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Feasibility and Safety of Laparoscopy-Assisted Subtotal Gastrectomy for Gastric Cancer Invading the Upper Stomach

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This study evaluated the feasibility and safety of laparoscopy-assisted subtotal gastrectomy preserving a minimal remnant stomach for clinical T1 gastric cancer invading the upper stomach. Forty-three consecutive patients who underwent laparoscopy-assisted subtotal gastrectomy preserving a minimal remnant stomach were examined. In addition to the conventional laparoscopy-assisted distal gastrectomy, some short and posterior gastric arteries were resected. A minimal remnant stomach-jejunum anastomosis was made by using a circular stapler with regular anvil or transoral anvil. Transoral anvil was selected in 19 patients, and regular anvil was used in 24 patients. The median operation time was 288 minutes, and the median blood loss was 50 mL. Conversion to open surgery was required in 2 patients due to bleeding. No patient required conversion to open surgery due to the difficulty of the anastomosis. Nine patients developed postoperative complications, including grade 3 duodenal stump leakage in 1 patient and grade 2 anastomotic bleeding in another patient. No mortality was observed. Laparoscopy-assisted subtotal gastrectomy preserving a minimal remnant stomach is safe and feasible for early gastric cancer invading the upper stomach.

Key words: Laparoscopy – Subtotal gastrectomy – Roux-en-Y anastomosis

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Early gastric cancer is almost a curable disease, and a successful cure can often be achieved by surgery alone.[1] Laparoscopy-assisted gastrectomy has become widespread for early gastric cancer. The feasibility and safety of laparoscopic surgery have been confirmed in multicenter prospective studies in patients with distal gastrectomy[2] but not in those with total or proximal gastrectomy. As laparoscopy-assisted total gastrectomy (LATG) and proximal gastrectomy (LAPG) are technically more difficult than laparoscopy-assisted distal gastrectomy (LADG), the complication rates of LATG and LAPG are higher than that of LADG.[3–9] Moreover, the quality of life after LATG and LAPG is reported to be inferior to that after LADG.[10,11]

For tumors invading the upper stomach, total gastrectomy with nodal dissection had been recommended, regardless of the tumor progression or the distance from the esophagogastric junction.[12] This was to guarantee the safety margin for the resection line. However, recent progress in endoscopic diagnostics has made it possible to determine the precise margin of the tumor, especially in early cancer spreading to the mucosal surface.

It may thus be possible to avoid LATG for early gastric cancer at a certain distance from the margin of the tumor to the esophagogastric junction by preserving the minimal remnant stomach. However, it would be difficult to perform a Roux-en Y reconstruction with a linear stapler, because the remnant stomach is very small. In contrast, a circular stapler is applicable even for a minimal remnant stomach because the anvil head can be set at the resected line of the stomach. With these factors in mind, we reported on laparoscopy-assisted subtotal gastrectomy preserving a minimal stomach (LAsTG) for early gastric cancer invading the upper stomach in 2010,[13] instead of LATG or LAPG. We defined LAsTG as distal gastrectomy including the resection of the lower, middle, and part of the upper third of the stomach, with the conventional dissection of the lymph nodes located in the upper third of the stomach that was resected, in addition to the need for nodal dissection for conventional distal gastrectomy. All short and posterior gastric arteries could be resected if necessary. The blood supply after the procedure for the very small remnant stomach is provided by only the cardiac branch of the subphrenic artery when all short and posterior gastric arteries were resected. Recently, Jiang *et al* retrospectively examined the feasibility and safety of this procedure in 23 patients in 2011.[14] More recently, their group reported the safety of this procedure after increasing the sample size to 57 in 2014.[15]

Compared with conventional LADG, LAsTG may increase some risks for anastomotic leakage due to the technical difficulty of the anastomosis and the decreased blood supply, which is caused by cutting the short gastric artery, and for splenic injury due to nodal dissection around the spleen or reconstruction in the narrow space around the spleen. Although the previous study demonstrated low anastomotic leakage and acceptable blood loss,[15] no other group has demonstrated the safety of LAsTG. The present study aimed to confirm the feasibility and safety of LAsTG for early gastric cancer invading the upper stomach.

Materials and Methods

Patients

Between January 2007 and December 2013, 43 patients underwent LAsTG at the Department of Gastrointestinal Surgery, Kanagawa Cancer Center, Yokohama, Japan. All patients were histologically diagnosed with gastric cancer. The surgical indications for LAsTG were as follows: (1) clinical depth of invasion limited to T1 at the upper stomach, but limited to T2 in the middle to the lower third of the stomach; (2) no clinical nodal or distant metastasis; (3) the distance from the proximal margin of the tumor to the esophagogastric junction was more than 3 cm; (4) no previous history of surgery in the upper abdomen; and (5) no serious comorbidities. The evaluation of tumor progression and treatment followed the third English edition of the Japanese Classification of Gastric Carcinoma[16] and the Japanese Gastric Cancer Treatment Guidelines 2010 (ver. 3).[17]

Additional endoscopy was performed preoperatively for all patients to place 2 to 3 endoscopic clips at the tumor-negative proximal site, as confirmed by endoscopic biopsy, approximately 0.5 to 1 cm away from the tumor.

Surgery

All surgical procedures were performed or supervised by 2 experienced surgeons (T. Yoshikawa and H. Cho) who had experience with at least 50 laparoscopic gastrectomies and had been certified by the Japan Society for Endoscopic Surgery by the endoscopic surgical skill qualification system.

The surgical procedure was described in our previous report.[13] Mobilization of the stomach and lymph node dissection were performed in the laparoscopic field according to our standardized

Table 1 Clinical backgrounds

Variable	Patients, n, or median (range)
Sex (male/female)	28/15
Age (years)	64 (43–83)
Body mass index (kg/m^2)	22.6 (15.4–29.9)
Body weight (kg)	62.0 (34.8–80.3)
Previous operation history (Yes/No)	10/33
Appendectomy	7
Obstetrics surgery	4
Comorbidity (Yes/No)	26/17
Cardiovascular disorders	9
Diabetes mellitus	5
Respiratory disorders	3
Others	9
Tumor progression	
Stage IA, T1aN0	9
Stage IA, T1bN0	24
Stage IB, T2N0	10

methods.[18] The minimal extent of lymph node dissection was based on the Japanese Gastric Cancer Association (JGCA) guidelines[17] [that is, D1+ lymph node dissection, which is D1 with the nodes along the left gastric artery (#7), the common hepatic artery (#8a), and the celiac artery (#9)] was performed for T1N0 tumors. D2 lymph node dissection, which is D1+ in addition to the nodes along the proper hepatic artery (#12a) and proximal portion of the splenic artery (#11p), was performed for T2N0 tumors.[13] Some short and posterior gastric arteries were resected, together with nodal dissection if necessary, for the resection of the stomach. The transection of the duodenum was performed intracorporeally with a linear stapler.

After mobilization of the stomach and the dissection of lymph nodes, a small incision (<7 cm) was placed at the upper abdomen. The stomach was pulled out through the mini-laparotomy. When the marking clips could be palpated, the stomach was transected extracorporeally. If the marking clips could not be palpated, the stomach was transected intracorporeally just below the esophagogastric junction at the lesser curvature and at the equivalent height at the greater curvature.

Two types of circular staplers were selected for the remnant stomach-jejunum anastomosis. When the stomach was transected intracorporeally, a 25-mm transoral anvil (EEA 25 Tilt-Top Plus; OrVil, Medtronic plc., Dublin, Ireland) was applied intracorporeally. When the stomach was transected extracorporeally, a 25-mm regular anvil (EEA 25: EEA, Medtronic plc.) was applied extracorporeally.

A jejunojejunostomy (Y-anastomosis) was performed intracorporeally or extracorporeally in a side-to-side manner with a linear stapler or circular stapler prior to the remnant stomach-jejunum anastomosis. The remnant stomach-jejunum anastomosis was performed intracoporeally or extracorporeally, based on the individual characteristics of the patient. The distal limb of the jejunum was brought up via the antecolic route. The anvil and circular stapler were connected, and the anastomosis was performed using either a double stapling method (OrVil) or hemi-double stapling method (EEA). The jejunal stump was closed with a linear stapler.

The patients were treated according to the enhanced recovery after surgery protocol. The details have already been reported in a previous study.[19]

Evaluation

Complications were classified according to the Clavien-Dindo classification.[20] To avoid description bias, only grade 2 or higher morbidities were picked up from the patient record. The need for re-operation and the duration of the hospital stay after surgery were also recorded. Surgical mortality was defined as postoperative death from any cause within 30 days after surgery or during the same hospital stay. The data are expressed as the medians and ranges. This study was approved by the Institutional Review Board Committee of the Kanagawa Cancer Center.

Results

The clinical background of the patients is shown in Table 1. Approximately two-thirds of the patients were men. None of the patients had a body mass index (BMI) greater than 30 kg/m^2. A previous history of surgery was noted in 10 patients, including appendectomy alone in 6 patients and obstetric surgery alone in 4 patients, and both of these surgeries were performed in 1 patient.

Table 2 shows the surgical, pathologic, and final findings. The OrVil was selected for 19 patients and the EEA was used in 24 patients. None of the patients required a blood transfusion. No patients had a pathologically positive margin for the tumor. In 1 patient who was diagnosed with T2N0 pre- and intraoperatively, but without peritoneal dissemination detected during surgery, a small node on the omentum along the right gastroepiploic artery was

Table 2 Surgical, pathologic, and final findings

Variable	Patients, n, or median (range)
Surgical findings	
Operation time (minutes)	288 (187–587)
Blood loss (mL)	50 (0–785)
Conversion to open surgery	
Due to bleeding	2
Related with anastomosis	0
Lymph node dissection	
D1+	33
D2	10
Number of lymph nodes retrieved	40 (11–88)
Reconstruction devices	
Transoral anvil: OrVil	19
Regular anvil: EEA	24
Pathologic/final findings	
Proximal resection margin (mm)	20 (5–60)
Distal resection margin (mm)	190 (35–190)
T	
T1a/T1b	20/17
T2	3
T3	2
T4a	1
N	
N0	40
N1	2
N2	1
M	
M0	42
M1	1
Stage	
IA	36
IB	4
IIA	1
IIB	1
IV	1

pathologically diagnosed to be peritoneal dissemination after curative surgery.

The short-term outcomes are shown in Table 3. No mortality was observed in our series. Nine patients (20.9%) experienced postoperative complications of more than grade 2. Only 1 patient (2.3%) developed a grade 3 complication. This patient required re-operation due to duodenal stump leakage. Anastomotic bleeding was observed in 1 patient (2.3%). No patient developed anastomotic leakage or stenosis. The median duration of the hospital stay after surgery was 9 days.

Discussion

LAsTG for T1 tumors invading the upper stomach is an attractive approach to preserve the stomach, but is a challenging surgery because the safety, feasibility, and long-term outcome have not been fully clarified. The present study demonstrated that the safety and feasibility of LAsTG were acceptable.

Table 3 Short-term outcomes

Variable	Patients, n (% or grade), or median (range)
Any complication (≥grade 2)	9 (20.9%)
Anastomotic bleeding	1 (grade 2)
Duodenal stump leakage	1 (grade 3)
Pancreatitis	2 (grade 2)
Liver dysfunction	2 (grade 2)
Paralytic ileus	1 (grade 2)
Pneumonia	1 (grade 2)
Delirium	1 (grade 2)
Re-operation	1 (2.3%)
Mortality	0 (0%)
Duration of hospital stay after surgery (days)	9 (7–16)
Days to the first flatus (days)	2 (1–5)
Days to start soft diet (days)	3 (2–6)

Different from conventional LADG, the remnant stomach becomes minimal in LAsTG. The blood supply and the site for the anastomosis are limited in the minimal remnant stomach. Necrosis of the remnant stomach and anastomotic leakage are therefore considered to be of great concern in LAsTG. However, no anastomotic leakage was observed in the present study. None of the patients developed necrosis of the remnant stomach. Kosuga *et al* previously reported that anastomotic leakage after LAsTG was not found.[15] On the other hand, Kojima *et al* reported that the rate of anastomotic leakage was 5% in Billroth I reconstruction and 0% in Roux-en Y reconstruction after the conventional LADG.[21] In our previous report, the rate of anastomotic leakage after LADG was 1.6%.[18] Thus, our data strongly suggest that the risk of anastomotic leakage was not increased in LAsTG compared with conventional LADG. Conversely, the rate of anastomotic leakage was reported to be high, at 1.5% to 10.4%, after LATG, which is the current standard procedure used for tumors invading the upper stomach.[3,5] LAsTG was therefore considered to be a less hazardous surgery in terms of anastomotic leakage compared with LATG.

Another concern is the procedure around the spleen. In contrast to conventional LADG, LAsTG may induce more splenic injury during the lymph node dissection or the reconstruction. Conversion to open surgery was required in 1 patient due to a splenic injury that occurred during the nodal

dissection. In the present study, another patient required conversion to open surgery due to a reason not related to LAsTG. To avoid the development of excessive bleeding, it is important to pay special attention to dissecting the lymph nodes. These 2 cases with conversion occurred during the first half of the period, and with an increase in experience with LAsTG, this complication has not occurred since.

Previously, Kosuga *et al* reported that the blood loss during LAsTG was 51 mL.[15] They did not experience any cases of splenic injury. Conversely, previous studies reported that the blood loss associated with conventional LADG ranged from 43.5 to 103.6 mL.[2,21] In our previous report, the blood loss during LADG was 35 mL.[18] Conversely, the blood loss due to LATG was reported to be 182 to 190.7 mL.[3,9] Thus, LAsTG may slightly increase the risk of bleeding, especially around the spleen, compared with conventional LADG. However, the risk seems to be low compared with LATG.

The operation time is also an important measure for any newly developed surgery. The length of LAsTG was 288 minutes in the present study, whereas it was 289.3 minutes in the study of Kosuga *et al*.[15] Our data are therefore similar to those reported by Kosuga *et al*. Conversely, the length of the operation for conventional LADG was reported to be 250 to 275.1 minutes.[2,21] The difference in the length of the surgery between LAsTG and conventional LADG might result from the special care required for the reconstruction and operation to avoid injuring the spleen. The length of LATG was reported to be much longer, at 205.5 to 305.4 minutes,[3,5] which would be explained by the technical difficulty of LATG. LAsTG therefore has an advantage over LATG in terms of the length of the operation.

The overall complication rate defined by complications of grade 2 or more was 20.9% in the present study. However, the only specific complication related to the anastomosis was anastomotic bleeding, which was observed in 1 patient (2.3%), and that patient was successfully treated without reoperation. Kosuga *et al* also reported anastomotic bleeding in 1 patient (1.8%) after LAsTG.[15] Conversely, the development of anastomotic bleeding after using a circular stapler was reported to occur in 0.8% of cases after open distal gastrectomy.[22] No anastomotic bleeding was observed after conventional LADG in our previous study.[18] Nevertheless, it is necessary to determine ways to prevent this complication. The anastomotic lumen should be checked just after performing the anastomosis in all patients, if possible. Endoscopy has also been reported to be useful for both the confirmation of bleeding and therapeutic intervention.[22]

At present, a linear stapler is commonly used for the remnant stomach-jejunum anastomosis after LADG. Noshiro *et al* reported that a linear stapler is applicable for reconstruction of a very small remnant stomach and jejunum by constructing an anastomotic site at the transected line of the stomach.[23] However, this procedure is complicated and requires the use of advanced techniques. Conversely, the anastomosis with a circular stapler could be simply placed on the transection line of the minimal remnant stomach,[14,24,25] although the anvil of the circular stapler must be inserted into the small remnant stomach. Kosuga *et al* used the OrVil for all of their patients.[15] They made a mini-laparotomy by extending the intraumbilical trocar, so they could not choose the EEA, which must be inserted by handling the remnant stomach from a mini-laparotomy made at the upper abdomen. Conversely, we used both the OrVil and the EEA depending on the situation. When the remnant stomach could be handled from the mini-laparotomy, we chose to use the EEA to simplify the technique. As a result, we did not experience any patients who required conversion to open surgery due to the difficulty of the anastomosis, and there were no anastomotic complications higher than grade 3, suggesting that our technique was feasible and safe.

In conclusion, the feasibility and safety of LAsTG were acceptable compared with those of conventional LADG or LATG.

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