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ORIGINAL ARTICLE

Surgical techniques to prevent reflux esophagitis in proximal gastrectomy reconstructed by esophagogastrostomy with preservation of the lower esophageal sphincter, pyloric and celiac branches of the vagal nerve, and reconstruction of the new His angle for early proximal gastric cancer

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Abstract
Purpose This article describes the surgical techniques to prevent reflux esophagitis (RE) after proximal gastrectomy reconstructed by esophagogastrostomy (PGE) preservation of the lower esophageal sphincter (LES) and both pyloric and celiac branches of the vagal nerve (PCVN), and reconstruction of the new His angle (HA) for early proximal gastric cancer (PGC).
Methods Twenty patients after PGE were divided into 2 groups (group A: 10 patients without preserved LES and PCVN for advanced PGC; group B: 10 patients with preserved LES and PCNV and the addition of a new HA for early PGC). A postoperative interview on gastroesophageal reflux disease (GERD) and satisfaction with this procedure and the collection of endoscopic findings for RE and stasis of the remnant stomach (SRS) were conducted 1 year after PGE in groups A and B.
Results The rates of proton pump inhibitor administration and the symptoms of GERD, RE and SRS in group A were significantly higher than those in group B ($p = 0.0433$, $p = 0.0190$, $p = 0.0253$, $p = 0.0190$, respectively). Seven out of 10 patients in group A voiced dissatisfaction. Patients in group B were significantly more satisfied with this procedure than those in group A ($p = 0.0010$).
Conclusion This method is useful for preventing postoperative GERD including RE in early PGC patients.

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Keywords Proximal gastrectomy reconstructed by esophagogastrostomy · Lower esophageal sphincter · Pyloric and celiac branches of the vagal nerve · His angle · Reflex esophagitis

Introduction

To select appropriate surgical options regarding gastric excision and reconstructive operation, clinical studies have been accumulated that focused on the postoperative status [1, 2]. As a result, the surgical treatment of patients with gastric cancer, in terms of function-preserving operation, has already become satisfactory in terms of its survival benefit; thus the most important problem currently awaiting resolution is how to improve the postoperative quality of life [2]. Until recently, proximal gastrectomy reconstructed by esophagogastrostomy (PGE) with D2 lymph node resection without a preserved lower esophageal sphincter (LES) and vagal nerves (i.e., extensive surgical operation) as a standard technique has been performed in patients with gastric cancer located in the proximal third of the stomach, even for early proximal gastric cancer (PGC), in Japan [3–5]. Although PGE without preservation of the LES and both pyloric and celiac branches of the vagal nerve (PCVN) is a simple operative technique, approximately half (30–60 %) of all patients suffer from gastroesophageal reflux disease (GERD), especially reflux esophagitis (RE), in a long period after operation [6–9].

To prevent GERD including RE, LES, vagal nerve including the pyloric and celiac branches, and His angle are important factors of the anti-gastroesophageal reflux [1, 2, 10–17]. It is well known that the LES is one of the most important factors to prevent GERD [10]. Previously, in a manometric study of the LES, we reported that total gastrectomy with preserved LES can prevent alkaline RE

[17]. It is also suggested that pyloric dysfunction leads to the stasis of the remnant stomach (SRS) and produces RE in patients after pylorus-preserving gastrectomy [1, 2]. That is to say, SRS may enhance GERD, especially RE, due to reflux of the gastric contents. The pyloric function is maintained by the pyloric branch of the vagal nerve [1, 2, 9]. The celiac branch of the vagal nerve maintains intestinal function including gastropyloroduodenal coordination [18]. Thus, PCVN coordinates antropyloroduodenal motility and prevents stasis of the SRS [19]. Besides, it is well known that the His angle (HA) is one factor involved in the antigastroesophageal reflux mechanism [12, 14, 15]. Preservation of both the anterior and posterior trunks of the vagal nerves minimizes the damage of the HA in gastric surgery. According to these results, the author hypothesized that PGE with preservation of the LES and PCVN, and reconstruction of the new HA is better than PGE without these procedures to prevent GERD. In order to reduce GERD including RE, the author performed PGE while preserving the LES and PCVN as a function-preserving operation. Moreover, the author made a new HA to prevent GERD. In this report, the author presents the key points of this technique and its application. The benefit of preventing GERD using this procedure is also reported.

Patients and methods

From 1990 to 2008, 20 patients with gastric cancer in the U region (tumor located at the upper third of the stomach) visited my hospital. These patients after PGE for PGC were divided into 2 groups [group A: 10 patients without a preserved LES and PCVN (7 men and 3 women, aged 49–77 years with a mean age of 68.7 years); group B: 10 patients with a preserved LES and PCVN and reconstruction of a new HA (8 men and 2 women, aged 44–78 years with a mean age of 66.4 years)]. All patients in group B had early PGC (mucosal cancer: 6 patients, submucosal cancer: 4 patients). All patients in group A had advanced PGC.

Postoperative interview on symptoms of GERD and for determination of postoperative satisfaction was conducted on all patients 1 year after PG. The author also asked all patients whether they were being treated with a proton pump inhibitor (PPI). Endoscopic findings including RE and SRS were also recorded. None presented tumor recurrence, local and/or distant, when visiting my hospital 1 year after operation.

Statistical analyses were conducted using the Fisher's exact test and Mann–Whitney *U* test (Stat View version 5.0 for Windows; Abacus Concepts Inc., Berkeley, CA). A $p < 0.05$ was considered to be statistically significant.

The operative indications for PGE with or without preservation of both the LES and PCVN.

These procedures were performed on patients for PGC who could retain two-thirds or half of the distal stomach.

PGE with preservation of the LES and PCVN

This procedure was performed in early PGC. No invasion to the abdominal esophagus was confirmed by an endoscopic examination preoperatively and according to the findings of operative abdominal exploration. No lymph node metastasis was also confirmed by whole-body CT and MRI. D1 lymphadenectomy (dissection of the N1 lymph node; lymph nodes along the stomach) with preservation of the LES and PCVN was performed in mucosal cancer cases. D2 lymphadenectomy (dissection of N1 and N2 lymph nodes; those along the artery to the stomach) with preservation of the LES and PCVN was also performed in submucosal cancer cases. This is because pathological lymph node metastasis according to my clinical data was detected at a rate of 0 % in mucosal cancers and approximately 15 % in submucosal cancers, in terms of accompanying lymph node metastasis in the D2 area [13]. The author previously suggested, according to the histology, that cancer cell invasion of the gastric wall 2 cm or less from the tumor edge represents early gastric cancer, while 4 cm or less from the tumor edge represents advanced gastric cancer [17]. According to these results, the author employed PGE with preserved LES and PCVN in patients for early PGC.

PGE without preservation of the LES and PCVN

D2 lymphadenectomy without preservation of the LES along with total truncal vagotomy was performed in patients with advanced PGC and early PGC who could not retain the LES and PCVN due to tumor invasion to the abdominal esophagus and lymph node metastasis (N1 and/or N2).

Surgical technique

The author's technique of PGE and reconstruction comprises three key aspects. First, the author preserved the PCVN to prevent GERD including RE due to SRS. Second, the author left the abdominal esophagus including the LES to prevent GERD including RE. Namely, the LES region above the esophagogastric junction (EGJ) was preserved. Third, the author made a new HA to reinforce the prevention of GERD including RE.

Preservation technique of the PCVN

The hepatic and celiac branches bifurcating from the anterior and posterior trunks of the vagal nerve were completely

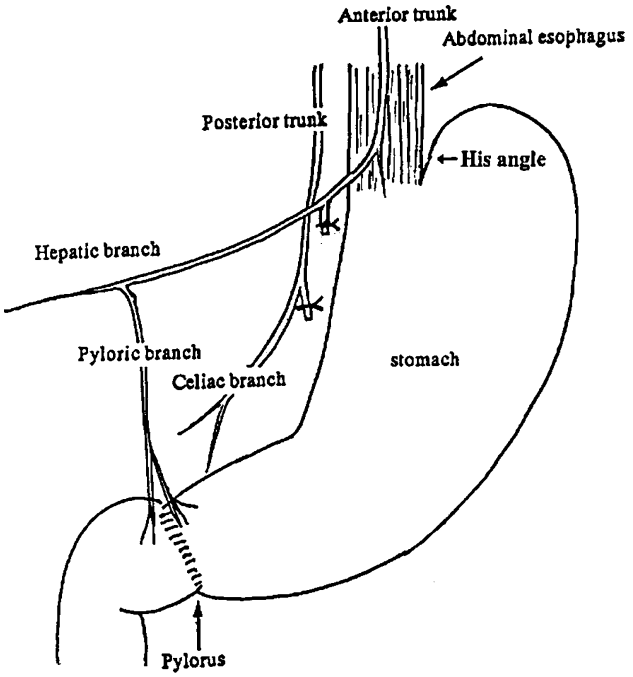

Fig. 1 Vagal nerve-preserving technique. Only the gastric branches alone of the anterior and posterior trunks are cut off

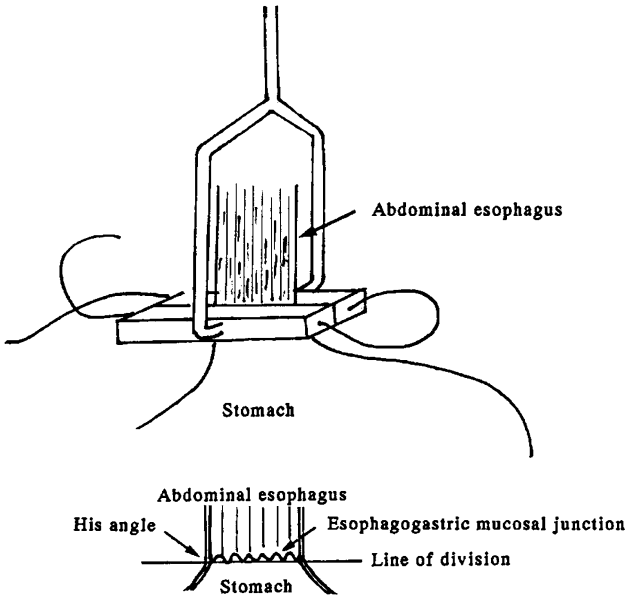

Fig. 2 Preservation of the lower esophageal sphincter. LES preservation is performed by leaving the abdominal esophagus at the esophagogastric mucosal junction. Esophagogastric mucosal junction located at the His angle. The dissected abdominal esophagus is subjected to purse string suturing using the PURSTRING TM 65 instrument

preserved together with the anterior pyloric branches. Namely, the anterior and posterior gastric branches alone were removed (Fig. 1). The hepatic branch from the anterior trunk transverses at a high position adhered to the lesser omentum of the liver and therefore was easily identified and could be preserved. However, the branch occasionally runs close to the right cardiac lymph node, requiring caution. The pyloric branch bifurcating from the hepatic branch enters the hepatoduodenal ligament. Then, the right gastric artery was to be cut off at a position close to the stomach to preserve the pyloric branch. The celiac branch bifurcating from the posterior trunk approaches the right gastric artery as it comes close to the celiac ganglion. Therefore, the posterior trunk in the lipid tissue surrounded by the right and left crura of the diaphragm was taped in place, which was then pulled right to cut off the posterior gastric branch running to the lesser curvature of the stomach. In addition, the left gastric artery was also cut off.

Severing of the abdominal esophagus to preserve the LES

In LES preservation, it is functionally important to leave 2 cm or more of the abdominal esophagus from the oral side of the EGJ [10]. Therefore, the author resected the abdominal esophagus at the level of the HA at the left angle to the longitudinal axis of the esophagus. For this purpose, disposable forceps, namely, PURSTRING TM 65 (United States Surgical Corp., Norwalk, CT, USA), was used to suture the amputation stump with tobacco suturing thread upon dissection of the esophagus (Fig. 2). When the HA was not clearly identified, the author directly observed the EGJ through gastrostomy on the upper anterior wall of the stomach.

Proximal gastrectomy

Following gastrostomy on the upper anterior wall, the author directly observed the lesional region in the proximal stomach, and the cutting line of the stomach to maintain a sufficient surgical margin was then decided. The safe surgical margin lies 2 cm from the tumor in the case of early PGC and 4 cm from it in the case of advanced PGC. Gastrectomy was performed using a linear stapler (GIA 50, United States Surgical Corp.) (Fig. 3).

Anastomosis of the abdominal esophagus and the remnant stomach

The anterior wall of the remnant stomach (5 cm on the anal side from the resected margin of the remnant stomach) was cut down 4 cm with electrical scissors. A circular stapler device (PCEEA, United States Surgical Corp.) without an anvil was inserted into the remnant stomach from cut wound (i.e., gastrostomy), and the center rod of the PCEEA penetrated through the resected margin

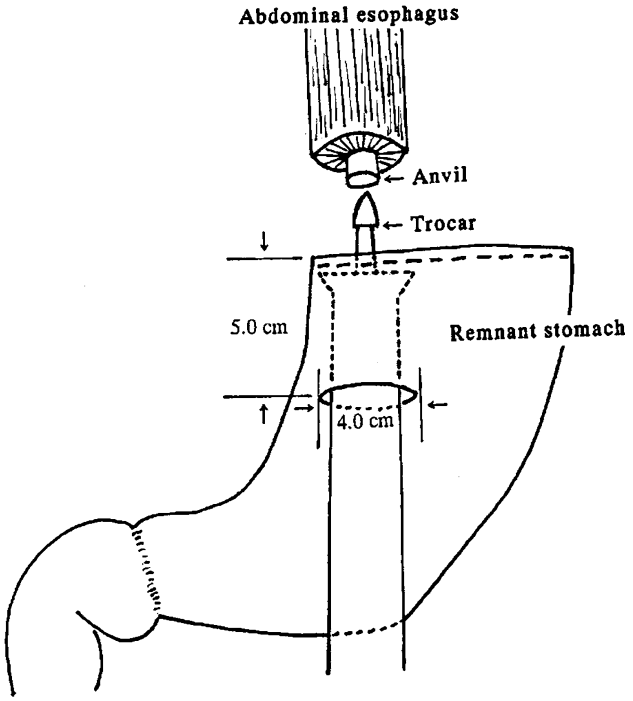

Fig. 3 Anastomosis of the abdominal esophagus with the remnant stomach. The PCEEA is inserted into the oral side of the remnant stomach through the cut wound. The trocar with PCEEA out of the distal margin of the resected remnant stomach binds with the anvil in the abdominal esophagus

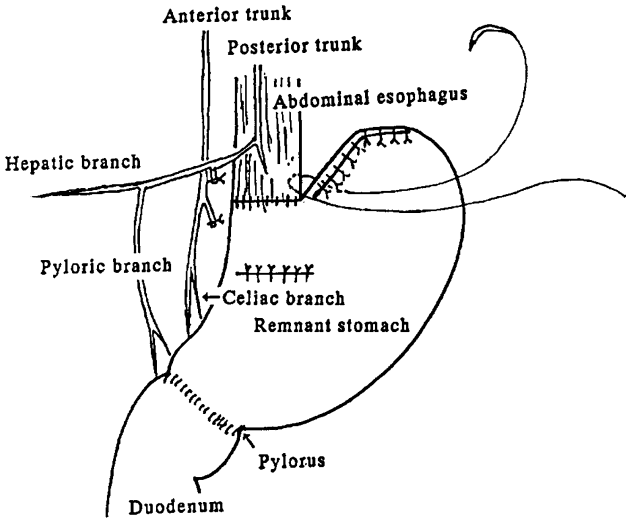

Fig. 4 Illustration of completed proximal gastrectomy reconstructed by esophagogastrostomy with preservation of the lower esophageal sphincter and pyloric and celiac branches of the vagal nerve. Moreover, to prevent RE, stitching of the resected margin of the remnant stomach on the left-hand side of the abdominal esophagus and crus of diaphragma is carried out for about 2.5 cm, and a new His angle is formed

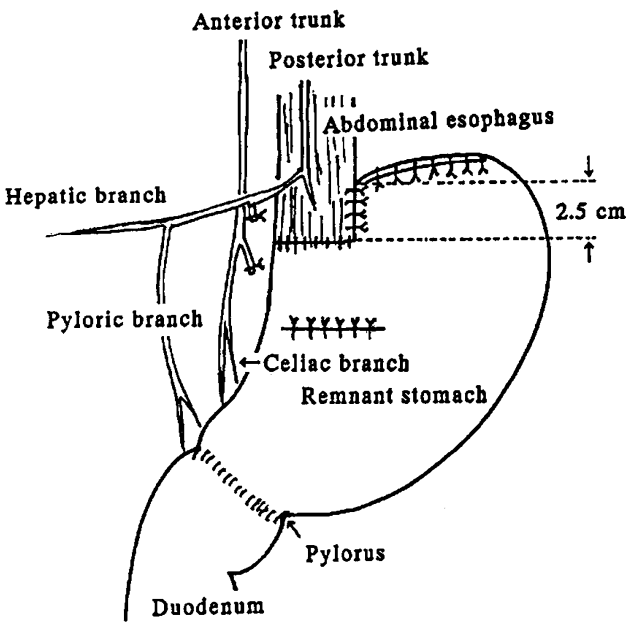

Fig. 5 A schematic diagram of my new surgical procedure for early proximal gastric cancer

of the remnant stomach. Next, the center rod was bound with an anvil in the abdominal esophagus and then the PCEEA instrument was closed and thereafter the staplers were fired. A circular double staggered row of staplers joined the organs (i.e., the abdominal esophagus and remnant stomach) and the circular blade in the instrument formed a stoma (i.e., end-to-end esophagogastrostomy) (Fig. 3). For this mechanical anastomosis, attention should be paid to avoid contamination by foreign matter, the formation of a hematoma due to adherence of the anastomosed region to the arterial and venous end branches at the remnant stomach margin, and anastomosis at hyperextension to avoid postoperative incomplete suturing (anastomotic leakage) and stenosis of the anastomosis. Intestinal continuity was re-established with end-to-end esophagogastrostomy. End-to-end direct anastomosis was performed with a 25 mm diameter circular stapler.

Closure of the anterior wound of the remnant stomach and construction of a new HA

A TA 55 instrument (United States Surgical Corp.) was used to close the cut wound on anterior wound. The resected margin of the remnant stomach was sutured to the left side of the abdominal esophagus at approximately 2.5 cm in order to make a new HA (Figs. 4, 5). To prevent GERD including RE, stitching of the resected margin of the remnant stomach to the left-hand side of the abdominal

esophagus and crus of the diaphragma was carried out for approximately 2.5 cm, and a new HA is formed.

Using the above surgical technique, PGE with the preservation of the LES and PCVN, as well as reconstruction of the new HA, was completed (Fig. 5).

Results

Patient's characteristics

The patient's characteristics are summarized in Table 1. There were no differences in the number of cases, age and sex between groups A and B. Group A was advanced PGC and group B had early PGC. The size of tumor in group A was significantly greater than in group B ($p = 0.0001$). In the mucosa, submucosa invasions and muscularis, the depth of invasion in group A was significantly greater than in group B ($p = 0.0054$, $p = 0.0433$ and $p = 0.0115$, respectively). In the subserosa, there was no significant difference between groups A and B ($p = 0.2368$). The frequencies of N0 lymph node metastasis in group B was significantly higher than that in group A ($p = 0.0003$). The frequency of N1 lymph node metastasis in group A was significantly higher than group B ($p = 0.0162$). In terms of the frequency of N2 lymp node metastasis, there was no significant difference between groups A and B ($p = 0.1052$). No distant metastasis was found in groups A and B.

Surgical characteristics

The surgical characteristics are summarized in Table 2. There were no significant differences in the operation time or blood loss between groups A and B ($p = 0.6907$ and $p = 0.8265$, respectively). In terms of the size of the remnant stomach compared with that before operation, 70.0 % (7/10) had 2/3 remaining in group A and 100 % (10/19) had this in group B. A total of 30.0 % (3/10) had 1/2 remaining in group A and 0 % (0/10) had this in group B. There was no significant difference between groups A and B in this regard ($p = 0.1052$). Postoperative complications were found two cases. An ileus was found one case in group A. Wound infection was found one case in group B. The lengths of hospital stay were 24.0 ± 3.0 days in group A and 21.0 ± 4.0 days in group B. There was only a tendency for a significant difference between groups A and B ($p = 0.0739$). Therefore, there were no significant differences in the surgical characteristics between groups A and B.

Symptoms of GERD

Symptoms of GERD (i.e., heart burn, dyspepsia, regurgitation, swallowing difficulty, and chest pain) were noted in 60 % (6/10) of group A and 10 % (1/10) of group B which was significantly differenct ($p = 0.0190$) (Table 3).

Table 1 Patient characteristics

	Group A	Group B	*p* value
Number of case	10	10	
Male/female	7/3	8/2	0.5
Age (years)			
Mean ± SD	68.7 ± 9.9	66.4 ± 11.8	0.6424
Size of tumor (mm)	34.1 ± 8.8	20.1 ± 3.6	0.0001
Depth of invasion			
Mucosa	0 % (0/10)	60.0 % (6/10)	0.0054
Submucosa	0 % (0/10	40.0 % (4/10)	0.0433
Muscularis	80.0 % (8/10)	0 % (0/10)	0.0115
Subserosa	20.0 % (2/10)	0 % (0/10)	0.2368
Lymph node metastasis			
N0	20.0 % (2/10)	100 % (10/10)	0.0003
N1	50.0 % (5/10)	0 % (0/10)	0.0162
N2	30.0 % (3/10)	0 % (0/10)	0.1052
Distant metastasis			
Positive	0 % (0/10)	0 % (0/10)	
Negative	100 % (10/10)	100 % (10/10)	

Group A: PGE without preservation of the LES and PCVN ($n = 10$)

Group B: PGE with preservation of the LES and PCVN and reconstruction of the new HA ($n = 10$)

LES lower esophageal sphincter, *PCVN* pyloric and celiac branches of the vagal nerve, *PGE* proximal gastrectomy reconstructed by esophagogastrostomy, *HA* His angle

Endoscopic findings

RE was noted in 40 % (4/10) of group A and 0 % (0/10) of group B which was significantly different ($p = 0.0253$) (Table 3). In group A, according to the Los Angeles classification [20], 2 cases were at grade A, 1 case grade B and 1 case grade C.

SRS was noted in 60 % (6/10) of group A and 10 % (1/10) of group B which was significantly different ($p = 0.0190$) (Table 3).

Stasis in the remnant stomach was defined as follows (with reference to ref. [21]): after a prohibition of diet from 9:00 pm previous day, endoscope was performed at 9:00 am. The author defined as a stasis in the remnant stomach if a small amount or more of residual food in the stomach could be found by the endoscopist.

PPI administration

To treat RE, PPI was only administrated to some of the patients in group A (40.0 %: 4/10). There was a significant difference between groups A and B in this regard ($p = 0.0433$) (Table 4).

Table 2 Surgical characteristics

	Group A	Group B	*p* value
Operation time (min)			
Mean ± SD	269.5 ± 58.2	289.3 ± 69.5	0.6907
Blood loss (ml)			
Mean ± SD	266.7 ± 238.7	292.6 ± 280.7	0.8265
Size of the remnant stomach compared with before operation			
2/3	70.0 % (7/10)	100 % (10/10)	0.1052
1/2	30.0 % (3/10)	0 % (0/10)	
Postoperative complication			
Positive	10.0 % (1/10) (ileus)	10.0 % (1/10) (wound infection)	
Negative	90.0 % (0/9)	90.0 % (9/10)	
Hospital stay (days)			
Mean ± SD	24.0 ± 3.0	21.0 ± 4.0	0.0739

Group A: PGE without preservation of the LES and PCVN ($n = 10$)

Group B: PGE with preservation of the LES and PCVN and reconstruction of the NHA ($n = 10$)

LES lower esophageal sphincter, *PCVN* pyloric and celiac branches of vagal nerve, *PGE* proximal gastrectomy reconstructed by esophagogastrostomy, *HA* His angle

Table 3 Frequencies of symptomatic and endoscopic reflux esophagitis after PGE with or without preservation of the LES and PCVN and reconstruction of a new HA

	Group A	Group B
Symptoms of GERD	60.0 % (6/10)[a]	10.0 % (1/10)[b]
Endoscopic RE	40.0 % (4/10)[c]	0 % (0/10)[d]
Endoscopic SRS	60.0 % (6/10)[e]	10.0 % (1/10)[f]

a vs. b: $p = 0.0190$, c vs. d: $p = 0.0253$, e vs. f: $p = 0.0190$

Group A: PGE without preservation of the LES and PCVN ($n = 10$)

Group B: PGE with preservation of the LES and PCVN, and reconstruction of the new HA ($n = 10$)

LES lower esophageal sphincter, *PCVN* pyloric and celiac branches of the vagal nerve, *PEG* proximal gastrectomy reconstructed by esophagogastrostomy, *HA* His angle, *GERD* gastroesophageal reflux disease

Table 4 Proton pump inhibitor administration

	Group A	Group B	*p* value
Yes	40.0 % (4/10)	0 % (0/10)	0.0433
No	60.0 % (6/10)	100 % (10/10)	

Group A: PGE without preservation of the LES and PCVN ($n = 10$)

Group B: PGE with preservation of the LES and PCVN and reconstruction of the new HA ($n = 10$)

LES lower esophageal sphincter, *PCVN* pyloric and celiac branches of the vagal nerve, *PGE* proximal gastrectomy reconstructed by esophagogastrostomy, *HA* His angle

Patient satisfaction with their operation

The author asked the patients directly whether they were satisfied with the operation. The rate of patient satisfaction in group A was 30.0 % (3/10) and that in group B was 100.0 % (10/10). The remaining patients in group A voiced dissatisfaction. The patients in group B were significantly more satisfied than those in group A ($p = 0.0010$). Patients in group A were significantly more dissatisfied than those in group B ($p = 0.0015$) (Table 5).

Table 5 Frequencies of satisfaction after proximal gastrectomy with or without preservation of the LES and PCVN, and reconstruction of a new HA

Group A	Group B	
Satisfaction	30.0 % (3/10)[a]	100 % (1/10)[b]
Dissatisfaction	70.0 % (7/10)[c]	0 % (0/10)[d]

a vs. b: $p = 0.0010$, c vs. d: $p = 0.0015$

Group A: PGE without preservation of the LES and PCVN ($n = 10$)

Group B: PG with preservation of the LES and PCVN, and reconstruction of the new HA ($n = 10$)

LES lower esophageal sphincter, *PCVN* pyloric and celiac branches of vagal nerve, *HA* His angle

Discussion

PGE without preservation of the LES and PCVN for PGC has been employed as a standard technique even for early PGC in Japan [3–5]. However, approximately half (30–60 %) of the patients after standard PGE experience GERD, especially RE, are troubled by GERD in the long-term after the operation [6–9]. Recently, reconstruction operations that preserve the original condition of the abdominal esophagus, including the LES and/or vagal nerve, as much as possible have become appropriate to prevent postgastrectomy disorders [2]. Clinical assessments

of GERD in patients with or without preserved LES and PCVN after PGE are still inconclusive. The detailed effects of reconstruction of the new HA are also unknown. The purpose of this study was to clarify the significance of both LES and PCVN preservation and reconstruction of the new HA procedures after PGE for the prevention of GERD including RE. Therefore, the author has employed PGE with preserved LES and PCVN and reconstruction of a new HA to prevent GERD in patients with early PGC. In this study, the author presented the key points of the LES and PCVN preservation, the techniques for reconstruction of a new HA and their application. The benefits of using this procedure were also reported herein. In the present study, PGE with preservation of the LES and PCNV, as well as reconstruction of a new HA, was performed in early PGC cases. PEG without these was performed in advanced PGC cases. There were no significant differences in the surgical characteristics among these 2 groups.

It is well known that the LES is the most important factor to prevent GERD [10]. Anatomically, the LES is a dynamic sphincter that is indistinguishable from other circular muscles in the abdominal esophagus and recognized by an esophageal manometric study [11, 22–26]. The LES is the physiologic sphincter that separates the esophagus from the stomach at the EGJ. At rest, the LES plays an important role in preventing GERD by maintaining an intraluminal pressure that is higher than the stomach pressure [24]. The LES relaxes upon swallowing and allows passage of ingested food and/or liquid into the stomach [10, 25, 26]. The LES also prevents gastroesophageal reflux of ingested food and/or liquid from the stomach to the esophagus [10, 24–26]. It is suggested that preservation of the abdominal esophagus is necessary to prevent GERD [10, 17, 22–26]. In LES preservation, it is functionally important to leave 2 cm or more of the abdominal esophagus. The author retains the abdominal esophagus, including the LES, from the EGJ in this procedure as much as possible. The author speculates that resection of the abdominal esophagus at the level of EGJ using a circular stapler leaves 2 cm or more of the abdominal esophagus. In this procedure, the abdominal esophagus could be cut less than 1 cm from the oral side of the EGJ.

Regarding the vagal nerve, especially the PCVN, it is necessary to maintain esophagogastrointestinal functions including the LES and pyloric functions [1, 19]. A pylorus- preserving operation without preservation of the PCVN often shows abdominal fullness with SRS after a meal compared with a pylorus-preserving operation with preservation of the PCVN [1]. Antropyloroduodenal discoordination in patients after gastrectomy without preservation of PCVN leads to SRS and promotes GERD due to SRS. Upon PGE with these procedures in order to retain both the pyloric function and antropyloroduodenal coordination by preservation of both the PCVN, an endoscopic inspection did not disclose both RE and SRS 1 year after PGE.

Incidentally, it is well known that the HA is also a factor involved in the prevention of GERD [12, 14, 15]. It is reported that damage of the HA may be minimized in patients after operation with preservation of both the anterior and posterior truncal vagal nerves in distal gastrectomy [15]. Therefore, the author made a new HA to prevent GERD. After PGE with preservation of the LES and PCVN and reconstruction of a new HA, the patients were satisfied with their postoperative status.

In the present study, the rates of PPI administration, the symptoms of GERD and endoscopic findings for RE in patients after PGE without preserved LES and PCVN, as well as without reconstruction of the new HA, were significantly higher than those in patients after PGE with these procedures. In addition, the author was unable endoscopically to detect SRS in PGE patients with preservation of PCVN and reconstruction of a new HA. In contrast, the author sometimes experienced stagnation in PGE without preservation of LES and PCVN. To treat ER, PPI was administrated to 4 out of 10 patients without preservation of the LES and PCVN, as well as without reconstruction of a new HA. All cases of PGE with preservation of the LES and PCVN, as well as reconstruction of a new HA, were associated with significant satisfaction with the postoperative conditions compared with cause of PGE without these procedures. Therefore, the author applied this technique to patients with early PGC.

In conclusion, in PGE using my procedure for early PGC, nearly all patients reported no GERD including RE and a few patients showed SRS. All patients after PGE with these procedures were satisfied with their postoperative status. The pathogenesis of GERD is multifarious and different mechanisms may be involved in different patients [20, 26–28]. Abnormal esophageal peristalsis may be involved in the LES dysfunction observed in patients with esophagitis [26–28]. Thus, further assessment of the relationships between LES with or without preservation of the PCVN and esophageal motility is required. The usefulness of the present surgical operation will also be further investigated in terms of the relationship between the LES function and 24 h pH monitoring in the esophagus. In addition, the pathogenesis of GERD comprises both gastroesophageal and duodenogastric refluxes. The duodenogastric reflux should thus be studied by 24-h pH monitoring in the future. To evaluate the clinical symptoms of GERD and the endoscopic findings in patients after PGE with or without preservation of the LES, PCVN as well as reconstruction of a new HA, a long follow-up period is also necessary [29].

Compliance with ethical standards

Conflict of interest The author declares no conflicts of interest in association with this study.

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