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Evaluation of a Pylorus-Preserving Gastrectomy for Patients Preoperatively Diagnosed with Early Gastric Cancer Located in the Middle Third of the Stomach

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Abstract

Purpose. Patients diagnosed with early gastric cancer located in the middle third of the stomach have two major surgical options, namely a conventional distal gastrectomy with Billroth I anastomosis (DG) or a pylorus-preserving gastrectomy (PPG). Pylorus-preserving gastrectomy is thought to have greater functional benefits than DG, but the evaluation of its prognosis and outcome has so far been insufficient.

Methods. Between 1997 and 2007, 133 patients were diagnosed with early gastric cancer located in the middle third of the stomach. Distal gastrectomy was performed in 87 and PPG was performed in 46 of these patients. The clinicopathological characteristics were compared between the groups.

Results. There were fewer dissected lymph nodes in PPG (mean: 21.9) than in DG (mean: 30.4, $P = 0.001$). Complications were detected in 16.1% of DG patients and in 6.5% of PPG patients. The occurrence of stasis after PPG (6.5%) was similar to that observed after DG (6.9%). One patient in the DG group died from cancer recurrence, but cancer recurrence was not detected in the PPG group. Although the difference was not significant, the overall 5-year survival rate in the 46 PPG patients (95%) was better than that in the 87 DG patients (86%, $P = 0.087$).

Conclusions. Pylorus-preserving gastrectomy patients had fewer postoperative complications than DG patients. The long-term follow-up of these patients will clarify the nutritional and prognostic benefits of PPG.

Key words Early gastric cancer · Pylorus-preserving gastrectomy · Prognosis

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Introduction

A pylorus-preserving gastrectomy (PPG) was originally utilized as a surgical modality for gastric ulcer patients to prevent dumping syndrome and duodenal juice reflux.[1] Recently, this procedure has been recognized as one of the few treatment options for patients with early gastric cancer located in the middle third of the stomach.[2] To maintain the pyloric function, the right gastric artery and the pyloric branch of the vagus nerve are preserved and the suprapyloric lymph nodes are not excised in this operation.[3,4] Therefore, performing this surgery with an incomplete suprapyloric lymph node dissection for early gastric cancer in the middle third of the stomach might lead to an increased risk of cancer recurrence.

Patients ($n = 133$) who were preoperatively diagnosed with early gastric cancer in the middle third of the stomach underwent either conventional distal gastrectomy (DG) or PPG. The goal of this study was to retrospectively evaluate the difference in outcomes between the two groups (DG and PPG).

Patients and Methods

Patients

Between 1997 and 2007, 133 patients were diagnosed with early gastric cancer in the middle third of the stomach by upper gastrointestinal series and endoscopy. Preoperative computed tomography (CT) in our hospital showed no evidence of lymph node metastasis. A preoperative diagnosis of gastric cancer was established by endoscopic and histopathological examinations. The extent of tumor invasion was evaluated to be either the mucosal or submucosal layer by endosonography. Patients who were treated with either an endoscopic mucosal resection or endoscopic submucosal dissection were excluded from this study.

A distal gastrectomy with D2 lymph node dissection has been a standard operation (open method) for early gastric cancer located in the middle third of the stomach for quite some time in our hospital. A laparoscope-assisted distal gastrectomy (LADG) with D1+α or β lymphadenectomy was first performed in 2001, and PPG gradually started to be utilized in 1997. The indications for this surgery include the following criteria: (1) a diagnosis of early gastric cancer, (2) tumor located in the middle third of the stomach, (3) no lymph node metastasis, and (4) tumor less than 5.0 cm in diameter. Laparoscope-assisted PPG (LAPPG) began to be performed in 2002 for patients with early gastric cancer based on the same criteria. In total, DG was performed in 87 patients (open DG: 66 and LADG: 11) and PPG was performed in 46 patients (open PPG: 28 and LAPPG: 15). Although this study is retrospective and not randomized, the clinicopathological differences were compared among the four groups (open DG, LADG, open PPG, and LAPPG) and the differences in outcomes were compared between DG and PPG. Surgical morbidity or mortality rates were defined as any complication or death associated with gastrectomy, respectively. The patients were followed until February 2009. Any deaths after surgery, including operative death and death from causes other than cancer, were included in the survival analysis.

Surgical Procedure

In conventional open DG and open PPG operations for early gastric cancer, the greater omentum was preserved. The right cardiac (No. 1), lesser curvature (No. 3), left gastroepiploic artery (No. 4sb), right gastroepiploic artery (No. 4d), suprapyloric (No. 5), infrapyloric (No. 6), left gastric artery (No. 7), common hepatic artery (No. 8a), celiac artery (No. 9), suprapancreatic (No. 11p), and hepatic artery (No. 12a) lymph nodes were excised during open DG. In LADG, D1+α or β lymphadenectomy was performed. A conventional distal gastrectomy with Billroth I anastomosis (BI) was performed in the DG group.

To retain the pyloric function and blood flow to the remnant antral segment, the pyloric and hepatic branches of the vagus nerve and right gastric artery were preserved during PPG. As a result, the No. 5 and No. 12 lymph nodes were not dissected in the PPG group (Fig. 1). A distal gastrectomy was performed while preserving a 3-cm length of the antral segment. The proximal stomach was divided at a point approximately 3 cm distant from the primary tumor. End-to-end anastomosis was performed using the Gambee suture technique.

Clinicopathological Findings

The histopathological findings, stage classification, depth of tumor invasion, lymph node grouping, and curability of the gastric resection were reported according to the Japanese Classification of Gastric Carcinoma.[5]

Statistical Analysis

Both the chi-square and Fisher exact probability tests were used to compare the distribution of individual variables between patient groups. Differences in the data among the groups were evaluated using the Mann–Whitney *U*-test and the Kruskal–Wallis test. The survival rates were estimated by the Kaplan–Meier method, and the statistical differences between survival curves were examined by the log-rank test. A P value of less than 0.05 was regarded as statistically significant.

Results

A total of 133 patients were preoperatively diagnosed with early gastric cancer located in the middle third of the stomach with no lymph node metastasis. The clinicopathological characteristics were compared between the DG group (87 patients) and the PPG group (46 patients). Figure 2 shows the number of patients who underwent DG or PPG. Between 2004 and 2007, over 50% of patients who were preoperatively diagnosed with early gastric cancer in the middle third of the stomach underwent PPG. Table 1 shows the clinicopathological differences between the two groups. Laparoscopic surgery was more frequently utilized for PPG than for DG. The tumor size in patients undergoing PPG was much smaller than that in the patients undergoing DG. In addition, there were fewer dissected lymph nodes in the patients undergoing PPG than in the patients undergoing DG. The number of dissected lymph nodes in open PPG (n = 30, mean ± standard deviation, 20.4 ± 11.1) was smaller than that in open DG (n = 76, 30.9 ± 14.8, P = 0.001). The number of dissected lymph nodes in laparoscope-assisted (LA) PPG (n = 15, 25.1 ± 9.8) was smaller than that in LADG (n = 11, 27.6 ± 11.3), but the difference was not significant (P = 0.719). Neither the degree of tumor invasions nor the tumor stages was significantly different between the two groups (Table 1).

The clinical findings such as operation time, intraoperative blood loss, and hospital stay after operation were compared between open DG and open PPG, and between LADG and LAPPG (Table 2). The length of operation time in open PPG was shorter than that in open DG, and the volume of intraoperative blood loss in open PPG was smaller than that in open DG.

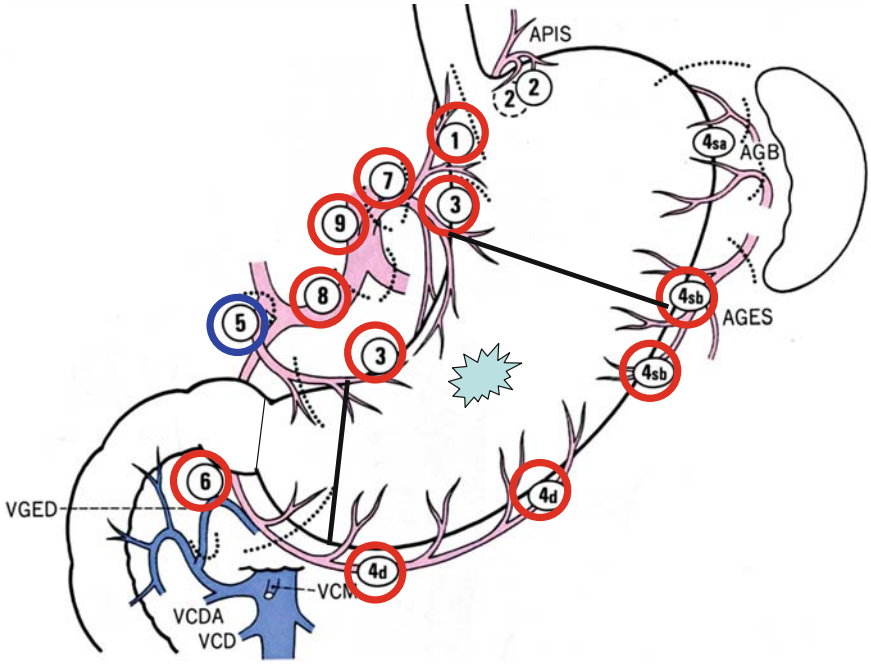

Fig. 1. Dissected lymph node stations in a pylorus-preserving gastrectomy (PPG). The lymph nodes at the No. 5 station were not dissected during PPG. A distal gastrectomy was performed in order to preserve a 3-cm length of antral segment. *AGB*, arteria gastrica breves; *AGES*, A. gastroepiploica sinistra; *APIS*, A. phrenica inferior sinstra; *VCD*, vena colica dextra; *VCDA*, V. colica dextra accessoria; *VCM*, V. colica media; *VGED*, V. gastroepiploica dextra

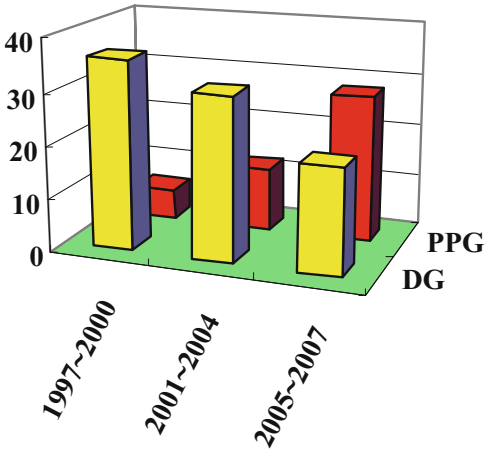

Fig. 2. Number of patients who underwent a conventional distal gastrectomy (*DG*) or pylorus-preserving gastrectomy (*PPG*)

However, there was no difference with regard to the length of hospital stay after operation between the two groups (open DG and open PPG). The length of operation time and the volume of intraoperative blood loss were similar between LADG and LAPPG; however, the length of hospital stay after operation in LAPPG was much shorter than that in LADG. One patient died after open DG because of an anastomotic leak. Complications were detected in 17 of 133 (12.8%) patients (DG: 14/87, PPG: 3/46, $P = 0.116$). The incidence of complications after open DG (10/76, 13.2%) was similar to the incidence of complications after open PPG (3/31, 9.7%, $P = 0.617$). However, there were more complications after LADG (4/11, 36.4%) than after LAPPG (0/15, 0%, $P = 0.011$). The incidence of stasis after PPG was anticipated to be higher than after DG, but it was almost the same after PPG (6.5%) as after DG (6.9%). Anastomotic and pancreatic leaks were detected in 4.6% of the patients in the DG group, although they were not detected in the PPG group (Table 3). Therefore, the duration of hospital stay after LADG was longer than that of hospital stay after LAPPG (Table 2).

The mean postoperative follow-up period for the 133 patients was 62 months (range, 1–144 months). The mean follow-up period for the 87 patients in the DG group (69.8 months) was longer than that for the 46 patients in the PPG group ($P = 0.003$). A total of 18 patients died during the follow-up period. In the DG group, one patient died from cancer recurrence (1.1%) and 15 patients died from other diseases. In the PPG group, one patient died of pancreatic cancer 20 months after gastrectomy and one patient died of liver cirrhosis. The overall 5-year survival rate in the 133 patients was 85.7% and the disease-specific 5-year survival rate was 99%. Even though the difference was not significant, the overall 5-year survival rate in the 46 patients in the PPG group (95%) was higher than that in the 87 patients in the DG group (86%, $P = 0.087$, Fig. 3). The disease-specific 5-year survival of DG patients (98.6%) was also not significantly different from that of PPG patients (100%).

Table 1. Clinicopathological findings of the two groups (DG versus PPG)

	DG	PPG	*P*
n	87	46	
Age, years (mean)	64.2	62.8	0.499
Sex (male/female)	56/31	24/22	0.172
Cases with laparoscopic operation (%)	11 (12.6)	15 (32.6)	0.007
Histology (differentiated/undifferentiated)	45/42	28/15	0.313
Tumor size, cm (mean)	3.1	2.6	0.011
No. of dissected lymph nodes (mean)	30.4	21.9	0.001
No. of cases with lymph node metastasis (%)	10 (11.5)	2 (4.3)	0.171
Depth of tumor invasion			0.265
m	37	28	
sm	39	16	
mp	7	1	
ss	3	1	
se	1	0	
Tumor stage			0.193
IA	72	43	
IB	7	3	
II	6	0	
IIIA	2	0	

m, mucosa; sm, submucosa; mp, muscularis propria; ss, subserosa; se, serosa

Table 2. Clinical differences were compared between open DG and open PPG, and laparoscope-assisted (LA) DG and LAPPG

	Open DG	Open PPG	*P*	LADG	LAPPG	*P*
n	76	31		11	15	
Operation time, min (mean)	258	204	0.004	330	348	0.603
Intra-operative blood loss, ml (mean)	219	99	0.079	155	105	0.443
Hospital stay after operation, days (mean)	21	20.8	0.917	31.1	12.7	0.003

DG, distal gastrectomy; PPG, pylorus-preserving gastrectomy

Table 3. Occurrence of complications after DG and PPG

	Open DG	Open PPG	LADG	LAPPG
n	76	31	11	15
Complications				
Stasis	5	3	1	0
Pancreatic leak	0	0	2	0
Anastomotic leak	1	0	1	0
Others	4	0	0	0
Total	10 (13.2%)	3 (9.7%)	4 (36.4%)	0 (0%)

Discussion

Many previous reports have focused on the functional aspects of PPG in comparison to traditional distal gastrectomy (DG). The incidence of dumping symptoms has been reported as ranging from 4% to 46% in DG patients, and from 0% to 13% in PPG patients.[6–8] Other studies have reported that gastric emptying was delayed in PPG patients in comparison to DG patients.[9–11] Therefore, a feeling of gastric fullness after meals was observed more frequently in PPG patients than in DG patients.[11,12] However, the frequency of postprandial symptoms after PPG was reduced during the long follow-up periods, and food intake increased in the 2 years following the operation.[12–14] Hotta et al.[15] reported the nutritional status and serum albumin and hemoglobin levels to be better in PPG patients than in DG patients. Park et al.[11] reported that gastritis, bile reflux, and gallbladder stones were observed in DG patients, but not in PPG patients. These results strongly suggest that patients with early gastric cancer that undergo PPG seem to have greater quality of life (fewer gastrointes-

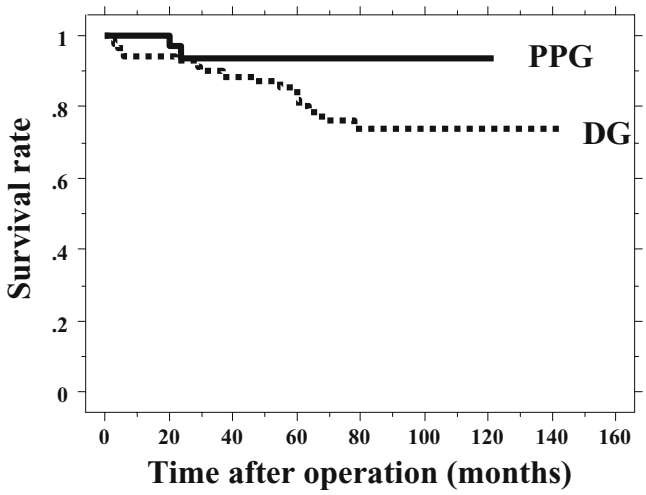

Fig. 3. Overall 5-year survival rate of the 46 pylorus-preserving gastrectomy (*PPG*) patients (*solid line*) was 95% and that of the 87 conventional distal gastrectomy (*DG*) patients (*dotted line*) was 86%. The difference was not significant ($P = 0.087$)

tinal symptoms, better nutritional status, and lower gallbladder stone incidence) than patients who undergo DG.

The 5-year survival rate in patients with early gastric cancer ranged from 93% to 98% after PPG, although the long-term outcomes associated with this procedure have not been extensively evaluated. To retain the pyloric function, the pyloric and hepatic branches of the vagus nerve are preserved in PPG. However, clear evidence for the preservation of the pyloric and hepatic branches of the vagus nerve to retain the pyloric function has not been demonstrated. Nakabayashi et al.[16] concluded that gastric stasis during the early postoperative period was due to tonic and phasic contractions of the pylorus, and it was not necessary to preserve the pyloric branch of the vagus for gastropyloroduodenal motility after PPG. However, Phillips et al.[17] demonstrated the importance of preserving the hepatic branch of the vagus nerve to mediate a multiplicity of gastrointestinal functions in rats. The success of this nerve-preserving operation was supported by the clinical data.[18,19] Therefore, we preserve the pyloric and hepatic branches of the vagus nerve in both open PPG and in LAPPG. In addition, the suprapyloric lymph nodes are usually not dissected. The number of dissected lymph nodes in PPG patients was considerably lower than that in DG patients. We therefore hypothesized that gastric cancer may return more frequently in the PPG group than in the DG group during the long follow-up period. However, we observed cancer recurrence in only one patient in the DG group, and cancer recurrence was not detected in the PPG patients. The disease-specific survival of PPG patients was not significantly different from that of DG patients. Park et al.[11] reported that they found no gastric cancer recurrence in either the DG or PPG groups.

The overall 5-year survival rate in our PPG patient group was 95%. Morita et al.[2] investigated the outcomes of 611 patients who underwent PPG and reported the overall 5-year survival rate of these patients to be 96.3%. However, we found the overall survival rate of DG patients to be 86%, which was lower than that of PPG patients. Many DG patients died from liver dysfunction, pneumonia, or heart failure. In Japan, the overall 5-year survival rate of patients with early gastric cancer who have undergone gastrectomy has been reported to be 89%–94%.[20–22] Although the follow-up periods were different (the follow-up periods of PPG patients were shorter than those of DG patients), the nutritional advantage associated with PPG may underlie the better overall survival of PPG patients.

Laparoscopy-assisted gastrectomy with lymph node dissection is now a commonly used modality for early gastric cancer surgery.[23] Recently, this less invasive surgery has been aggressively indicated for early gastric cancer. As a laparoscopy-assisted function-preserving operation, PPG is now one of the major operative methods for the patients with early gastric cancer located in the middle third of the stomach.[24,25]

In conclusion, our data show that PPG may not have significantly different outcomes than DG in patients with early gastric cancer located in the middle third of the stomach. A long-term follow-up period is necessary to investigate the nutritional benefits and survival rates associated with PPG.

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