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ORIGINAL ARTICLE

Laparoscopic double-tract proximal gastrectomy for proximal early gastric cancer

Sang-Hoon Ahn · Do Hyun Jung · Sang-Yong Son · Chang-Min Lee · Do Joong Park · Hyung-Ho Kim

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Abstract
Background Proximal gastrectomy is not routinely performed because it is associated with increased reflux symptoms and anastomotic strictures. The purpose of this study is to describe a novel method of laparoscopic proximal gastrectomy (LPG) with double-tract reconstruction (DTR) for proximal early gastric cancer (EGC), and to evaluate the technical feasibility, safety, and short-term surgical outcomes, especially reflux symptoms, after LPG.
Methods Retrospective review of the prospective cohort data of 43 patients who presented to a single tertiary hospital from June 2009 through April 2012 and underwent LPG with DTR for proximal EGC. The data of this prospective cohort were analyzed, and the reflux symptoms, clinicopathologic characteristics, surgical outcomes, postoperative morbidities and mortalities, and follow-up findings were analyzed.
Results The mean surgical time was 180.7 min; mean estimated blood loss, 120.4 mL; mean length of the proximal resection margin, 4.13 cm; mean number of retrieved lymph nodes, 41.2; and mean postoperative hospital stay, 7.1 days. Early complication rate was 11.6 % ($n = 5$); major complication (grade higher than Clavien-Dindo IIIa) occurred in 1 patient (2.3 %). Late complication rate was 11.6 % ($n = 5$): 2 patients had esophagojejunostomy stenosis, which was successfully treated with fluoroscopic balloon dilatations; 1, chylous ascites; and 2 had Visick grade II reflux symptoms (4.6 %), managed by medication during the mean follow-up period of 21.6 months.
Conclusion DTR after LPG is a feasible, simple, and novel reconstruction method with excellent postoperative outcomes in terms of preventing reflux symptoms. Its clinical applicability must be validated by prospective randomized trials.

Keywords Gastric cancer · Laparoscopy · Proximal gastrectomy · Laparoscopic proximal gastrectomy (LPG) · Double tract reconstruction (DTR) · Proximal EGC

Introduction

In Korea, over the last 2 decades, the incidence of early gastric cancer (EGC) and proximal gastric cancer has gradually increased from 24.8 % to ~50 % and from 5.3 to 14.0 %, respectively. Proximal EGC comprises 30.3 % of all proximal gastric cancers, whereas distal EGC comprises 51.5 % of all distal gastric cancers. Consequently, the need for surgical treatment of proximal EGC, by total or proximal gastrectomy has gradually been increasing. However, since proximal gastrectomy often leads to reflux esophagitis and anastomotic strictures, it is not routinely performed in Korea and other countries. In 2009, proximal gastrectomy was performed in only 1 % (139 cases) of all gastric operations in Korea, including open cases [1–3]. Furthermore, although various reconstruction methods have been reported thus far, the optimal reconstruction method after proximal gastrectomy remains controversial

S.-H. Ahn · D. H. Jung · S.-Y. Son · C.-M. Lee · D. J. Park · H.-H. Kim
Department of Surgery, Seoul National University College of Medicine, Seoul, Korea

S.-H. Ahn · D. H. Jung · S.-Y. Son · C.-M. Lee · D. J. Park · H.-H. Kim (✉)
Department of Surgery, Seoul National University Bundang Hospital, 300 Gumi-dong, Bundang-gu, Seongnam, Gyeonggi-do 463-707, Korea
e-mail: hhkim@snubh.org

[4]. In general, total gastrectomy is recommended due to the high morbidity rates associated with proximal gastrectomy [5].

However, if the rate of reflux esophagitis and anastomotic stricture after proximal gastrectomy can be lowered to that of total gastrectomy, proximal gastrectomy may become a treatment of choice for proximal EGC. The purpose of this study was to assess the feasibility, safety, and surgical outcomes of a novel technique designed to prevent reflux symptoms-laparoscopic proximal gastrectomy (LPG) with double tract reconstruction (DTR). To our knowledge, thus far, this is the first study to report a surgical procedure involving LPG and DTR for proximal EGC.

Methods

Patients

From June 2009 to April 2012, 43 patients underwent LPG with DTR for proximal EGC at Seoul National University Bundang Hospital, Korea. In this study, we included patients with a preoperative diagnosis of a <5-cm wide T1N0 lesion in the proximal stomach, in whom no lymph node (LN) enlargement was observed in LN stations 5, 6, and 10, according to endoscopy, endoscopic ultrasonography, and computed tomography (CT). Preoperative reflux esophagitis were evaluated by the Visick score and endoscopic findings (Los Angeles classification). Double tract reconstruction is a reconstruction method after proximal gastrectomy which consists of 3 anastomoses: esophagojejunostomy (E-Jstomy), gastrojejunostomy(G-Jstomy) 15 cm below E-Jstomy and jejunojejunostomy (J-Jstomy) 20 cm below G-Jstomy (Fig. 1). Double tract means that food passage after reconstruction flows simultaneously to the stomach and jejunum.

Procedures

Laparoscopic proximal gastrectomy

The patient was placed in a reverse Trendelenburg position under general anesthesia. The operator, a scopist, was positioned on the right side of the patient, and the first assistant was positioned on the left side of the patient. Five working ports were placed, consisting of a 12-mm umbilical port, two 5-mm ports on right mid-clavicular and left mid-axillary line below the costal margin, a 12-mm port on the right mid-clavicular line 2–3 cm above the umbilicus, and a 12 mm port on the left mid-clavicular line at the umbilicus. First, the falciform ligament and left lobe of the liver were retracted by combined suture retraction of the

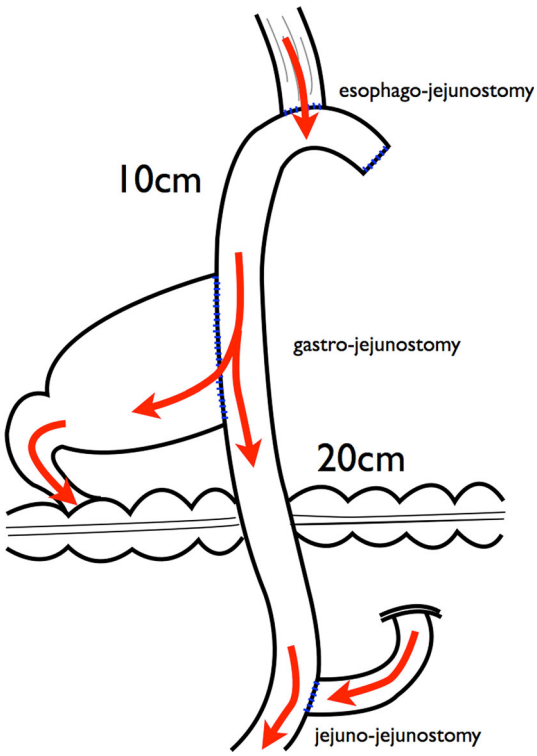

Fig. 1 Schematic illustration of double tract reconstruction

lesser omentum [6]. Partial omentectomy was started about 4 cm away from the gastroepiploic arcade. The left gastroepiploic vessels were ligated distal to the omental branch to prevent omental infarction and then divided using hemoclips. The omentum was dissected from the mesocolon around the transition zone of LN stations 4d to 6, and the right gastroepiploic vessels were preserved. The peritoneum along the superior edge of the pancreas was mobilized. The lesser omentum was mobilized with careful preservation of the right gastric vessels and the hepatic branch of the anterior vagus nerve. The hepatic and pyloric branches of the vagus nerves were routinely preserved (this is an important step to prevent delayed gastric emptying caused by pyloric dysfunction). Dissection proceeded along the LN stations 7, 8a, and 9. The coronary vein (left gastric vein) and the left gastric artery were then clipped and divided. Dissection was continued along the splenic artery up to the splenic hilum (LN stations 11p and 11d). The esophagogastric junction was mobilized. Next, an intracorporeal purse-string suture clamp "LapJack" (Eterne, Seoul, Korea) (Fig. 2) was applied to the esophagus, and endo-bulldog (B. Braun Melsungen AG, Melsungen, Germany) was applied to its distal portion for the prevention of spillage from the stomach. After a purse-string suture was made using a straight needle (Prolene 2–0), the esophagus was transected. Dissection was carried out by the "downstream method" to dissect the LN stations 2 and 4sa. A 3–4-cm-long transverse incision was made

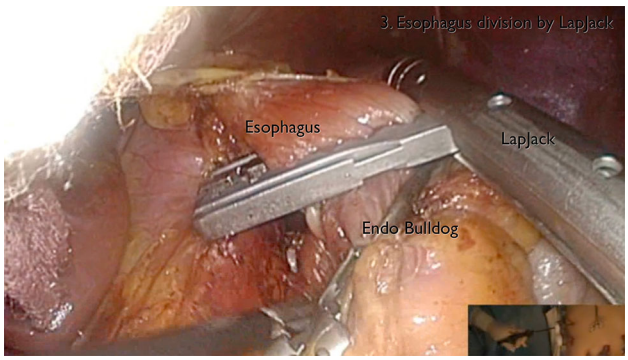

Fig. 2 Intracorporeal purse-string suture clamp (LapJack) application

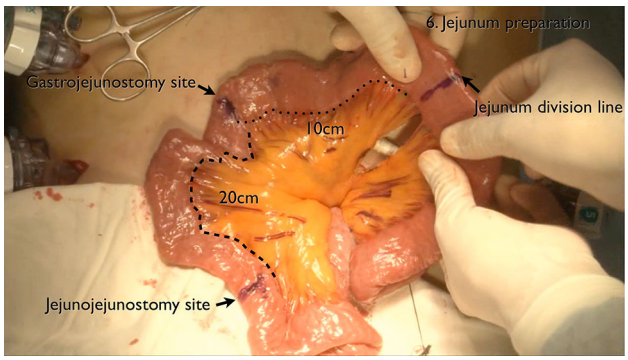

Fig. 3 Jejunum preparation

with extension of the left 12-mm trocar site. The stomach was delivered through this mini-laparotomy, and the specimen was transected by linear staplers after ensuring the distal resection margin and trimming the gastroepiploic arcade.

Reconstructions

The anvil head of the circular stapler was placed in the abdominal cavity, and the pneumoperitoneum was re-established using a wound retractor and glove. The anvil head was intracorporeally inserted into the esophagus stump using a laparoscopic anvil clamp, and the purse-string suture was tied laparoscopically. After the purse-string suture was tied, an Endo-loop (Ethicon Endo-Surgery, Somerville, NJ) was also added to the proximal portion of the first knot for reinforcement. A Roux-en-Y esophagojejunostomy (E-Jstomy) was performed by intracorporeal anastomosis with a circular stapler by a mini-laparotomy, and the jejunal stump was closed with a linear stapler. Next, side-to-side gastrojejunostomy (G-Jstomy), 10 cm below the E-Jstomy, was performed in an extracorporeal fashion using 2 linear staplers (Fig. 3). Finally, end-to-side jejunojejunostomy (J-Jstomy), 20 cm below the G-Jstomy, was performed by an extracorporeal hand-sewing suture. The abdominal cavity was checked, 1 or 2 Jackson-Pratt (J-P) drainage tubes were placed through the trocar wounds around the E-Jstomy, and the incisions were closed.

Postoperative care

During the postoperative period, the patients were managed according to our hospital's critical pathway protocols. Sips of water, a semifluid diet (SFD), and a soft blended diet (SBD) were given to the patients on postoperative days 3, 4, and 5, respectively. After SBD intake, the J-P drainage tube was removed. Finally, the patients were routinely discharged from the hospital on postoperative day 6 if they exhibited no discomfort, abdominal pain, or abnormal laboratory test results.

Evaluation of the clinical parameters

The clinical features, surgical parameters (e.g., sex, age, tumor size, histological type, length of resection margin, and number of retrieved and metastatic LNs), early postoperative complications (0–30 days), and late postoperative complications (>30 days) were analyzed based on the information obtained from our prospectively maintained gastric cancer database and electric medical record. Postoperative complications were classified according to the Clavien–Dindo classification, and grades of complications were recorded. Major complications were defined as those with grades higher than Clavien–Dindo classification IIIa. Patients were routinely followed at our outpatient clinic at 1, 3, 6, and 12 months postoperatively and annually thereafter. Anastomotic stenosis and reflux symptoms were diagnosed based on endoscopic findings and patient symptoms. The definition of anastomotic stenosis was diagnosed when patients complained of dysphagia during the postoperative follow-up and a 9-mm-diameter endoscope could not pass the E-Jstomy. Reflux symptoms were diagnosed by modified Visick scores. A telephone survey for the post-gastrectomy symptoms (abdominal pain, meal related distress, indigestion, diarrhea, constipation and dumping) and the relative volume of oral intake was performed. A gastric emptying scan was performed at 3 months after operation. Delayed gastric emptying and relative intake between the stomach and the small bowel were analyzed. Radioactivity was measured in every 30 up to 120 min after the intake of solid food mixed with 2 mCi technetium-99 m-DTPA (diethylene-triamine-pentaacetate). The half-life and the gastric emptying time were calculated by the exponential function. The normal range of gastric emptying time in our institution is 70–150 min. For evaluating the nutritional status, body weight and serum levels of total protein and albumin were measured

before the operation, and at 3, 6, and 12 months after the operation. This study was approved by the ethics committee of the hospital (No. B-1203/147–105).

Statistical analysis

Statistical analyses were performed with the SPSS statistical software, version 18.0, for Windows (SPSS, Chicago, IL, USA). All values are expressed as the mean ± standard deviation (SD) of the mean. Nutritional parameters were analyzed by the paired-samples *t*-test. $P < 0.05$ was considered statistically significant.

Results

Patient demographics

Patient characteristics are described in Table 1. The study cohort included 35 men and 8 women, with a mean age of 59.9 years. Comorbidities existed in 17 patients (30.2 %) and body mass index (BMI, kg/m^2) was 23.7 (range 17.4–30.3). Of the 43 patients, 10 patients had a history of previous abdominal operation. None of the patients had gastroesophageal reflux disease according to the Los Angeles classification during the preoperative evaluation by endoscopy and Visick score.

Surgical parameters and short-term surgical outcomes

All the surgeries, involving D1 + beta lymphadenectomy without any open conversion, were performed by a single surgeon (H.-H. Kim). The surgical parameters of the 43 patients are shown in Table 2. The surgical time was calculated from the start of the incision to the closure of the wound, and the mean operative time was 180.7 min (range 115–300 min). The mean estimated blood loss was 120.4 mL (range 30–300 mL). No serious intraoperative events or complications were observed. The median postoperative hospital stay was 7.1 days. The overall early complication rate was 11.6 % ($n = 5$); the early complications included 1 case each of postoperative bleeding at the mesentery of the Roux limb, wound seroma, lung atelectasis, aspiration pneumonia, and postoperative ileus. Wound and lung complications were treated and improved by conservative management. In the case of bleeding, the patient underwent immediate laparoscopic bleeding control on the night of the operation. Postoperative ileus was improved by fasting for 5 days. A major complication, defined by a grade higher than Clavien–Dindo IIIa, was observed in 1 patient (2.3 %).

Late complications (reflux esophagitis and anastomotic stricture) and post-gastrectomy symptoms

The overall rate of late complications was 11.6 % (5 of 43 patients). These complications included 2 cases of anastomotic stenosis, 2 cases of reflux symptoms, and 1 case of chylous ascites. The 2 patients with stenosis were successfully treated with fluoroscopic balloon dilatations. Reflux symptoms in the other 2 patients were classified as

Table 1 Patient demographics

	LPG ($n = 43$)	Range
Age (years, mean ± SD)	59.9 (±11.9)	35–85
Gender (male:female)	35:8	
Smoking	30.2 % ($n = 13$)	
Body mass index (BMI, kg/m^2)	23.7 (±2.9)	17.4–30.3
Previous abdominal surgery	23.3 % ($n = 10$)	
Comorbidity	39.5 % ($n = 17$)	
ASA score		
1	17	
2	22	
3	3	
Gastroesophageal reflux disease (based on Visick score and LA classification)	0 %	

ASA American society of anesthesiologists, *LA* Los Angeles

Table 2 Operative data and short-term surgical outcomes

	LPG ($n = 43$)	Range
Operative time (minutes)	180.7 (±38.7)	115–260
Estimated blood loss (EBL, mL)	120.4 (±74.3)	12–300
Gas passing (POD)	4.0 (±0.9)	2–6
Start of diet (POD)	4.0 (±0.7)	3–6
Postoperative hospital stays (days)	7.1 (±3.1)	6–22
Median follow-up (months)	21.6 (±16.7)	1.7–79.5
Early complications	11.6 % ($n = 5$)	
Major[a]	1	
Minor[b]	4	
Late complications	11.6 % ($n = 5$)	
Anastomotic stenosis	4.65 % ($n = 2$)	
Reflux symptoms	4.65 % ($n = 2$)	
Chyle ascites	2.33 % ($n = 1$)	
Re-operation[a]	1	
Postoperative mortality	0	

[a] Major complication: re-operation due to postoperative bleeding

[b] Minor complication: 1 wound seroma, 1 lung atelectasis, 1 aspiration pneumonia and 1 postoperative ileus

Table 3 Postoperative endoscopic findings, the rate of post-gastrectomy symptoms, and relative volume of food intake after DTR comparing with volume of oral intake in the preoperative period

	LPG ($n = 43$)	Range
Success rate of endoscopic evaluation of remnant distal stomach	93.0 % (40/43)	
Rate of food residue in endoscopy	48.9 % (21/43)	
Rate of gastritis in endoscopy	14.0 % (6/43)	
Abdominal pain	16.3 % (7/43)	
Meal-related distress	30.2 % (13/43)	
Indigestion	11.6 % (5/43)	
Diarrhea	27.9 % (12/43)	
Constipation	23.3 % (10/43)	
Dumping	11.6 % (5/43)	
Relative volume of food intake	72.3 % (±24.0)	40–100

Table 4 Pathologic findings, recurrence and survival data

	LPG ($n = 43$)	Range
Tumor size (cm)	2.51 (±1.33)	0.6–6.1
Proximal resection margin (cm)	4.13 (±2.24)	2.2–11.3
Distal resection margin (cm)	3.54 (±1.36)	2.2–9.1
T stage		
T1	33	
T2	8	
T3	2	
N stage		
N0	37	
N1	3	
N2	2	
N3a	1	
Stage		
Ia	33	
Ib	4	
II	4	
IIIb	1	
IIIc	1	
Numbers of retrieved lymph node	41.2 (±19.7)	16–117
Recurrence	2.3 % ($n = 1$)	
Adjuvant chemotherapy	11.6 % ($n = 5$)	
Overall survival rate	100 %	
Median follow-up	21.6 (±16.7)	3.1–79.5

Visick grade II, based on the Visick score, and were easily controlled by medications (Table 2).

Endoscopic evaluation of reflux esophagitis and a remnant distal stomach

At 3 months after the operation, we routinely performed endoscopy for evaluation of reflux esophagitis and a remnant distal stomach. In the 43 patients who received an endoscopy, no reflux esophagitis was found during the endoscopic evaluation and 3 intubation failures occurred during the examination for a remnant distal stomach (Table 3).

Pathologic findings, and recurrence and survival data

The pathologic findings of this study are shown in Table 4. All the patients were diagnosed with proximal EGC during the preoperative examinations. All the LN dissections were D1 + beta, and the mean number of LNs retrieved was 41.2 (range 16–117). The mean lengths of the proximal and distal resection margins were 4.13 and 3.54 cm, respectively. Adjuvant chemotherapy was recommended in 5 patients with stage II, and III disease, according to the AJCC/UICC sixth edition until 2010 and the AJCC/UICC seventh edition since 2010. The median follow-up period was 21.6 (range 3.1–79.5) months. At the final follow-up, tumor recurrence was found to occur in 1 patient, with a median follow-up. The disease stage in this patient was stage IIIb. The recurrence pattern was peritoneal seeding. The overall survival rate of our study group was 100 %.

Gastric emptying scan

We performed a routine gastric emptying scan at 3 months after the operation. The mean gastric emptying time was 164.3 min (range 18–377 min, $n = 31$); this finding shows that gastric emptying was delayed to some extent. Approximately 60 % of the food consumed remained in the stomach and 40 % in the jejunum. The relative ratio of food flow from the stomach to the small intestine after DTR was ~3:2.

Nutritional parameters

To evaluate the postoperative nutritional status, the serum levels of total protein and albumin at the first, third, and sixth postoperative months were measured and compared with the preoperative data. The total protein and albumin levels were both significantly decreased 1 month after the operation (7.11 versus 6.34, $P < 0.0001$; 4.36 versus 3.72, $P < 0.0001$, respectively). However, these levels returned to normal 3 months after the operation (Fig. 4). Additionally, the mean weight loss 1, 6 months after the operation was 2.9 and 5.9 %, respectively.

Comparison with previous study

When we compared these main results with our previous study [7], the mean operation time and postoperative hospital stay were significantly shorter and the early

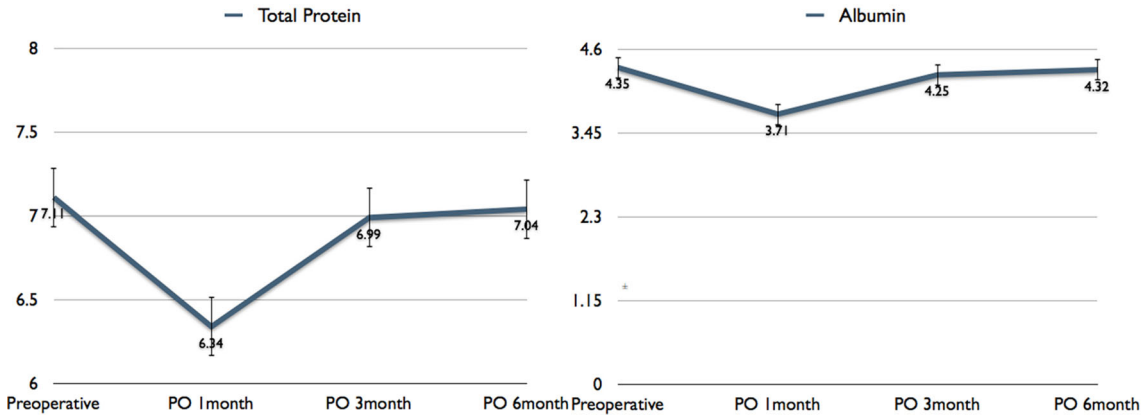

Fig. 4 Nutritional outcome

Table 5 Comparison of DTR with EEEG and SSEG which were analyzed in the previous our study in our institution

	EEEG ($n = 13$)	SSEG ($n = 37$)	DTR ($n = 43$)	P value
Operation time (minutes)	190.0	225.6	180.7	0.009
Estimated blood loss (mL)	103.3	121.5	120.4	0.727
Postoperative hospital stays (days)	12.7	11.0	7.1	0.017
Early complications	15.4 % ($n = 2$)	27.0 % ($n = 10$)	11.6 % ($n = 5$)	0.135
Anastomotic stenosis	46.2 % ($n = 4$)	0 % ($n = 0$)	4.65 % ($n = 2$)	<0.001
Reflux symptoms	15.4 % ($n = 2$)	37.8 % ($n = 14$)	4.65 % ($n = 2$)	0.017
Visick II	1	7	2	
Visick III	0	4	0	
Visick IV	1	3	0	
Body weight change (kg)	−7.2	−5.4	−3.7	
Median follow up (months)	34.3	30.5	21.6	

EEEG end-to-end esophagogastrostomy, *SSEG* side-to-side esophagogastrostomy, *DTR* double-tract reconstruction

complication rates showed a trend toward being reduced in the DTR group. The rate of reflux symptoms significantly decreased from the E-Gstomy group to the DTR group. Furthermore, in the DTR group, there were no patients with greater than Visick score of II (Table 5).

Discussion

In this study, we analyzed the surgical outcomes of LPG with DTR in 43 patients with proximal EGC. To our knowledge, this is first report to describe the application of LPG with DTR for proximal EGC, which shows excellent postoperative outcomes, especially with respect to decreased reflux symptoms. This novel procedure was found to have acceptable oncologic outcomes, surgical time, and complications rates. Thus, we conclude that DTR after LPG with D1 + beta LN dissection is a likely acceptable treatment for proximal EGC; furthermore, it is a feasible, safe, and useful method for preventing reflux esophagitis.

Proximal gastrectomy is classified as modified gastrectomy for patients with cT1N0 by the Japanese gastric cancer treatment guidelines (third edition) [8]. The application of proximal gastrectomy to proximal EGC has been limited due to the following 3 main concerns: oncologic safety, functional benefits, and late complications such as reflux esophagitis and anastomotic stenosis. In a recent systematic and meta-analysis comparing total gastrectomy with proximal gastrectomy, it was concluded that total gastrectomy and proximal gastrectomy had similar overall survival outcomes for proximal gastric cancer; however, proximal gastrectomy with esophagogastrostomy showed a higher incidence of reflux esophagitis and anastomotic stenosis. Total gastrectomy was therefore recommended for proximal gastric cancer [9]. However, the number of cases of proximal EGC has been increasing in Korea due to national screening programs and advances in endoscopic diagnosis and devices [1–3]. Is it justified for all these patients with EGC, who are capable of showing a good survival rate after surgery, to undergo open total gastrectomy?

As a minimally invasive surgery, laparoscopic gastrectomy has several advantages over open gastrectomy, especially with respect to early postoperative outcomes—that is, it reduces postoperative pain, surgical stress, and estimated blood loss, it accelerates recovery and return to normal bowel function and oral intake, and it reduces the duration of hospital stay [10–13]. Because gastric cancer is mostly located in the distal area in Eastern countries, laparoscopic distal gastrectomy has been a more common procedure than laparoscopic total or proximal gastrectomy. However, recently, positive outcomes of laparoscopic total or proximal gastrectomy have been reported [7, 14, 15].

In this context, laparoscopic proximal gastrectomy is an attractive treatment option for proximal EGC when considering the prognosis of EGC, the advantages of a minimally invasive surgery and function preservation, including improved nutrition, prevention of anemia, improved production of gut hormones, and a reduction of postoperative complaints [16–19].

If the incidence of late complications such as reflux esophagitis and anastomotic stenosis could be decreased to that of total gastrectomy, LPG has the potential to become the standard procedure for proximal gastrectomy. The most important technical challenge of LPG may be the reconstruction method, which needs to be designed to prevent reflux symptoms and anastomotic strictures. Several reconstruction methods have already been reported; however, an optimal reconstruction after LPG has not yet been established.

Several previous studies have applied direct esophagogastric anastomosis as the reconstruction method, probably because it is simple and needs only 1 anastomosis. Anti-reflux procedures such as a gastric tube formation, fundoplication, esophagopexy with crural repair and pyloroplasty have been used for preventing reflux esophagitis and anastomotic strictures. However, all these methods involved esophagogastrostomy, and the results were disappointing since the rate of reflux esophagitis and anastomotic stenosis were still high [4, 7, 20]. A good alternative to esophagogastrostomy reconstruction after proximal gastrectomy is the Roux-en-Y type E-Jstomy, which is the most powerful anti-reflux reconstruction. There are 2 kinds of E-Jstomy that can be performed after proximal gastrectomy—jejunal interposition and DTR. Jejunal interposition has been introduced as an alternative method for preventing severe reflux and is widely performed in open surgery; however, laparoscopic jejunal interposition has not yet gained acceptance due to its technical complexities. These complexities include the formation of a pedicled jejunal flap and the formation of 3 anastomoses. The mean surgical time was also relatively long (233–614 min) [21, 22].

At our institution, LPG with esophagogastrostomy was also performed since May 2003; however, the rate of reflux symptoms and anastomotic stenosis after esophagogastrostomy was still high, even though we gradually began to perform a few anti-reflux procedures as well (i.e., gastric tube formation, esophagopexy with crural repair and fundoplication). Therefore, in April 2009, LPG with DTR was introduced at our institute.

The LPG with DTR procedure showed a mortality rate of zero and a low rate of early postoperative complications. The late complication rate was also low, especially with respect to the rate of reflux symptoms and anastomotic stricture, which was nearly equivalent to that of total gastrectomy and jejunal interposition [18, 23].

This procedure has the following advantages. First, LPG with DTR is easier to perform, and it is a time-saving procedure in comparison to laparoscopic total gastrectomy (LTG) with E-Jstomy. This procedure involves the addition of just 1 more anastomosis, G-Jstomy by stapling, which adds only 5–10 min to the conventional LTG anastomosis procedure (E-Jstomy and J-Jstomy); moreover, we can save on surgical time because we do not need to dissect LN stations 5, 6, 12a or divide the duodenum. It is thought to be more natural than jejunal interposition because DTR does not need mesentery division and maintains the continuity of the jejunum. Second, revision of E-Jstomy does not involve re-operation of the gastric stump cancer, contrary to esophagogastrostomy, and it is also easier than jejunal interposition because it is easy to resect the efferent jejunal limb and to perform G-Jstomy and re-anastomosis. Third, delayed gastric emptying is not a concern, because even if delayed gastric emptying occurs, there exists an alternative passage route for food, contrary to jejunal interposition. Thus, delayed gastric emptying after DTR is not a serious problem. In our series, actual rate of food residue in the remnant stomach was 48.9 % but the rate of symptoms related to the delayed gastric emptying (abdominal pain and indigestion) was not so high (16.3 and 11.6 %, respectively). However, in order to perform DTR, surgeons should have sufficient experience to independently perform secure laparoscopic E-Jstomy to perfection.

Clinicians tend to consider body weight as a measure of nutritional status. Difficulty in maintaining body weight is a defining characteristic of the post-gastrectomy syndrome. In this study, the mean weight loss 6 months after the procedure was 5.9 %, whereas an average weight loss of 16 % after total gastrectomy has been reported. Although various mechanism have been considered, such as decrease of gastric acid level, reflux esophagitis, intestinal floral alteration, and increased peristalsis and diarrhea, reduced food intake is the most conceivable explanation for body weight loss after total gastrectomy [24, 25]. We speculate that the difference in body weight loss is because of the limited reservoir function in total gastrectomy. When we compared the functional outcomes between esophago-

gastrostomy and DTR in the view of historical comparison, DTR showed the tendency of less body weight loss and rapid recovery of total protein and albumin [7].

This study has several limitations. First, this was a retrospective study of a case series. Second, we didn't assess the quality of life of the patients because it was not fully followed up by using a validated questionnaire, such as the Korean version of Gastro Intestinal Quality of Life Index (GIQLI) and the European Organization for Research and Treatment of Cancer (EORTC) Quality of Life Questionnaire (QLQ)-C30 and sto22. Third, the numbers of patients were relatively small. Fourth, we did not investigate the overall functional outcomes using clinical assessments, anthropometric tests, and laboratory tests. We only assessed the nutritional status based on body weight changes and total protein and albumin levels.

However, to our knowledge, this is the first study to report the procedure for DTR after LPG. In this era of function preserving surgery and minimally invasive surgery, this study provides an overview of the procedure for LPG with DTR, the surgical skills required, and other important surgery-related data. These encouraging data lead us to plan phase III multicenter prospective randomized clinical trial between LPG versus LTG.

In conclusion, our initial case series demonstrated that DTR after LPG is a feasible, simple, and useful reconstruction method with excellent postoperative outcomes in terms of preventing reflux symptoms. However, future prospective randomized trials are warranted to validate its clinical usefulness.

Conflict of interest Drs. S.-H. Ahn, D.J. Park, S.Y. Son, C.-M. Lee, J.H. Lee, and H.-H. Kim have no conflicts of interest or financial ties to disclose.

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