

Current Status of Pylorus-Preserving Gastrectomy for the Treatment of Gastric Cancer: A Questionnaire Survey and Review of Literatures

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Abstract

Purpose This study was designed to investigate the current status of pylorus-preserving gastrectomy (PPG) for the treatment of gastric cancer by sending a questionnaire to institutions in Japan.

Methods The questionnaire was prepared and sent to 930 institutions approved by the Japanese Society of Gastroenterological Surgery. Questions were the indications for PPG, preservation of the vagus nerves and the infra-pyloric artery, whether suprapyloric lymph nodes are dissected, distance between the pylorus and the gastrogastrostomy, and the advantages and disadvantages of PPG.

Results Responses were obtained from 345 institutions (37.1%). In 148 institutions, PPG was included in the choices of operations for gastric cancer and indicated for patients with tumors no deeper than the submucosal layer for differentiated-type carcinoma, or for tumors limited to the mucosa even in poorly differentiated types in 105 institutions. The vagus was preserved in 73.5%, the infra-pyloric artery was preserved in 49.4%, and the dissection of suprapyloric lymph nodes were partly performed in 56.2%. The distance between gastrogastrostomy and the pyloric ring was 3–3.9 cm in 43.4% and 2–2.9 cm in 39%. Layer-to-layer anastomosis was the most representative

technique for gastrogastrostomy. The advantages of PPG with decreased incidence of dumping syndrome and remnant gastritis were quoted in 130 and 82 institutions, respectively. Delayed gastric emptying was considered as the most frequent disadvantage of PPG, as quoted by 111 institutions.

Conclusions These results indicate that standard technique in PPG includes the preservation of the vagus and infrapyloric artery, in part dissection of suprapyloric lymph nodes, and layer-to-layer anastomosis for reconstruction. The optimal length of the antral cuff is still controversial.

Introduction

In 1967, Maki et al. [1] proposed pylorus-preserving gastrectomy (PPG) as an operative procedure for gastric ulcer and submucosal tumor in the stomach. This procedure left a 1.5-cm-long cuff of the distal antrum such that the pyloric ring would remain functional to prevent the postgastrectomy sequelae of gastritis due to regurgitation of duodenal contents and the dumping syndrome associated with rapid gastric emptying. For benign gastric ulcer, PPG is already established as an operative procedure that is safe and satisfactory in terms of quality of life [2].

Since the late 1980s, some surgeons have performed PPG in selected patients with early gastric cancer [3]. Early in this experience, some surgeons performed PPG by leaving the suprapyloric lymph nodes intact and preserving the hepatic branches of the vagus [4], whereas other surgeons maintained that PPG with wide dissection of lymph nodes, including the suprapyloric region was feasible without complications [5, 6]. Later, PPG leaving suprapyloric lymph nodes intact and preserving the hepatic branches of the vagus seemed to have become the standard [7,

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8]. In the gastric cancer treatment guidelines [9], PPG is defined as “a procedure to preserve the upper third of the stomach and the distal gastric antrum 3–4 cm proximal to the pylorus,” and “PPG may be considered in T1 and N0 patients when the tumor is located in the middle third of the stomach with its distal edge greater than 4 cm from the pylorus.” The technical details of PPG, however, are not described at all in the guidelines. PPG seems to have established its place as an operation for early gastric cancer. There are, however, some controversies in the use and indications for PPG. For example, the appropriate length of the antral cuff in PPG remains controversial. Initial observations in dogs suggested that transecting the antrum 1–2 cm proximal to the pylorus did not increase intraluminal pressure at the pyloric ring [1]. In contrast, recent studies have stated that symptoms after PPG were better in those whose patients in whom the antral cuff was longer than 1.5 cm [8, 10]. Although in theory preservation of hepatic, pyloric, and celiac branches of the vagal nerve in PPG should decrease the incidence of gallstone formation after gastrectomy, objective support for this concept has not been shown in randomized, controlled trial [11]. PPG is generally thought to offer several advantages in terms of dumping syndrome and bile reflux gastritis. Our goal was to investigate the current status of the use of PPG via a questionnaire sent to institutions in Japan to clarify the controversies of PPG.

Methods

Technical differences that occur between institutions or surgeons when performing a PPG are: (1) whether the infrapyloric artery that originates from the right gastroepiploic or gastroduodenal artery is preserved when dissecting the infra-pyloric lymph nodes; (2) whether the right gastric artery is divided at its root when dissecting the suprapyloric lymph nodes; and (3) whether the hepatic and celiac branches of the vagal nerve are preserved when dissecting lymph nodes along the lesser curvature and dividing the left gastric artery. Surgeons preserve the infrapyloric and right gastric arteries, because insufficient blood flow to the antral cuff associated with division of these two arteries is considered to cause complications after PPG. Surgeons who preserve the hepatic and celiac branches of the vagal nerve maintain that these branches help to prevent complications after PPG. The distance between the pyloric ring and the gastrogastrostomy also might differ between institutions and surgeons.

A questionnaire regarding the local technique of PPG was mailed to 930 institutions approved by the Japanese Society of Gastroenterological Surgery throughout Japan, and the response was sent to our office by fax.

The questionnaire as translated into English is shown as Table 1. We asked: (1) whether PPG is included in choices of operation for gastric cancer; (2) the number of patients who underwent PPG in 2006–2008; (3) the indications for PPG; (4) the technique for PPG (preservation of the vagal nerve and infrapyloric artery, dissection of suprapyloric lymph nodes, distance between the gastrogastrostomy and the pyloric ring, and the technique of anastomosis); (5) the believed advantages of PPG; and (6) the believed disadvantages of PPG. In some questions, the responders were able to choose multiple answers. Regarding technique of anastomosis (gastrogastrostomy), responders were able to choose one of five anastomoses; layer-to-layer anastomosis (two-layer anastomosis with mucosal and seromuscular sutures), Albert-Lembert anastomosis (transmural and seromuscular sutures), Gambee suture (vertical mattress suture), transmural one-layer anastomosis, and others.

Results

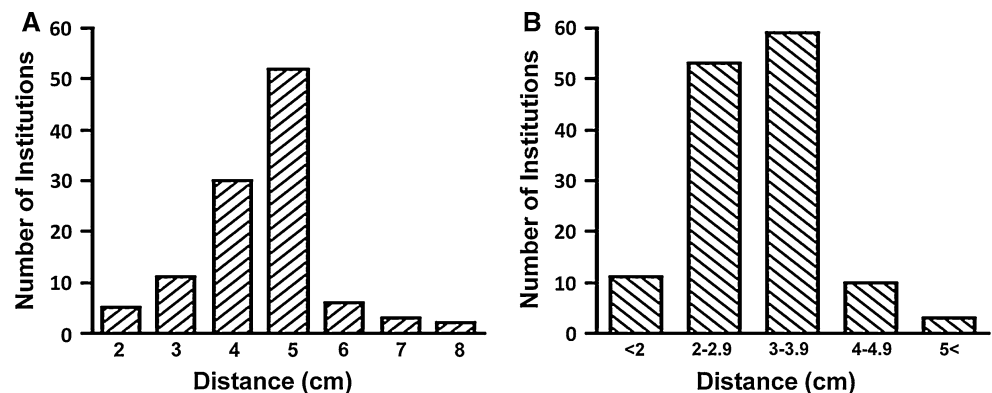
Responses were obtained from 345 institutions (345/930 = 37.1%). Of these 345 institutions, 148 institutions (148/345 = 42.9%) responded that PPG was included in their choices of operations for gastric cancer. Further analysis was performed regarding answers from these 148 institutions. The number of patients undergoing PPG was 690 in 2006, 733 in 2007, and 666 in 2008. PPG was indicated for patients with stage IA disease when the depth of tumor invasion was no deeper than the submucosal layer with differentiated tumors or when the depth of tumor invasion was limited to mucosa in poorly differentiated tumors in 105 of 148 institutions (70.9%). The remaining 43 institutions employed their own indications for PPG, which varied in each institution. One hundred nine institutions responded with the least distance between the distal extent of the cancer and the pylorus (Fig. 1a); the least distance was 5 cm in 52 institutions (47.7%), 4 cm in 30 institutions (27.5%), and 3 cm in 11 institutions (10.1%).

There were 147 institutions that responded to questions regarding preservation of the vagus (Fig. 2a). The vagus was always preserved in 108 institutions (73.5%), was preserved, if possible, in 35 institutions (23.8%), and no attempt was made to preserve in four institutions (2.7%). In the 108 institutions that preserved the vagus, both celiac and hepatic branches were preserved in 53 institutions (49.0%), only the hepatic branch in 22 institutions (20.4%), only the celiac branch in three institutions (2.8%), and in the remaining 30 institutions (27.8%), no formal description of how they preserve the branches was made (Fig. 2b). One hundred forty-four institutions responded concerning dissection of lymph nodes in the suprapyloric region (Fig. 2c); all suprapyloric lymph nodes were removed in

Table 1 Questionnaire survey on PPG

1. Is PPG included in your choices of operation for gastric cancer? Circle A or B
 - A. Yes (please go to questions 2–6)
 - B. No (end of questionnaire)
2. Please indicate number of patients who underwent PPG in 2006–2008 in your institution
2006 () patients, 2007 () patients, 2008 () patients
3. Please answer indication for PPG in your institution
 - 3–1. In terms of stage, depth invasion, histologic type. Circle A or B
 - A. Patients having tumor of T1N0 with depth no deeper than submucosal layer in differentiated types, or depth limited within mucosa in undifferentiated types.
 - B. Other (Please describe your indication)
 - 3–2. Distance between anal edge of the tumor and the pyloric ring: more than () cm
4. Please answer technique you do in PPG
 - 4–1. Do you preserve vagal nerves?
 - A. Always (please circle branch to preserve celiac branch hepatic branch)
 - B. If feasible
 - C. Never
 - D. Other
 - 4–2. Do you preserve infrapyloric artery?
 - A. Always
 - B. If feasible
 - C. Never
 - D. Other
 - 4–3. Do you dissect suprapyloric lymph nodes (#5 lymph nodes)?
 - A. No
 - B. Partly dissected
 - C. Completely dissected
 - D. Other
 - 4–4. Indicate the distance between gastrogastrostomy and pyloric ring after completing anastomosis () cm
 - 4–5. Choose a method for anastomosis from below (circle as many as you want)
 - A. Layer-to-layer
 - B. Albert-Lembert
 - C. Gambee
 - D. Albert
 - E. Other
5. What do you think advantages of PPG? (circle as many as you want)
 - A. Good oral intake
 - B. Reduced incidence of remnant gastritis
 - C. Reduced incidence of dumping syndrome
 - D. Reduced incidence of reflux esophagitis
 - E. Reduced incidence of anastomotic leakage
 - F. Other
6. What do you think disadvantages of PPG? (circle as many as you want)
 - A. Increased incidence of delayed gastric emptying
 - B. Increased probability of remnant gastric cancer
 - C. Incomplete lymph node dissection
 - D. No apparent disadvantage
 - E. Other

Fig. 1 a The least distance between the anal edge of the cancer lesion and the pylorus when performing PPG. *Vertical axis* indicates the number of institutions. **b** The distance between gastrogastrostomy and the pyloric ring after completion of the anastomosis. *Vertical axis* indicates the number of institutions



eight institutions (5.6%), the lymph nodes were only partially removed in 81 institutions (56.2%), and none were removed in 53 institutions (36.8%). Also, 144 institutions responded to the question regarding preservation of the infrapyloric artery (Fig. 2d); the artery was always preserved in 71 institutions (49.4%), or preserved whenever possible in 64 institutions (44.4%), but no attempt was

made to preserve the artery in nine institutions (6.3%). Responses to the question about the distance between the gastrogastrostomy and the pyloric ring after completion of the anastomosis were obtained from 136 institutions (Fig. 1b); the distance was less than 2 cm in 11 institutions (8.1%), 2–2.9 cm in 53 institutions (39%), 3–3.9 cm in 59 institutions (43.4%), 4–4.9 cm in ten institutions (7.3%),

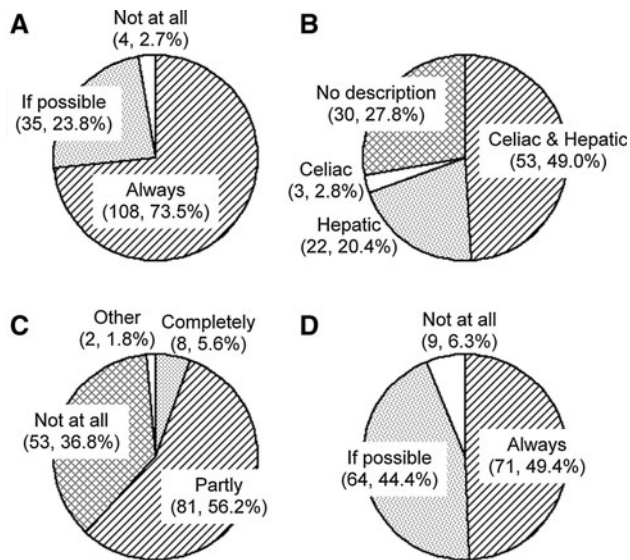


Fig. 2 **a** Results of a question asking if the vagal nerve is preserved or not. **b** Results of a question asking preserved branches of the vagal nerve. **c** Results of a question asking whether suprapyloric lymph nodes are completely dissected. **d** Results of a question asking whether infrapyloric artery is preserved

and 5 cm or greater in three institutions (2.2%). Although 147 institutions responded to the question concerning methods for anastomosis for PPG, the total number of responses exceeded 147, because choosing multiple answers were allowed. Layer-to-layer anastomosis in 147 institutions, Albert-Lembert anastomosis in 37 institutions, a Gambee anastomosis in 20 institutions, transmurial one-layer anastomosis in five institutions, and various other anastomoses in 14 institutions.

The advantages of PPG described were the following: a decreased incidence of dumping syndrome in 130/148 (87.8%) institutions, a decreased incidence of remnant gastritis in 82/148 (55.4%) institutions, a decreased incidence of reflux esophagitis in 44/148 (29.7%) institutions, excellent oral intake in 40/148 (27%) institutions, and a decreased incidence of anastomotic leakage in 38/148 (25.7%) institutions. Delayed gastric emptying was reported to be the most frequent disadvantage of PPG in 111/148 (75%) institutions. Incomplete dissection of lymph nodes and increased probability of the remnant gastric cancer also were considered as disadvantages by 52/148 (35.1%) and 11/148 (7.4%) institutions, respectively.

Discussion

In our questionnaire survey, PPG was considered as an option for gastric cancer in almost half of institutions that returned the questionnaire, and approximately 600–700 patients/year underwent PPG across these 148 institutions.

These results indicate that PPG is recognized widely as one of treatment procedures for early gastric cancer in Japan. Although total response rate in this survey 37.1% (345/930) is low, we believe that responses from institutions where more than 2,000 PPGs were performed are reliable and deserve reporting.

Regarding the indications for PPG concerning tumor depth, histologic type, and lymph node metastasis, Kodama and Koyama [12] described the incidence of lymph node metastases in patients who underwent distal gastrectomy for T1 tumors located in the middle third of the stomach and concluded that PPG should be indicated for: (1) tumors smaller than 2 cm in diameter; (2) tumors of 2–4 cm limited to the mucosa, located along the greater curvature, and an elevated type cancer. In more recent years, the proposed indications for PPG are simpler than those suggested previously. Other investigators also microscopically studied the condition of the gastric cancer in which metastasis to the suprapyloric region is zero or extremely rare and established criteria of performing PPG [13, 14]. Morita et al. [15] have performed PPG in more than 600 patients with T1 tumors located in the middle third of the stomach; this group reported an excellent 5 years survival of 96.3%. Other groups also have reported excellent 5 years survivals after PPG for patients with T1N0 cancers in the middle third of the stomach [16, 17]. Because our criteria in the questionnaire proposed based on our previous report [18] were stricter than the reported indications by others, they were supported by approximately three of four of total responders.

Our questionnaire also showed that preservation of the celiac and hepatic branches of the vagal nerve and infrapyloric artery with in part dissection of the suprapyloric lymph nodes should be regarded as a standard technique for PPG. In many reports about PPG, techniques for the preservation of the celiac and/or hepatic and pyloric branches of the vagus have been described [8, 15, 16, 19–21], but few studies compared the clinical results between groups with and without vagal preservation. Tomita et al. [22] reported that the incidence of gallstone disease in patients with preservation of hepatic and pyloric branches was less than those in whom these vagal branches were not preserved. The extent of dissection of suprapyloric lymph nodes varied in each report as well; some groups removed all the suprapyloric lymph nodes by dividing the right gastric artery at its bifurcation [23–25], whereas others did not remove any suprapyloric lymph nodes [15, 16, 19, 21, 26]. “Cherry-picking” of only the enlarged nodes or sampling of the suprapyloric lymph nodes was performed as “part dissection” in recent studies [8, 17]. Results of our survey suggest that avoidance of dissecting these nodes or just sampling them was popular, whereas the vast majority of responders did not favor the complete lymphadenectomy. The infrapyloric artery

originates from the left gastroepiploic or the gastroduodenal artery and supplies the gastric antrum along the great curvature close to the pylorus. Preservation of the infrapyloric artery assures sufficient blood flow to the antral cuff and decreases the incidence of gastric stasis [8].

Several concerns have been raised about a 1.5–2.0 cm antral cuff in the original report by Maki et al. [1]; some have argued that this distance is too close to the pylorus when performing the gastrogastrostomy. Results of our questionnaire revealed that a length of 3–4 cm, as recommended by the guidelines [9], was the most preferred length for the antral cuff. Postoperative outcomes in terms of postprandial symptoms, food intake, recovery of body weight, and gastric emptying were better in patients with antral cuff of 2.5 cm proximal to the pylorus than those who had a 1.5 cm antral cuff [27]. In another study, postoperative symptoms did not differ between patients with an antral cuff greater than 3 cm compared with those with a cuff less than 3 cm [28]. These observations suggest that the antral cuff should be longer than 1.5 cm, but the optimal length remains controversial.

The decreased incidence of dumping syndrome was considered the most recognized advantage of PPG and was well accepted in our questionnaire. We reported previously that the incidence of early dumping syndrome after PPG was less than that after a conventional distal gastrectomy in randomized, controlled, multicenter trial [18]. Other studies also reported that incidence of dumping syndrome after PPG was less than that after conventional distal gastrectomy [26, 29, 30]. More than 50% of responders believed that remnant gastritis after PPG is generally milder than after the other types of gastrectomy. Endoscopic examination revealed that remnant gastritis was more severe after distal gastrectomy with a Billroth-I anastomosis than after PPG [31–33].

Symptoms related to gastric stasis were reported as the most common disadvantage of PPG in our questionnaire. Food residue in the remnant stomach after PPG was greater than that after distal gastrectomy by endoscopic examination [31–33]. In contrast, scores based on postoperative symptoms after PPG are generally better than those after distal gastrectomy [25]. Development of a new primary gastric cancer in the gastric remnant was observed in three of 188 patients (1.6%) in one study with median follow-up period of 38 months [11] and two of 72 patients (2.8%) in another study [33] after PPG. These values are not considered different from the occurrence rate (31/1,984 patients, 1.6% with mean follow-up period of 15 years) of gastric remnant cancer after distal gastrectomy [34]. These results suggest that leaving the antral cuff after PPG does not increase the occurrence rate of remnant gastric cancer, although we have to be careful about follow-up period after the surgery.

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