J Gastric Cancer. 2023 Jul;23(3):487-498
https://doi.org/10.5230/jgc.2023.23.e26
pISSN 2093-582X·eISSN 2093-5641

Journal of Gastric Cancer

Original Article

# Feasibility and Potential of Reduced Port Surgery for Total Gastrectomy With Overlap Esophagojejunal Anastomosis Method

**Ho Seok Seo, Sojung Kim, Kyo Young Song, Han Hong Lee**

Division of Gastrointestinal Surgery, Department of Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea



**Received:** Jul 4, 2023
**Revised:** Jul 12, 2023
**Accepted:** Jul 13, 2023
**Published online:** Jul 26, 2023

**Correspondence to**
**Han Hong Lee**
Division of Gastrointestinal Surgery, Department of Surgery, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 06591, Korea.
Email: painkiller9@catholic.ac.kr



**ORCID iDs**
Ho Seok Seo
https://orcid.org/0000-0002-3606-6074
Sojung Kim
https://orcid.org/0000-0002-5030-2918
Kyo Young Song
https://orcid.org/0000-0002-5840-1638
Han Hong Lee
https://orcid.org/0000-0002-7541-8490

**Funding**
This study was supported by a National Research Foundation of Korea (NRF) grant funded by the Korean government (MSIT) (No. 2020R1A2C1012007 and RS-2022-00166271), the Catholic Medical Center Research

## ABSTRACT

**Purpose:** Reduced port surgery (RPS) for gastric cancer has been frequently reported in distal gastrectomies but rarely in total gastrectomies. This study aimed to determine the feasibility of 3-port totally laparoscopic total gastrectomy (TLTG) with overlapping esophagojejunal (EJ) anastomosis.
**Materials and Methods:** A total of 81 patients who underwent curative TLTG for gastric cancer (36 and 45 patients with 3-port and 5-port TLTG, respectively) were evaluated. All 3-port TLTG procedures were performed with the same method as 5-port TLTG, including EJ anastomosis with the intracorporeal overlap method using a linear stapler, except for the number of ports and assistants. Short-term outcomes, including the number of lymph nodes (LNs) harvested by station and postoperative complications, were analyzed retrospectively.
**Results:** Clinical characteristics were not significantly different among the groups, except that the 3-port TLTG group was younger and had a lower rate of pulmonary comorbidity. There were no cases of open conversion or additional port placement. All operative details and the number of harvested LNs did not differ between the groups, but the rate of suprapancreatic LN harvest was higher in the 3-port TLTG group. No significant differences were observed in the overall complication rates between the 2 groups.
**Conclusions:** Three-port TLTG with overlapping EJ anastomoses using a linear stapler is a feasible RPS procedure for total gastrectomy to treat gastric cancer.

**Keywords:** Minimally invasive surgical procedures; Stomach neoplasms; Laparoscopy; Gastrectomy

## INTRODUCTION

Laparoscopic gastrectomy is a widely performed surgical approach for gastric cancer treatment owing to its cosmetic benefits, reduced pain, and lower incidence of complications than open surgery [1,2]. With improvements in survival rates after gastric cancer surgery, there has been an increased demand for minimally invasive procedures that provide patients with the highest possible quality of life. Advancements in surgical instruments and techniques and accumulated experience with laparoscopic surgery have accelerated the development of these procedures [3,4].

Foundation in the program year 2021, the Research Supporting Program of the Korean Gastric Cancer Association (KGCA2022IC2 and KGCA2022IC3), and the Korean Society of Endo-Laparoscopic & Robotic Surgery for 2022 (No. KSERS-22-04) and. The sponsor of the study was not involved in the study design, analysis, interpretation of data, writing of the report, or the decision to submit the study results for publication.

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

**Author Contributions**
Conceptualization: S.H.S., L.H.H.; Data curation: S.H.S., K.S.; Formal analysis: S.H.S.; Investigation: S.H.S., K.S.; Validation: S.K.Y., L.H.H.; Writing - original draft: S.H.S.; Writing - review & editing: S.H.S., K.S., S.K.Y., L.H.H.

Reduced port surgery (RPS), which includes 4-port, 3-port, and 2-port laparoscopic surgeries, has been reported to be feasible for both short- and long-term outcomes in gastric cancer surgery, with some randomized controlled trials currently in progress [5-8]. Most studies suggest that RPS is feasible for LN dissection without an increase in complications, with long-term outcomes non-inferior to those of conventional 5-port surgery [9,10]. However, most studies on RPS in gastric cancer have been limited to distal gastrectomy, and the total number of gastrectomy cases is insufficient to determine its feasibility.

Only a few studies have compared RPS with conventional 5-port surgery with respect to laparoscopic total gastrectomy. The surgical procedure of total gastrectomy presents greater difficulties than distal gastrectomy owing to the need for dissection of LNs #2, #4sa, and #11d, and possibly LN #10 [11]. Moreover, total gastrectomy is associated with a higher risk of complications and challenging visualization of the esophagojejunal (EJ) anastomosis. One study compared RPS totally laparoscopic total gastrectomy (TLTG) using a linear stapler with 5-port laparoscopic assisted total gastrectomy using a circular stapler, and another study used a circular stapler in both the RPS and 5-port groups. Therefore, an accurate comparison between the 2 groups was difficult because of the differences in the EJ anastomosis method [12,13].

The objective of this study was to identify the feasibility of the 3-port TLTG as an RPS compared with the conventional 5-port TLTG.

## MATERIALS AND METHODS

### Patients and data collection

Patients who underwent TLTG for the treatment of gastric cancer between January 2016 and April 2022 at the Catholic Medical Center were included. The inclusion criteria were as follows: (1) diagnosis of gastric cancer, (2) curative radical gastrectomy, and (3) pathological stage I. Patients who underwent complete total gastrectomy or neoadjuvant chemotherapy and those with pathological stages II or III were excluded. After reviewing the medical records of the 178 patients who underwent TLTG, 81 were analyzed after exclusion (**Supplementary Figs. 1** and **2**). Given that the 3-port approach for total gastrectomy has not yet been considered a standard procedure, the authors have decided to include only patients with pathological stage I to mitigate potential bias. All surgeries were performed by 3 gastrointestinal surgeons (S.K.Y., L.H.H., and S.H.S.) who specialize in gastric cancer surgery using similar laparoscopic techniques. The surgical approach was determined according to the operator's preference (**Supplementary Fig. 3**).

A total of 81 patients were divided into 2 groups: 36 patients for the 3-port TLTG group and 45 patients for the 5-port TLTG group. Demographics, clinical and pathological characteristics, operative details, and short-term postoperative outcomes were the compared between these groups. Pathological stage was classified using the TNM criteria of the Eighth edition of the American Joint Cancer Committee [14].

This study was approved by the Institutional Review Board of the Ethics Committee of the College of Medicine, The Catholic University of Korea (approval No. KC23RASI0372). Patient records were anonymized and de-identified prior to the analysis.


https://doi.org/10.5230/jgc.2023.23.e26

Journal of Gastric Cancer

## Surgical procedures

*Operation team position*

In the 3-port TLTG, the operative team involved only the operator and scopist, with the operator standing on the right side of the supine-positioned patient and the scopist on the right side of the operator, as previously reported for the 3-port totally laparoscopic distal gastrectomy (TLDG) [15]. In the 5-port TLTG, an assistant stood on the opposite side of the operator.

*Trocar location*

The first 12-mm-diameter trocar was inserted through the umbilicus, which was mainly used for the camera operation. The other trocars (12 mm and 5 mm in diameter), which were mainly used by the operator, were inserted through the right upper side of the first trocar (12 mm) and the right subcostal area (5 mm). In the case of 5-port TLTG, additional 12- or 5-mm-diameter trocars were inserted through the left side of the umbilical trocar and the left subcostal area, respectively, and used by the assistant [15].

*LN dissection*

Standard radical gastrectomy with D1+ or D2 LN dissection was performed for all surgeries according to the Korean Practice Guidelines for Gastric Cancer [11]. During 5-port TLTG, LN dissection was initiated by dividing the greater omentum for partial omentectomy. After LN #4sb dissection and left gastroepiploic vessel ligation, LN #4sa dissection and short gastric artery ligation were performed in the upper direction. The duodenum was transected after LN #4d and LN #6 dissection, and then LN #5 was dissected. The assistant performed counter-traction using long-jaw forceps during this period. Suprapancreatic LN dissection started from LN #8a and #12a and moved in the direction of the distal pancreas for dissection of LN #11p and #11d through LN #7 and # 9. The assistant compressed the upper border of the pancreas during suprapancreatic LN dissection. LN #10 was dissected if necessary. Finally, LN #1 and #2 were dissected, followed by esophageal transection. The assistant performed stomach traction during this period (**Fig. 1A and B**).

During 3-port TLTG, most LN dissection procedures were performed similarly, but the order of dissection varied. Owing to the absence of counter-traction by the assistant, LN #4sa was dissected after duodenal or even esophageal transection, as needed. To provide countertraction using physiological adhesion and the weight of the stomach, LN #5 was dissected before duodenal transection. LN #10 dissection was performed after esophageal transection as needed, and en bloc resection was maintained [16]. In addition to changing the order of LN dissection, the present authors also utilized the push cautery method for suprapancreatic LN dissection to overcome the lack of countertraction, as reported in a previous article [15]. During all procedures, the principle of en bloc resection was strictly followed (**Fig. 1C and D**).

## Reconstruction

All esophagojejunostomies were performed using an overlapping method [17]. The distal end of the esophagus was transected using a 45-mm linear stapler to ensure a sufficient safety margin. A small portion was intentionally left at the left end to allow insertion of a linear stapler. This small portion was then cut using scissors, and the mucosal opening was confirmed. The proximal jejunum was brought up to the level of the anastomosis and placed in an antecolic manner, and a hole was made at an appropriate location. The staple side of the 45-mm linear stapler was inserted into the jejunum through a 12-mm diameter trocar on the right side or umbilicus, while the anvil side was inserted into the esophagus

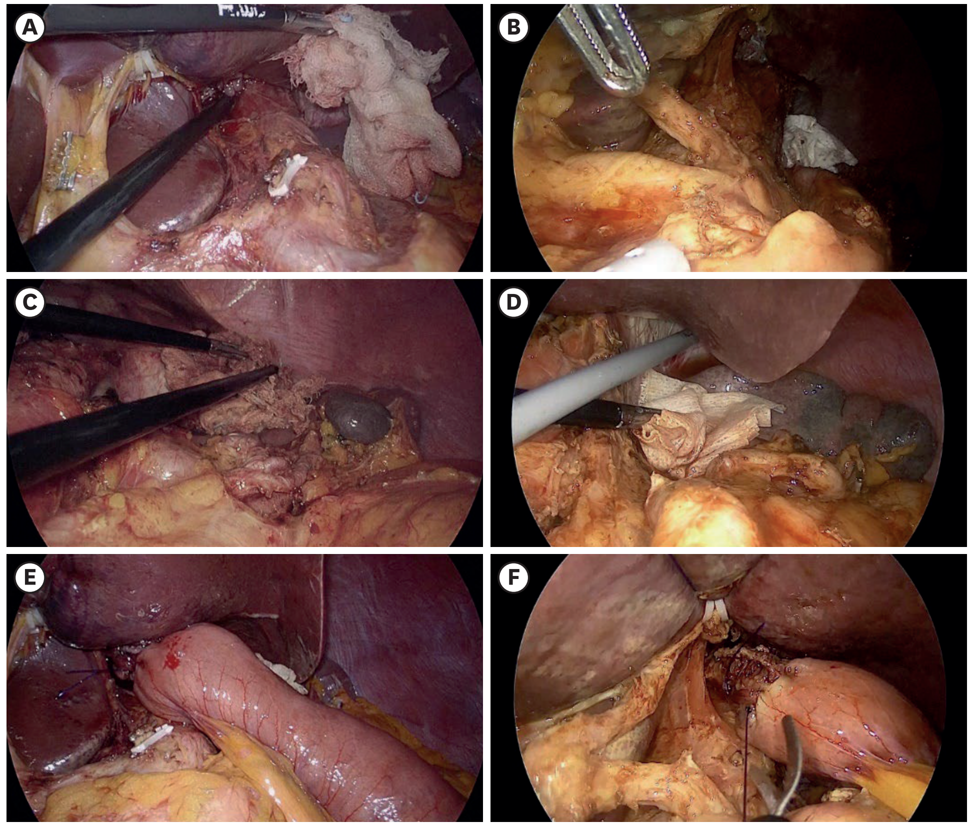


**Fig. 1.** Surgical fields. (A) Suprapancreatic LN dissection, 3-port group. (B) Suprapancreatic LN dissection, 5-port group. (C) Splenic hilar LN dissection, 3-port group. (D) Splenic hilar LN dissection, 5-port group. (E) EJ anastomosis, 3-port group. (F) EJ anastomosis, 5-port group.
LN = lymph node; EJ = esophagojejunal.

for anastomosis. The entry hole was closed using a barbed suture [18-21]. Jejunojejunostomy was intracorporeally performed 40 cm distal to the esophagojejunostomy using a 45-mm linear stapler. All stapler entry holes were closed using a hand-sewing technique with a barbed suture material. Petersen's and mesenteric defects were occasionally closed with non-absorbable suture materials (**Fig. 1E and F**).

### Statistical analysis

Student's t-test was used for parametric continuous variables. Data are presented as mean ± standard deviation. Categorical data were analyzed using the $\chi^2$ test or Fisher's exact test. Multivariate analyses were performed using logistic regression to determine odds ratios. All 9 comorbidity-related variables were combined into a single variable, that is, the Eastern Cooperative Oncology Group (ECOG) performance status score, resulting in the 9 independent variables used in the logistic regression analysis. Differences were considered statistically significant at a 2-sided P-value of <0.05. SPSS (ver.24; SPSS, Inc., Chicago, IL, USA) for Windows was used for statistical analysis.

## RESULTS

The clinical characteristics such as body mass index, ECOG score, history of abdominal surgery and endoscopic submucosal dissection, and clinical stage were not significantly


https://doi.org/10.5230/jgc.2023.23.e26

jgc Journal of Gastric Cancer

different between the groups, although the 3-port TLTG group was younger (60.4 years vs. 66.9 years, P=0.006) and had relatively fewer pulmonary comorbidities (2.8% vs. 17.8%, P=0.033) (**Table 1**). With respect to operative details, no cases of open conversion or additional port insertion were reported. The extent of LN dissection, operative time, and estimated blood loss were not significantly different between the groups (**Table 2**).

Similarly, there were no significant differences in pathological results between the groups (**Table 3**). Meanwhile, although there were no significant between-group difference in the number of retrieved LNs (51.5 vs. 44.8, P=0.134), the number of retrieved suprapancreatic LNs was significantly higher in the 3-port TLTG group (13.1 vs. 10.0, P=0.019) (**Table 3**, **Fig. 2**). The detailed number of harvested LNs according to station is shown in **Supplementary Fig. 4** and **Supplementary Table 1**.

**Table 1.** Clinical characteristics

| Variables | 3-Port TLTG (n=36) | 5-Port TLTG (n=45) | P-value |
|---|---|---|---|
| Age (yr) | 60.4±9.9 | 66.9±10.5 | 0.006 |
| Sex | | | 0.237 |
| Male | 29 (80.6) | 32 (71.1) | |
| Female | 7 (19.4) | 13 (28.9) | |
| BMI (kg/m$^2$) | 24.2±3.0 | 24.5±3.4 | 0.683 |
| ECOG score | | | 0.718 |
| 0 | 28 (77.8) | 31 (68.9) | |
| 1 | 7 (19.4) | 13 (28.9) | |
| 2 | 1 (2.8) | 1 (2.2) | |
| Comorbidity | | | |
| Hypertension | 13 (36.1) | 23 (51.1) | 0.130 |
| Diabetes | 3 (8.3) | 10 (22.2) | 0.081 |
| Pulmonary | 1 (2.8) | 8 (17.8) | 0.033 |
| Hepatic | 1 (2.8) | 4 (8.9) | 0.257 |
| Renal | 0 (0) | 1 (2.2) | 0.556 |
| Cardiac | 1 (2.8) | 6 (13.3) | 0.097 |
| Cerebral | 1 (2.8) | 4 (8.9) | 0.257 |
| Others | 9 (25) | 15 (33.3) | 0.285 |
| History of abdominal surgery | 8 (22.2) | 7 (15.6) | 0.314 |
| History of ESD | 4 (11.1) | 7 (15.6) | 0.404 |
| Smoking history | | | 0.807 |
| Non smoker | 16 (44.4) | 23 (51.1) | |
| Past smoker | 12 (33.3) | 12 (26.7) | |
| Current smoker | 8 (22.2) | 10 (22.2) | |
| Alcohol history | | | 0.436 |
| No drinking | 22 (61.1) | 24 (53.3) | |
| Social drinking | 10 (27.8) | 18 (40.0) | |
| Heavy drinking | 4 (11.1) | 3 (6.7) | |
| cT stage | | | 0.894 |
| 1 | 21 (58.3) | 27 (60.0) | |
| 2 | 12 (33.3) | 13 (28.9) | |
| 3 | 3 (8.3) | 5 (11.1) | |
| cN stage | | | 1.000 |
| 0 | 34 (94.4) | 41 (91.1) | |
| 1 | 2 (5.6) | 2 (4.4) | |
| 2 | 0 (0) | 1 (2.2) | |
| 3 | 0 (0) | 1 (2.2) | |
| CEA (U/mL) | 1.6±0.9 | 1.9±1.2 | 0.240 |
| CA19-9 (U/mL) | 9.7±10.2 | 12.1±11.3 | 0.360 |

Data are given as numbers (%) or the mean ± standard deviation.
TLTG = totally laparoscopic total gastrectomy; BMI = body mass index; ECOG = Eastern Cooperative Oncology Group; ESD = endoscopic submucosal dissection; cT stage = clinical depth of invasion; cN stage = clinical nodal metastasis; CEA = carcinoembryonic antigen; CA19-9 = cancer antigen 19-9.

Journal of Gastric Cancer

**Table 2.** Operative details

| Variables | 3-Port TLTG (n=36) | 5-Port TLTG (n=45) | P-value |
|---|---|---|---|
| LN dissection | | | 0.202 |
| D1+ or less | 19 (52.8) | 29 (64.4) | |
| D2 or more | 17 (47.2) | 16 (35.6) | |
| Operation time (min) | 213.8±43.1 | 200.2±36.1 | 0.127 |
| EBL (mL) | 150.7±146.8 | 134.2±164.9 | 0.641 |
| Combined resection | | | 0.694 |
| No | 35 (97.2) | 44 (97.8) | |
| Colon segmental resection | 0 (0) | 1 (2.2) | |
| Jejunal segmental resection | 1 (2.8) | 0 (0) | |
| Additional port insertion | 0 (0) | 0 (0) | - |
| Open conversion | 0 (0) | 0 (0) | - |

Data are given as numbers (%) or the mean ± standard deviation.
LN = lymph node; EBL = estimated blood loss; TLTG = totally laparoscopic total gastrectomy.

**Table 3.** Pathologic results

| Variables | 3-Port TLTG (n=36) | 5-Port TLTG (n=45) | P-value |
|---|---|---|---|
| No. of tumors | | | 0.585 |
| 1 | 29 (80.6) | 40 (88.9) | |
| 2 | 6 (16.7) | 4 (8.9) | |
| 3 | 1 (2.8) | 1 (2.2) | |
| Tumor diameter (cm) | 3.5±1.7 | 2.8±2.0 | 0.110 |
| Histology | | | 0.755 |
| Differentiated | 17 (47.2) | 25 (55.6) | |
| Undifferentiated | 16 (44.4) | 16 (35.6) | |
| Others | 3 (8.3) | 4 (8.9) | |
| Location, longitudinal | | | 0.415 |
| Cardia | 0 (0) | 2 (4.4) | |
| Upper 1/3 | 31 (86.1) | 34 (75.6) | |
| Middle 1/3 | 4 (11.1) | 8 (17.8) | |
| Lower 1/3 | 1 (2.8) | 1 (2.2) | |
| Location, circumferential | | | 0.243 |
| LC | 18 (50.0) | 21 (46.7) | |
| GC | 0 (0) | 4 (8.9) | |
| AW | 6 (16.7) | 10 (22.2) | |
| PW | 12 (33.3) | 10 (22.2) | |
| PRM (cm) | 2.0±1.2 | 2.7±1.8 | 0.053 |
| DRM (cm) | 12.3±3.7 | 13.6±3.8 | 0.124 |
| No. of retrieved LNs | 51.5±17.9 | 44.8±21.0 | 0.134 |
| Suprapancreatic | 13.1±6.3 | 10.0±5.3 | 0.019 |
| Perigastric | 36.9±13.9 | 35.2±18.9 | 0.660 |
| pT stage | | | 0.328 |
| 1 | 29 (80.6) | 39 (86.7) | |
| 2 | 7 (19.4) | 6 (13.3) | |
| pN stage | | | 0.161 |
| 0 | 35 (97.2) | 40 (88.9) | |
| 1 | 1 (2.8) | 5 (11.1) | |
| Stage (AJCC 8th edition) | | | 0.514 |
| IA | 28 (77.8) | 34 (75.6) | |
| IB | 8 (22.2) | 11 (24.4) | |

Data are given as numbers (%) or the mean ± standard deviation.
LC = lesser curvature; GC = greater curvature; AW = anterior wall; PW = posterior wall; PRM = proximal resection margin; DRM = distal resection margin; LN = lymph node; pT stage = pathological depth of invasion; pN stage = pathological nodal metastasis; AJCC = American Joint Committee of Cancer; TLTG = totally laparoscopic total gastrectomy.

The complication rates were 11.1% and 13.3% (P=0.519), respectively. There were 3 and 5 cases of severe complications (Clavien-Dindo classification 3) in each group. With respect to EJ anastomosis, the 3-port TLTG group included 2 cases (5.6%) of anastomosis leakage, while

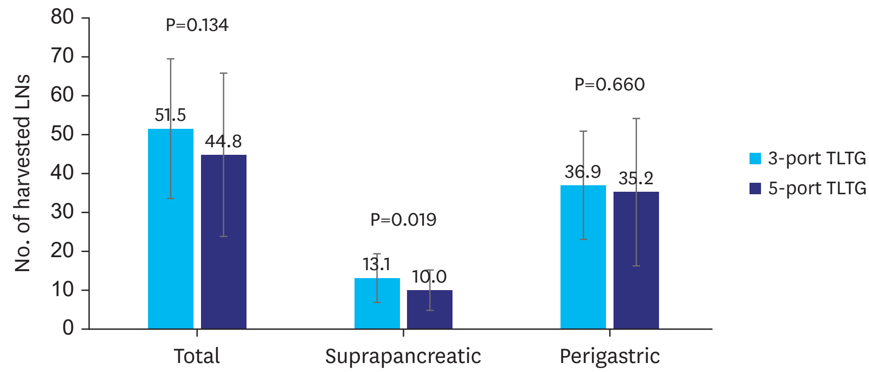


**Fig. 2.** Number of harvested LNs according to the area. The number of retrieved suprapancreatic LNs is significantly higher in the 3-port TLTG group (13.1 vs. 10.0, P=0.019).
LN = lymph node; TLTG = totally laparoscopic total gastrectomy.

**Table 4.** Postoperative short-term outcomes

| Variables | 3-Port TLTG (n=36) | 5-Port TLTG (n=45) | P-value |
|---|---|---|---|
| Duration to flatus (days) | 2.8±0.9 | 3.4±1.8 | 0.079 |
| Duration to soft diet (days) | 4.4±1.2 | 5.6±3.0 | 0.032 |
| Duration to discharge (days) | 10.2±8.7 | 12.4±20.6 | 0.541 |
| All complications | 4 (11.1) | 6 (13.3) | 0.519 |
| CDC ≥3 | 3 (8.3) | 5 (11.1) | 0.488 |
| Mortality | 0 (0) | 0 (0) | - |
| Complication details | | | |
| Anastomosis leakage | 2 (5.6) | 4 (8.9) | 0.450 |
| Anastomosis stricture | - | - | - |
| Anastomosis bleeding | - | - | - |
| Duodenal stump leakage | - | - | - |
| Intra-abdominal bleeding | 0 (0) | 1 (2.2) | 0.556 |
| Intra-abdominal infection | 1 (2.8) | 1 (2.2) | 0.694 |
| Pulmonary | 1 (2.8) | 2 (4.4) | 0.584 |
| Ileus | - | - | - |
| Wound infection | - | - | - |

Data are given as numbers (%) or the mean ± standard deviation.
CDC = Clavien-Dindo classification; TLTG = totally laparoscopic total gastrectomy.

the 5-port TLTG group included 4 cases (8.9%), with no significant differences. No instances of anastomotic stricture or bleeding were observed in either group. In addition, there was no significant difference with respect to postoperative short-term outcomes, except that the duration to soft diet was slightly shorter in the 3-port TLTG group (4.4 days vs. 5.6 days, P=0.032) (**Table 4**).

Univariate and multivariate logistic regression analyses to determine the risk factors for overall complications showed that none of the variables, including number of ports, were independent risk factors (**Table 5**).

## DISCUSSION

Numerous studies have explored the use of RPS in gastric cancer surgery [5,6,8-10,12,13,15]. Although significant cosmetic improvement or pain relief is difficult to demonstrate, the short- and long-term outcomes consistently indicate the surgical and oncological safety of RPS [7,15,22]. Furthermore, RPS has been proposed as a solution to address the shortage of


https://doi.org/10.5230/jgc.2023.23.e26

**Table 5.** Risk factors for overall complications

| Variables | Univariate | | | | Multivariate | | | |
|---|---|---|---|---|---|---|---|---|
| | OR | LCI | UCI | P-value | OR | LCI | UCI | P-value |
| Age | 1.032 | 0.924 | 1.152 | 0.581 | | | | |
| Female sex | 0.116 | 0.007 | 1.989 | 0.137 | 0.203 | 0.023 | 1.827 | 0.155 |
| ECOG score | | | | | | | | |
| 0 | Reference | | | 0.469 | | | | |
| 1 | 0.211 | 0.018 | 2.512 | 0.218 | | | | |
| 2 | 0.000 | 0.000 | | 0.999 | | | | |
| BMI | 0.834 | 0.637 | 1.091 | 0.186 | | | | |
| History of abdominal surgery | 3.540 | 0.591 | 21.201 | 0.166 | | | | |
| History of ESD | 4.554 | 0.537 | 38.655 | 0.165 | | | | |
| D2 LN dissection | 7.891 | 1.100 | 56.621 | 0.040 | 3.337 | 0.818 | 13.603 | 0.093 |
| Pathologic stage IB | 0.820 | 0.105 | 6.394 | 0.849 | | | | |
| 3-Port TLTG | 1.884 | 0.355 | 10.001 | 0.457 | | | | |

OR = odds ratio; LCI = lower confidence interval; UCI = upper confidence interval; ECOG = Eastern Cooperative Oncology Group; BMI = body mass index; ESD = endoscopic submucosal dissection; LN = lymph node; TLTG = 3-port total laparoscopic total gastrectomy.

surgical personnel and the excessive workload placed on surgeons [15]. The authors reported the feasibility of 3-port TLDG, which used only 3 ports on the right side of the patient without any special instruments, as an RPS option in treating gastric cancer [6,9,10,15]. Although the majority of studies examining RPS in gastric cancer surgery have focused on distal gastrectomy for early stage gastric cancer, the feasibility of RPS for total gastrectomy remains unclear owing to the complexity of the procedure [23,24].

Total gastrectomy requires the additional dissection of LN #2, #4sa, #11d, and #10 [11]. These LN stations are all located in the upper left quadrant; this makes it relatively challenging for the operator to access them through the right-side trocars because they are farthest from the operator's side. Particularly, in the case of the RPS, the absence of an assistant pushing the stomach to the left increases the difficulty. Moreover, the increased distance creates a narrower instrument angle, making it challenging to manipulate a relatively large stomach fundus. To address this, the authors employed gauze packing and position-tilting techniques [15]. During LN #10 dissection, it is particularly challenging to proceed with dissection using only one hand while lifting the stomach with the other hand [25]. Hence, if necessary, we first performed esophageal transection and then dissected LN #10 while lifting the stomach to the left side of the patient. This change in the order of LN dissection enabled en bloc resection without the need for special instruments. Despite the challenges posed by this approach, the results showed no significant differences in the number of harvested LNs at the corresponding stations between the 2 groups.

Performing EJ anastomosis presents a challenge during total gastrectomy, as it requires simultaneous manipulation of the esophagus, crus muscle, and jejunum [17,18,26]. A significant aspect of our study was the intracorporeal execution of all EJ anastomoses using a linear stapler. Typically, a 12-mm trocar on the right side is used for linear staplers; however, in cases where achieving the necessary angle for anastomosis with a right-side trocar is challenging, a 12-mm umbilical trocar facilitates EJ anastomosis. Careful consideration is given to selecting the optimal jejunal anastomosis point, ensuring adequate mesenteric length to prevent tension or jejunal perforation during linear stapling anastomosis. Furthermore, meticulous closure of the entry hole is performed by manual suturing with a barbed suture to prevent post-EJ anastomotic strictures [27].

Comparatively, EJ anastomosis using a linear stapler yielded favorable outcomes in terms of anastomosis-related complications, especially in anastomosis stricture [18,20]. Additionally, this procedure offers the advantage of avoiding mini-laparotomy, thereby contributing to the growing preference for linear stapler anastomosis. This preference is particularly evident in RPS cases, wherein the benefits of using a linear stapler for anastomosis can be maximized. In the current study, the 3-port TLTG group showed no significant increase in operation time or complications compared to the 5-port group. Although assistant support is essential for EJ anastomosis using a circular stapler, the overlapping method with a linear stapler demonstrates the feasibility of safely performing the procedure without the need for assistant support [18].

Several studies have investigated the feasibility of RPS [5,12,13,23,29]. However, there was no unified method for EJ anastomosis across the groups, even within each group. Some studies utilized a circular stapler in the 5-port group and a linear stapler in the RPS group [5,12,13], while another study employed both linear and circular staplers in both groups [23]. Additionally, a case report described the use of manual suturing for EJ anastomosis [28]. Meanwhile, the present study used intracorporeal linear stapling for all anastomoses in both groups and closed the entry holes with the same barbed suture material. This standardized approach allowed a precise comparison of the surgical procedures, including EJ anastomosis. Furthermore, although some previous studies have used specialized instruments, such as a flexible scope or multichannel port in the RPS group, the present study used only standard instruments, including an energy device, rigid scope, straight forceps, and conventional trocars, without a multichannel port in the 3-port TLTG [5,13,23]. The findings suggest that the 3-port TLTG procedure can be performed without specialized instruments, which is another strength of the present study.

The present study has several limitations that need to be considered. First, this was a single-center retrospective study with a relatively small sample size. The results may not be generalizable to other populations or settings. Second, the results may have been affected by selection bias because the decision to perform 3-port TLTG was based on the surgeon's preference and experience. The younger age and fewer pulmonary comorbidities in the 3-port group could potentially influence postoperative complications. However, it can be argued that 3-port TLTG can be safely performed with careful patient selection. Finally, because these procedures are oncologic surgeries, conducting a comparison based on clinical stage or survival analysis according to pathologic stage is crucial for clinical application. This study involved patients with early stage disease, with a focus on assessment of the technical feasibility of RPS in total gastrectomy using a short-term report. Despite these limitations, this study also has several strengths. One of the notable strengths is that, to our best knowledge, this is the first study to demonstrate the feasibility of RPS for total gastrectomy using only a linear stapler and standard instruments, without the need for any specialized tools. Another advantage is that 3-port TLTG can be performed by a surgeon with just one assistant, potentially alleviating the shortage of surgical personnel and reducing excessive workload. Based on these strengths, we are currently conducting a prospective study on the RPS for distal gastrectomy, and the results of this study are expected to serve as a basis for future prospective research on the RPS for total gastrectomy.

In conclusion, 3-port TLTG with overlapping EJ anastomosis is a safe and effective alternative to conventional 5-port TLTG in select patients. In addition, it can be used as a new standard approach in patients requiring total gastrectomy for stage I gastric cancer.


https://doi.org/10.5230/jgc.2023.23.e26

Journal of Gastric Cancer

## SUPPLEMENTARY MATERIALS

### Supplementary Table 1

Number of retrieved LNs according to the station

Click here to view

### Supplementary Fig. 1

Patient enrollment flowchart.

Click here to view

### Supplementary Fig. 2

Distribution of port numbers by stage.

Click here to view

### Supplementary Fig. 3

Distribution of port numbers by surgeons.

Click here to view

### Supplementary Fig. 4

Number of harvested lymph nodes according to the stations.

Click here to view

## REFERENCES

1. Kim W, Kim HH, Han SU, Kim MC, Hyung WJ, Ryu SW, et al. Decreased morbidity of laparoscopic distal gastrectomy compared with open distal gastrectomy for stage I gastric cancer: short-term outcomes from a multicenter randomized controlled trial (KLASS-01). Ann Surg 2016;263:28-35.
PUBMED | CROSSREF
2. Kim HH, Han SU, Kim MC, Kim W, Lee HJ, Ryu SW, et al. Effect of laparoscopic distal gastrectomy vs open distal gastrectomy on long-term survival among patients with stage I gastric cancer: the KLASS-01 randomized clinical trial. JAMA Oncol 2019;5:506-513.
PUBMED | CROSSREF
3. Kim A, Lee CM, Park S. Is it beneficial to utilize an articulating instrument in single-port laparoscopic gastrectomy? J Gastric Cancer 2021;21:38-48.
PUBMED | CROSSREF
4. Lee Y, Kim HH. Single-incision laparoscopic gastrectomy for gastric cancer. J Gastric Cancer 2017;17:193-203.
PUBMED | CROSSREF
5. Kawamura H, Tanioka T, Kuji M, Tahara M, Takahashi M. The initial experience of dual port laparoscopy-assisted total gastrectomy as a reduced port surgery for total gastrectomy. Gastric Cancer 2013;16:602-608.
PUBMED | CROSSREF
6. Seo HS, Lee HH. Short-term outcomes of three-port totally laparoscopic distal gastrectomy in the treatment of gastric cancer: comparison with a four-port approach using a propensity score matching analysis. J Laparoendosc Adv Surg Tech A 2016;26:531-535.
PUBMED | CROSSREF

7. Lee HH, Jeong O, Seo HS, Choi MG, Ryu SY, Sohn TS, et al. Long-term oncological outcomes of reduced three-port laparoscopic gastrectomy for early-stage gastric carcinoma: a retrospective large-scale multi-institutional study. J Gastric Cancer 2021;21:93-102.
PUBMED | CROSSREF
8. Lai H, Yi Z, Long D, Liu J, Qin H, Mo X, et al. Is the 5-port approach necessary in laparoscopic gastrectomy? Comparison of surgical effects of reduced-port laparoscopic gastrectomy and conventional laparoscopic-assisted gastrectomy: a meta-analysis. Medicine (Baltimore) 2020;99:e22525.
PUBMED | CROSSREF
9. Seo HS, Lee HH. Is the 5-ports approach necessary in laparoscopic gastrectomy? Feasibility of reduced-port totally laparoscopic gastrectomy for the treatment of gastric cancer: a prospective cohort study. Int J Surg 2016;29:118-122.
PUBMED | CROSSREF
10. Seo HS, Jung YJ, Kim JH, Park CH, Lee HH. Three-port right-side approach-duet totally laparoscopic distal gastrectomy for uncut Roux-en-Y reconstruction. J Laparoendosc Adv Surg Tech A 2018;28:1109-1114.
PUBMED | CROSSREF
11. Kim TH, Kim IH, Kang SJ, Choi M, Kim BH, Eom BW, et al. Korean practice guidelines for gastric cancer 2022: an evidence-based, multidisciplinary approach. J Gastric Cancer 2023;23:3-106.
PUBMED | CROSSREF
12. Kim HB, Kim SM, Ha MH, Seo JE, Choi MG, Sohn TS, et al. Comparison of reduced port totally laparoscopic-assisted total gastrectomy (duet TLTG) and conventional laparoscopic-assisted total gastrectomy. Surg Laparosc Endosc Percutan Tech 2016;26:e132-e136.
PUBMED | CROSSREF
13. Kunisaki C, Makino H, Kimura J, Takagawa R, Ota M, Kosaka T, et al. Application of reduced-port laparoscopic total gastrectomy in gastric cancer preserving the pancreas and spleen. Gastric Cancer 2015;18:868-875.
PUBMED | CROSSREF
14. Amin MB, Greene FL, Edge SB, Compton CC, Gershenwald JE, Brookland RK, et al. The Eighth Edition AJCC Cancer Staging Manual: continuing to build a bridge from a population-based to a more "personalized" approach to cancer staging. CA Cancer J Clin 2017;67:93-99.
PUBMED | CROSSREF
15. Seo HS, Song KY, Jung YJ, Kim JH, Park CH, Lee HH. Right-side approach-duet totally laparoscopic distal gastrectomy (R-duet TLDG) using a three-port to treat gastric cancer. J Gastrointest Surg 2018;22:578-586.
PUBMED | CROSSREF
16. Jeong GA, Cho GS, Song OP, Kim HC, Lim CW, Shin EJ, et al. A useful procedure in laparoscopy-assisted total gastrectomy: the downstream procedure. J Minim Invasive Surg 2008;11:15-20.
17. Inaba K, Satoh S, Ishida Y, Taniguchi K, Isogaki J, Kanaya S, et al. Overlap method: novel intracorporeal esophagojejunostomy after laparoscopic total gastrectomy. J Am Coll Surg 2010;211:e25-e29.
PUBMED | CROSSREF
18. Guo Z, Deng C, Zhang Z, Liu Y, Qi H, Li X. Safety and effectiveness of overlap esophagojejunostomy in totally laparoscopic total gastrectomy for gastric cancer: a systematic review and meta-analysis. Int J Surg 2022;102:106684.
PUBMED | CROSSREF
19. Miura S, Kanaya S, Hosogi H, Kawada H, Akagawa S, Shimoike N, et al. Esophagojejunostomy with linear staplers in laparoscopic total gastrectomy: experience with 168 cases in 5 consecutive years. Surg Laparosc Endosc Percutan Tech 2017;27:e101-e107.
PUBMED | CROSSREF
20. Park KB, Kim EY, Song KY. Esophagojejunal anastomosis after laparoscopic total gastrectomy for gastric cancer: circular versus linear stapling. J Gastric Cancer 2019;19:344-354.
PUBMED | CROSSREF
21. Ebihara Y, Kurashima Y, Tanaka K, Nakanishi Y, Asano T, Noji T, et al. A multicenter retrospective study comparing surgical outcomes between the overlap method and functional method for esophagojejunostomy in laparoscopic total gastrectomy: analysis using propensity score matching. Surg Laparosc Endosc Percutan Tech 2022;32:89-95.
PUBMED | CROSSREF
22. Kang SH, Yoo M, Hwang D, Lee E, Lee S, Park YS, et al. Postoperative pain and quality of life after single-incision distal gastrectomy versus multiport laparoscopic distal gastrectomy for early gastric cancer - a randomized controlled trial. Surg Endosc 2023;37:2095-2103.
PUBMED | CROSSREF

Journal of Gastric Cancer


23. Teng W, Liu J, Liu W, Jiang J, Chen M, Zang W. Short-term outcomes of reduced-port laparoscopic surgery versus conventional laparoscopic surgery for total gastrectomy: a single-institute experience. BMC Surg 2023;23:75.
PUBMED | CROSSREF

24. Choi S, Son T, Song JH, Lee S, Cho M, Kim YM, et al. Intracorporeal esophagojejunostomy during reduced-port totally robotic gastrectomy for proximal gastric cancer: a novel application of the single-site® plus 2-port system. J Gastric Cancer 2021;21:132-141.
PUBMED | CROSSREF

25. Kinoshita T, Sato R, Akimoto E, Yoshida M, Harada J, Nishiguchi Y. Can laparoscopic spleen-preserving splenic hilar lymph node dissection replace prophylactic splenectomy for proximal advanced gastric cancers that invade the greater curvature? Eur J Surg Oncol 2021;47:1466-1472.
PUBMED | CROSSREF

26. Inokuchi M, Otsuki S, Fujimori Y, Sato Y, Nakagawa M, Kojima K. Systematic review of anastomotic complications of esophagojejunostomy after laparoscopic total gastrectomy. World J Gastroenterol 2015;21:9656-9665.
PUBMED | CROSSREF

27. Umemura A, Koeda K, Sasaki A, Fujiwara H, Kimura Y, Iwaya T, et al. Totally laparoscopic total gastrectomy for gastric cancer: literature review and comparison of the procedure of esophagojejunostomy. Asian J Surg 2015;38:102-112.
PUBMED | CROSSREF

28. Dapri G, Gomez MG, Cadière GB, Yang HK. Three trocars laparoscopic total gastrectomy + D2 lymphadenectomy with intracorporeal manual esojejunostomy. Ann Surg Oncol 2017;24:1658-1659.
PUBMED | CROSSREF



https://doi.org/10.5230/jgc.2023.23.e26