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Laparoscopy-Assisted Pylorus-Preserving Gastrectomy for Treating Early Gastric Cancer

Hiroaki Saito, Yoji Fukumoto, Tomohiro Osaki, Yoshinori Yamada, Kenji Fukuda, Shigeru Tatebe, Shunichi Tsujitani and Masahide Ikeguchi

Division of Surgical Oncology, Department of Surgery, School of Medicine, Tottori University Faculty of Medicine, Yonago 683-8504 Japan

Laparoscopy-assisted pylorus-preserving gastrectomy (LAPPG) with lymphadenectomy has been used for treating early gastric cancer located in the middle-third of the stomach. However, firm evidence supporting its safety and usefulness is scant. This study examined 24 and 10 gastric adenocarcinoma patients who had undergone conventional pylorus-preserving gastrectomy (CPPG) and LAPPG, respectively, at our institution. Operation time for LAPPG (362.8 ± 49.6 min) was significantly longer than that for CPPG (221.9 ± 50.0 min; *P* = 0.04). Estimated blood loss with LAPPG (127.5 ± 91.2 mL) was not significantly different from that with CPPG (167.9 ± 149.9 mL; *P* = 0.44). Total number of resected lymph nodes was 26.3 ± 9.5 and 21.3 ± 10.8 with LAPPG and CPPG, respectively, with no statistically significant difference. C-reactive protein in serum on postoperative day 1 was significantly lower in the LAPPG than in the CPPG group (5.3 ± 1.7 mg/dL versus 7.8 ± 3.6 mg/dL; *P* = 0.049). The requirement for analgesia after surgery was more frequent in the CPPG than in the LAPPG group (3.7 ± 2.0 versus 2.2 ± 1.7; *P* = 0.04). Time to first flatus was shorter in the LAPPG than in the CPPG group (1.9 ± 0.9 days versus 3.1 ± 0.9 days; *P* = 0.0006). Postoperative hospital stay was significantly shorter in the LAPPG than in the CPPG group (12.0 ± 4.0 days versus 23.0 ± 10.7days; *P* = 0.0036). With regard to postoperative complications, stasis was observed more frequently in the CPPG (33.3%) than in the LAPPG (10%) group. In conclusion, patients treated by LAPPG showed a comparable quality of surgical operation compared with those treated by CPPG.

Key words: early gastric cancer; laparoscopy-assisted pylorus-preserving gastrectomy; pylorus preservation

Gastric cancer is one of the most common cancers in Asia and its mortality still ranks second among all cancer deaths worldwide (Ries et al., 2003). Recent progress in endoscopic devices and diagnostic techniques has improved the early detection rate. Since the prognosis of patients with early gastric cancer is extremely good in Japan, minimally invasive treatment or function-preserving techniques, such as endoscopic mucosal resection, endoscopic submucosal dissection and laparoscopic surgery, are used increasingly to maintain quality of life after treatment. Endoscopic resection enables resection of primary tumor and is indicated for nearly all mucosal cancers without lymph node metastasis (Gotoda et al., 2000). However, about 10% of early gastric cancers have

Abbreviations: CPPG, conventional PPG; LADG, laparoscopy-assisted distal gastrectomy; LAPPG, laparoscopy-assisted PPG; LCS, laparosonic coagulation shears; PPG, pylorus-preserving gastrectomy

lymph node metastasis, and gastrectomy with lymph node dissection remains the treatment of choice for mucosal cancers with high possibility of lymph node metastasis and submucosal cancers (Kikuchi et al., 2004). Laparoscopy-assisted distal gastrectomy (LADG) was first performed in Japan in 1991 and has recently been used increasingly in gastric cancer operations because it has been associated with less postoperative pain, an early return of bowel function, shorter periods of hospitalization and disability and better cosmetic results (Kitano et al., 1994; Mochiki et al., 2002). LADG with perigastric lymph node dissection is readily applicable to T1 stage gastric cancer.

Pylorus-preserving gastrectomy (PPG), which retains pyloric ring and gastric function, was first performed in 1967 (Maki et al., 1967). It was used as an alternative treatment for gastric ulcer, in order to prevent postoperative dumping syndrome and bile-juice reflux. Recently, PPG with radical lymph node dissection has been used for patients with early gastric cancer. Like LADG, laparoscopy-assisted PPG (LAPPG) with lymphadenectomy has been applied for treating early gastric cancer located in the middle-third of the stomach instead of conventional PPG (CPPG). Hiki et al. (2006) recently demonstrated that clinical outcomes of surgical treatment were comparable for gastric cancer patients who underwent LAPPG and those treated with CPPG in terms of station-dependent lymph node dissection, and estimated blood loss. However, firm evidence supporting its safety and usefulness is scant compared to LADG. Therefore, this study was undertaken to compare LAPPG and CPPG with respect to quality of lymph node dissection and other clinical outcomes.

Materials and Methods

Patients

This study examined 24 gastric adenocarcinoma patients who had undergone CPPG at our institution between September 1997 and May 2007, and 10 patients who had undergone LAPPG between September 2006 and May 2007. The clinicopathological findings were determined according to the Japanese Classification of Gastric Cancer (Japanese Gastric Cancer Association, 1998). Patient background is shown in Table 1. There were no differences in background except the distance of preserved pylorus between LAPPG and CPPG. All tumors were classified histologically as adenocarcinomas that had invaded only the mucosa or submucosa of the stomach without lymph node metastasis (cT1, cN0). Clinical classification of tumor depth (cT) and nodal involvement (cN) was determined by preoperative and intraoperative evaluation, including barium radiography, upper gastrointestinal tract endoscopy, abdominal ultrasonography, computed tomography and endoscopic ultrasonography. Intramucosal or submucosal carcinoma without lymph node metastasis (cT1, cN0) located in the middle-third of the stomach is indicated for either CPPG or LAPPG. The exclusion criteria affected patients who had cardiac (greater than New York Heart Association II), pulmonary (greater than Hugh-Jones II), hepatic (Child classes B and C) or renal insufficiency.

Surgical procedure

For CPPG, the peritoneal cavity is accessed through an upper medican incision. For LAPPG, the pneumoperitoneum is created by injection of carbon dioxide to 8 to10 mmHg and the laparoscopy is inserted through the umbilical port. Under the view of the laparoscopic image, a total of 4 ports including two 5-mm ports and two 12-mm ports are inserted into the left upper, left lower, right upper and right lower quadrants. For CPPG and LAPPG, the gastrocolic ligament is divided 4 cm distal to the epiploic arcade to reach the lesser peritoneal cavity. During LAPPG, laparosonic coagulation shears (LCS; Ethicon Endo-Surgery, Cincinnati, OH) is used. Toward the lower pole of the spleen-dividing gastrocolic ligament, the left gastroepiploic vein and artery are exposed and

Table 1. Background of patients included in the present study

Variable		LAPPG	CPPG	*P* value
Age	(year)	57.5 ± 11.3	62.0 ± 10.3	0.27
Gender				
Male		6	12	0.59
Female		4	12	
Tumor size	(cm)	2.2 ± 0.8	2.0 ± 0.9	0.41
Macroscopic appearance*				
Protruded		0	3	0.61
Depressed type		10	21	
Histology†				
Differentiated		5	14	0.95
Undifferentiated		5	10	
Depth of invasion‡				
M; tumor has invaded the lamina propria		4	9	0.81
SM; tumor has invaded the submucosa		6	14	
SS; tumor has invaded the subserosa		0	1	
Lymph node metastasis				
Absent		10	23	0.99
Present		0	1	
Stage				
1a		10	22	0.99
1b		0	2	
Distance of preserved pylorus	(cm)	3.9 ± 0.57	2.9 ± 1.2	0.018

* When the elevated lesion had a depressed area, we classified it as the depressed type.
† Differentiated, papillary or tubular adenocarcinoma; undifferentiated, poorly differentiated or mucinous adenocarcinoma, or signet-ring cell carcinoma.
CPPG, conventional pylorus-preserving gastrectomy; LAPPG, laparoscopy-assisted pylorus-preserving gastrectomy.

dissected (station 4sb). Then, the right side of the greater omentum is dissected from the transverse colon and the anterior sheet of the transverse mesocolon. The origin of the right gastroepiploic vein is then divided, and the right gastroepiploic artery is dissected (station 6). The infrapyloric artery is preserved in this step to maintain the blood supply to the remaining pyloric cuff. The right gastric artery and vein are also preserved up to the first branch of the stomach wall for the preservation of the pyloric branch of the vagal nerve without station 5 lymph node dissection. The pedicle of gastropancreatic ligament is then carefully lifted up, and the pancreatic capsule is dissected with the LCS for LAPPG at the suprapancreatic border toward the pancreatic tail. These steps expose the splenic artery and its root as a starting point of the station 9 lymph node dissection. The common hepatic artery is then exposed toward the root of the left gastric artery. During these procedures, the left gastric vein is confirmed and divided. Lymph node dissection of station 8a is continued on to lymph node dissection of station 9 around the celiac axis. The left gastric artery is resected by clip, accompanied by lymph node dissection of station 7. The cardiac lymph node (station 1) and the lymph nodes along the lesser curvature of the stomach (station 3) are then removed. The celiac branch of the vagus nerve is not preserved in this operation. The lymph node dissection is classified D0 because of the absence of station 5 lymph node dissection according to the Japanese Classification of Gastric Cancer. For LAPPG, a 5-cm middleline incision is made and the location of the tumor is comfirmed by the palpation of the preopearive clipping. The diatal and proximal portion of the stomach is then resected and gastrogastrostomy

Table 2. Operative data

Variable		LAPPG	CPPG	*P* value
Operation time	(min)	362.8 ± 49.6	221.9 ± 50.0	0.04
Bleeding volume	(mL)	127.5 ± 91.2	167.9 ±149.9	0.44
Number of dissected lymph nodes		26.3 ± 9.5	21.3 ± 10.8	0.21
Lymph nodes retrieved for each station				
Station 1		4.3 ± 2.3	2.0 ± 0.82	0.076
Station 3		3.2 ± 3.1	6.7 ± 5.5	0.069
Station 4sb		1.0 ± 0.94	1.6 ± 1.7	0.34
Station 4d		7.2 ± 5.6	6.7 ± 4.8	0.78
Station 6		3.7 ± 4.3	3.3 ± 3.4	0.76
Station 7		2.9 ± 1.7	2.3 ± 2.3	0.49
Station 8a		3.1 ± 2.2	3.0 ± 1.4	0.92
Station 9		1.1 ± 1.2	2.0 ± 1.5	0.45

CPPG, conventional pylorus-preserving gastrectomy; LAPPG, laparoscopy-assisted pylorus-preserving gastrectomy.

was performed extracorporeally using Gambee's handsewn methods through a small incision, with the wound protected.

Statistical analysis

Association among factors was evaluated by the chi-squared test and the significance of differences among means was determined by the Mann-Whitney *U* test. The accepted level of significance was $P < 0.05$. Stat View software (Abacus Concepts, Berkeley, CA) was used for all statistical analyses.

Results

Operation time for LAPPG (362.8 ± 49.6 min) was significantly longer than that for CPPG (221.9 ± 50.0 min; P = 0.04). Estimated blood loss with LAPPG (127.5 ± 91.2 mL) was not significantly different from that with CPPG (167.9 ± 149.9 mL; $P = 0.44$) (Table 2). Total number of resected lymph nodes was 26.3 ± 9.5 and 21.3 ± 10.8 with LAPPG and CPPG, respectively, and there was no statistically significant difference (Table 2). Furthermore, number of dissected lymph nodes in each lymph node station was similar between the 2 groups, with no significant differences (Table 2). These results demonstrated that the quality of lymph node dissection with LAPPG was satisfactory compared with that with CPPG.

With regard to postoperative outcomes (Table 3), C-reactive protein in serum on postoperative day 1 was significantly lower in the LAPPG than in the CPPG group (5.3 ± 1.7 mg/dL versus 7.8 ± 3.6 mg/dL; $P = 0.049$). The requirement for analgesia (diclofenac sodium or pentazocine) in hospital after surgery was more frequent in the CPPG than in the LAPPG group (3.7 ± 2.0 versus 2.2

Table 3. Postoperative data

Variable		LAPPG	CPPG	*P* value
C-reactive protein	(mg/dL)	5.3 ± 1.7	7.8 ± 3.6	0.049
Total frequency of analgesic drug administration in hospital	(times)	2.2 ± 1.7	3.7 ± 2.0	0.04
Time until start of flatus	(day)	1.9 ± 0.9	3.1 ± 0.9	0.0006
Postoperative hospital stay	(day)	12.0 ± 4.0	23.0 ±10.7	0.0036

CPPG, conventional pylorus-preserving gastrectomy; LAPPG, laparoscopy-assisted pylorus-preserving gastrectomy.

± 1.7; $P = 0.04$). Time to first flatus was shorter in the LAPPG than in the CPPG group (1.9 ± 0.9 days versus 3.1 ± 0.9 days; $P = 0.0006$). Postoperative hospital stay was significantly shorter in the LAPPG than in the CPPG group (12.0 ± 4.0 days versus 23.0 ± 10.7 days; $P = 0.0036$).

With regard to postoperative complications, no patient had anastomotic or pancreatic-juice leakage. On the other hand, stasis was observed more frequently in the CPPG (8 patients, 33.3%) than in the LAPPG (1 patient, 10%) group. No patients died of recurrent gastric cancer, and all patients remain disease-free.

Discussion

Many studies have compared the surgical features of LADG and conventional distal gastrectomy. Some have reported longer operation times for LADG than for conventional distal gastrectomy (Kitano et al., 2002; Mochiki et al., 2002). We also found that operation times for LAPPG were significantly longer than those for CPPG in the present study. In this regard, however, Adachi et al. (2000) have reported that LADG performed by skilled and experienced surgeons takes no more time than conventional distal gastrectomy. Therefore, it might be possible to shorten the operation time through experience. On the other hand, intraoperative blood loss tended to be less in LAPPG patients than in CPPG patients, as reported by others, probably due to the effect of magnification by laparoscopy (Adachi et al., 2000; Yano et al., 2001; Kitano et al., 2002; Mochiki et al., 2002; Migoh et al., 2003).

It has been demonstrated that lymph node metastasis and lymph node dissection were deemed as the most important prognostic factors in patients with resected gastric cancer (Siewert et al., 1998). Therefore, lymph node dissection is the most important procedure in surgery for gastric cancer. We determined the number of lymph nodes to be resected to evaluate the quality of lymph node dissection. The total number of dissected lymph nodes was similar between the 2 groups, with no significant differences. Moreover, number of dissected lymph nodes in each lymph node station was similar between the 2 groups, with no significant differences. This result demonstrated that the quality of lymph node dissection in LAPPG was satisfactory compared with that in CPPG.

Recovery of bowel movements after operation occurred at an earlier stage in the LAPPG group, as measured by first flatus and oral intake. This was an important feature, as reduction in the period of postoperative intestinal paralysis is one of the most valuable features of laparoscopic surgery, and early recovery of bowel function can result in early resumption of food intake and earlier discharge from hospital (Mochiki et al., 2002). Less administration of analgesic drugs was required for LAPPG patients, and this might have contributed to the greater activity of these patients postoperatively. As in the previous studies (Adachi et al., 2000; Mochiki et al., 2002; Migoh et al., 2003), the hospital stay was shorter in the LAPPG than in the CPPG group in the present study.

With regard to the postoperative complications, there was no difference, except for stasis, between the 2 groups. Postoperative gastric stasis due to aberrant pylorus function is the most common complication, occurring in 23 to 40% of patients after PPG (Kodama et al., 1995; Tomita et al., 2003). In this regard, Nunobe et al. (2007) have demonstrated that preservation of the vagus nerve and infrapyloric artery induces less stasis. The length of the antral segment and the volume of the remnant stomach are also important factors for gastric stasis after PPG. Nakane et al. (2002) have shown that longer length of the retained antrum is associated with less postprandial symptoms, improved food intake, earlier recovery of body weight and gastric emptying. In the present study, infrapyloric artery and the pyloric branch of the vagal nerve were preserved in the LAPPG group. Moreover, preserved length of the antral segment was longer in the LAPPG than in the CPPG group. With regard to length of the antral

segment, we have recently preserved the antral segment as long as possible in both CPPG and LAPPG patients. The difference in the preserved length of the antral segment we observed in the present study was simply due to the difference in period of operation. Longer length of the pyloric cuff and preservation of the infrapyloric artery and the pyloric branch of the vagal nerve might have resulted in the low frequency of gastric stasis.

In conclusion, our results demonstrated that LAPPG was a safe and useful operation for early gastric cancer located in the middle third of the stomach. Additional randomized control studies should be undertaken to analyze long-term outcomes.

References

1 Adachi Y, Shiraishi N, Shiromizu A, Bandoh T, Aramaki M, Kitano S. Laparoscopy-assisted Billroth I gastrectomy compared with conventional open gastrectomy. Arch Surg 2000;135:806–810.

2 Gotoda T, Yanagisawa A, Sasako M, Ono H, Nakanishi Y, Shimoda T, et al. Incidence of lymph node metastasis from early gastric cancer: estimation with a large number of cases at two large centers. Gastric Cancer 2000;3:219–225.

3 Hiki N, Shimoyama S, Yamaguchi H, Kubota K, Kaminishi M. Laparoscopy-assisted pylorus-preserving gastrectomy with quality controlled lymph node dissection in gastric cancer operation. J Am Coll Surg 2006;203:162–169.

4 Japanese Gastric Cancer Association. Japanese Classification of Gastric Carcinoma: 2nd English edition. Gastric Cancer 1998;1:10–24.

5 Kikuchi S, Katada N, Sakuramoto S, Kobayashi N, Shimao H, Watanabe M, et al. Survival after surgical treatment of early gastric cancer: surgical techniques and long-term survival. Langenbecks Arch Surg 2004;389:69–74.

6 Kitano S, Iso Y, Moriyama M, Sugimachi K. Laparoscopy-assisted Billroth I gastrectomy. Surg Laparosc Endosc 1994;4:146–148.

7 Kitano S, Shiraishi N, Fujii K, Yasuda K, Inomata M, Adachi Y. A randomized controlled trial comparing open vs laparoscopy-assisted distal gastrectomy for the treatment of early gastric cancer: an interim report. Surgery 2002;131:S306–S311.

8 Kodama M, Koyama K, Chida T, Arakawa A, Tur G. Early postoperative evaluation of pylorus-preserving gastrectomy for gastric cancer. World J Surg 1995;19:456–460; discussion 461.

9 Maki T, Shiratori T, Hatafuku T, Sugawara K. Pylorus-preserving gastrectomy as an improved operation for gastric ulcer. Surgery 1967;61:838–845.

10 Migoh S, Hasuda K, Nakashima K, Anai H. The benefit of laparoscopy-assisted distal gastrectomy compared with conventional open distal gastrectomy: a case-matched control study. Hepatogastroenterology 2003;50:2251–2254.

11 Mochiki E, Nakabayashi T, Kamimura H, Haga N, Asao T, Kuwano H. Gastrointestinal recovery and outcome after laparoscopy-assisted versus conventional open distal gastrectomy for early gastric cancer. World J Surg 2002;26:1145–1149.

12 Nakane Y, Michiura T, Inoue K, Sato M, Nakai K, Yamamichi K. Length of the antral segment in pylorus-preserving gastrectomy. Br J Surg 2002;89:220–224.

13 Nunobe S, Hiki N, Fukunaga T, Tokunaga M, Ohyama S, Seto Y, et al. Laparoscopy-assisted pylorus-preserving gastrectomy: preservation of vagus nerve and infrapyloric blood flow induces less stasis. World J Surg 2007;31:2335–2340.

14 Ries L, Eisner M, Kosary C. SEER cancer statistics review, 1975–2000. Bethesda: National Cancer Institute; 2003.

15 Siewert JR, Bottcher K, Stein HJ, Roder JD. Relevant prognostic factors in gastric cancer: ten-year results of the German Gastric Cancer Study. Ann Surg 1998;228:449–461.

16 Tomita R, Fujisaki S, Tanjoh K. Pathophysiological studies on the relationship between postgastrectomy syndrome and gastric emptying function at 5 years after pylorus-preserving distal gastrectomy for early gastric cancer. World J Surg 2003;27:725–733.

17 Yano H, Monden T, Kinuta M, Nakano Y, Tono T, Matsui S, et al. The usefulness of laparoscopy-assisted distal gastrectomy in comparison with that of open distal gastrectomy for early gastric cancer. Gastric Cancer 2001;4:93–97.

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Correspondence: Hiroaki Saito, MD