons. This limitation might cause some biases to the results, though the patient demographics were equally distributed in each group.

To the best of our knowledge, this is the first study comparing DPLDG with TPLDG, with the largest number of DPLDG cases enrolled. The short-term postoperative outcome of DPLDG and TPLDG did not differ. Regarding fewer incisions and easier approach for BI (delta) anastomosis, DPLDG can be an alternative option to TPLDG.

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Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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Investigation: All authors

Methodology: HSA, DSH
Project Administration: All authors

Writing – Original Draft: HSA, DSH
Writing – Review & Editing: All authors

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