

# Intracorporeal reconstruction after laparoscopic pylorus-preserving gastrectomy for middle-third early gastric cancer: a hybrid technique using linear stapler and manual suturing

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## Abstract

**Purpose** Laparoscopy-assisted pylorus-preserving gastrectomy has been increasingly reported as a treatment for early gastric cancer located in the middle third of the stomach because of its low invasiveness and preservation of pyloric function. Advantages of a totally laparoscopic approach to distal gastrectomy, including small wound size, minimal invasiveness, and safe anastomosis, have been recently reported. Here, we introduce a new procedure for intracorporeal gastro-gastrostomy combined with totally laparoscopic pylorus-preserving gastrectomy (TLPPG).

**Methods** The stomach is transected after sufficient lymphadenectomy with preservation of infrapyloric vessels and vagal nerves. The proximal stomach is first transected near the Demel line, and the distal side is transected 4 to 5 cm from the pyloric ring. To create end-to-end gastro-gastrostomy, the posterior wall of the anastomosis is stapled with a linear stapler and the anterior wall is made by manual suturing intracorporeally. We retrospectively assessed the postoperative surgical outcomes via medical records. The primary endpoint in the present study is safety.

**Results** Sixteen patients underwent TLPPG with intracorporeal reconstruction. All procedures were successfully performed

without any intraoperative complications. The mean operative time was 275 min, with mean blood loss of 21 g. With the exception of one patient who had gastric stasis, 15 patients were discharged uneventfully between postoperative days 8 and 11. **Conclusions** Our novel hybrid technique for totally intracorporeal end-to-end anastomosis was performed safely without mini-laparotomy. This technique requires prospective validation.

**Keywords** Laparoscopic gastrectomy · Gastric cancer · Intracorporeal anastomosis · Pylorus-preserving gastrectomy

## Introduction

Gastric cancer remains one of the most frequent causes of death from cancer in eastern Asia. Currently, many patients are now diagnosed with early-stage gastric cancer (EGC) because of advances in cancer screening, and the prognosis for EGC continues to improve [1]. Therefore, the focus of treatment for EGC has changed from extension of survival to improvement in patients' quality of life after surgery. Laparoscopy-assisted pylorus-preserving gastrectomy (LAPPG), one of the types of limited gastrectomy for EGC, has been reported increasingly as a treatment of EGC located in the middle third of the stomach because of its low invasiveness and preservation of pyloric function. However, this method requires that a mini-laparotomy is made on the upper abdomen to enable reconstruction [2].

Here, we introduce a novel laparoscopic procedure for intracorporeal gastro-gastrostomy, a hybrid technique using a linear stapler and manual suturing. In addition, we describe the

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short-term surgical results from our initial experience with totally laparoscopic pylorus-preserving gastrectomy (TLPPG).

## Patients and methods

### Indications for TLPPG

The indications for TLPPG were cT1, cN0 gastric cancer with confirmed adenocarcinoma located in the middle third of the stomach with its distal margin located more than 6 cm proximal to the pyloric ring. Patients who had indications for endoscopic mucosal resection or endoscopic submucosal dissection were excluded from the study.

The diagnosis was based on preoperative examinations including gastrointestinal endoscopy, upper gastrointestinal series, and abdominal computed tomography. The disease stage was determined according to the third English edition of the *Japanese Classification of Gastric Carcinoma* [3].

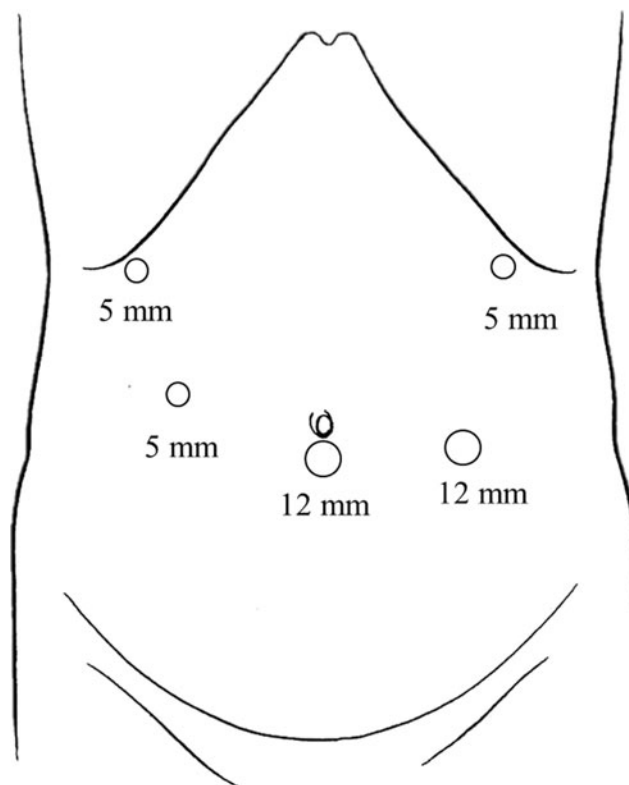
### Preoperative lesion marking

During the operation, the exact location of the tumor is usually difficult to identify by laparoscopic observation from the serosal side. Therefore, marking of the preoperative lesion by both endoscopic clipping of the safe resection margins and submucosal tattooing is performed to verify the location of the lesion and the safe resection margin.

### Operative procedure

Under general anesthesia, the patient is placed in a modified lithotomy position. An initial trocar for the laparoscope is inserted through the umbilicus using an open method. After establishing a pneumoperitoneum with carbon dioxide, four operating trocars are placed as illustrated in Fig. 1. The extent of lymph node dissection is, in principle, D1+ according to the Japanese gastric cancer treatment guidelines from 2010 (version 3) [4]. The infrapyloric artery and vein are preserved to maintain the blood supply and prevent congestion of the antrum. The hepatic and celiac branches of the vagal nerve are also preserved. The lymph node dissection is performed as previously described [5].

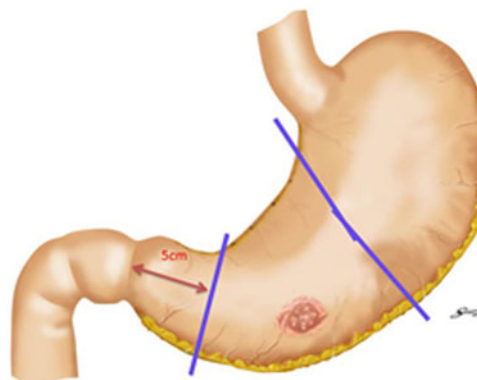
The proximal stomach is first transected by double 60-mm linear staplers at the Demel line vertical to the greater curvature. The distal margin is transected by a 60-mm linear stapler extracorporeally or intracorporeally at the proximal side 5 cm from the pylorus (Fig. 2). We remove the specimen from the umbilical port site with a 3- to 4-cm extension of the longitudinal incision. After the re-pneumoperitoneum, entry holes are made on both edges of the greater curvature corners, and the linear stapler is inserted at both the proximal and distal stomach through these entry holes. The posterior walls of both



**Fig. 1** Trocar placement for totally laparoscopic pylorus-preserving gastrectomy

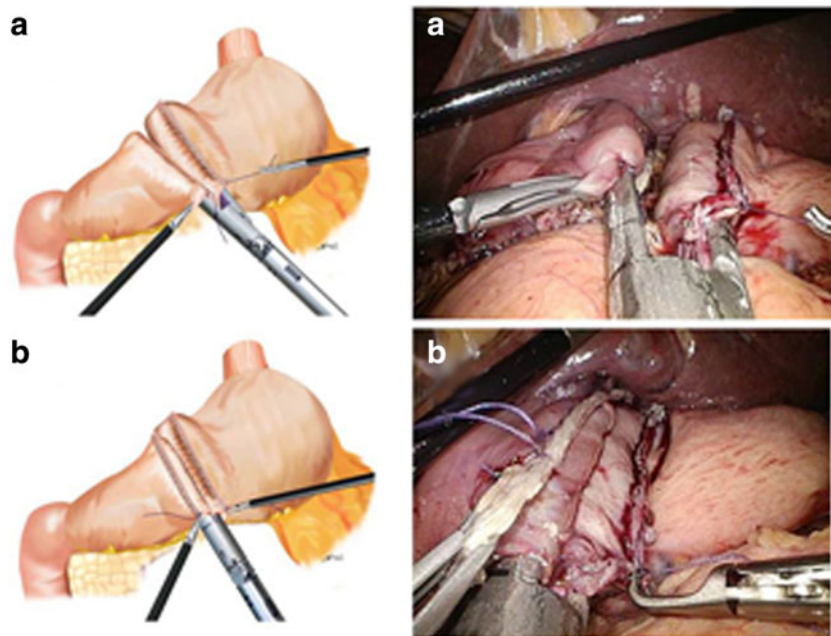
stumps are stapled by a 60-mm linear stapler, whereas both staple lines of the anterior wall are removed by laparoscopic coagulation shears. Stay sutures are placed at both sides of the greater and lesser curvatures, and the stitches are pulled to prevent contamination of gastric content within the operative field and, thus, maintain oncologic safety (Figs. 3 and 4).

The layer-to-layer hand-sewn anastomosis is made intracorporeally. We use the V-Loc (Covidien, Dublin, Ireland) for this procedure. The inner-layer closure starts from the greater curvature and extends toward the lesser curvature with continuous suturing. The second seromuscular layer is



**Fig. 2** Proximal stomach is transected by double linear staplers. The distal line is made at 5 cm from the pyloric ring and transected by a 60-mm linear stapler

**Fig. 3** Illustration and laparoscopic views of intracorporeal gastro-gastrostomy. **a** The entry holes are made on both edges of the greater curvature corners and the 60-mm linear stapler is inserted at both the proximal and distal stomach through these entry holes. **b** The posterior walls of both stumps of the stomach are stapled



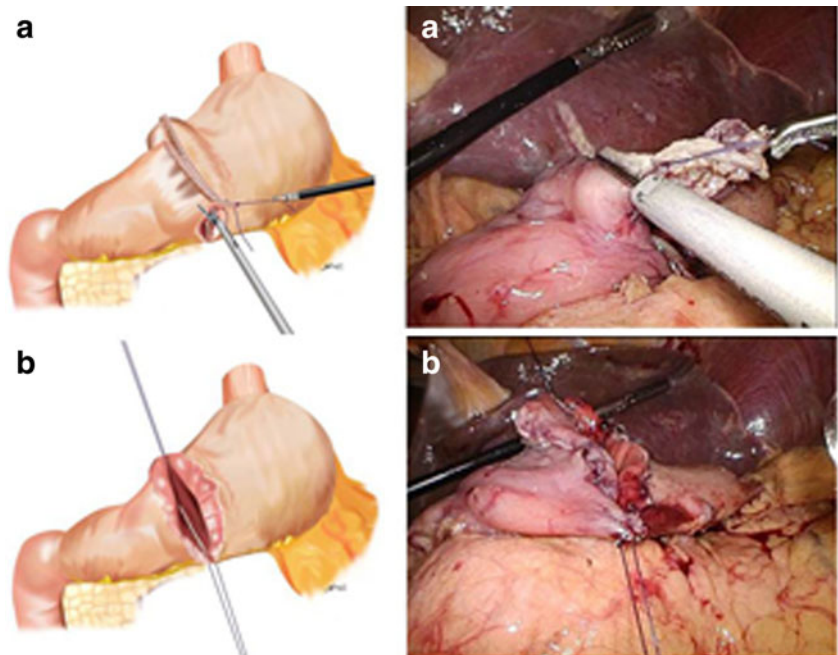
turned back toward the greater curvature. After the last stitch, the suture is simply cut without any knots. The intracorporeal end-to-end anastomosis is now complete (Figs. 5 and 6).

The detailed procedures are given in a video clip (Online Resource 1).

## Results

The clinical characteristics, surgical outcomes, and pathological findings of the patients are presented in Table 1.

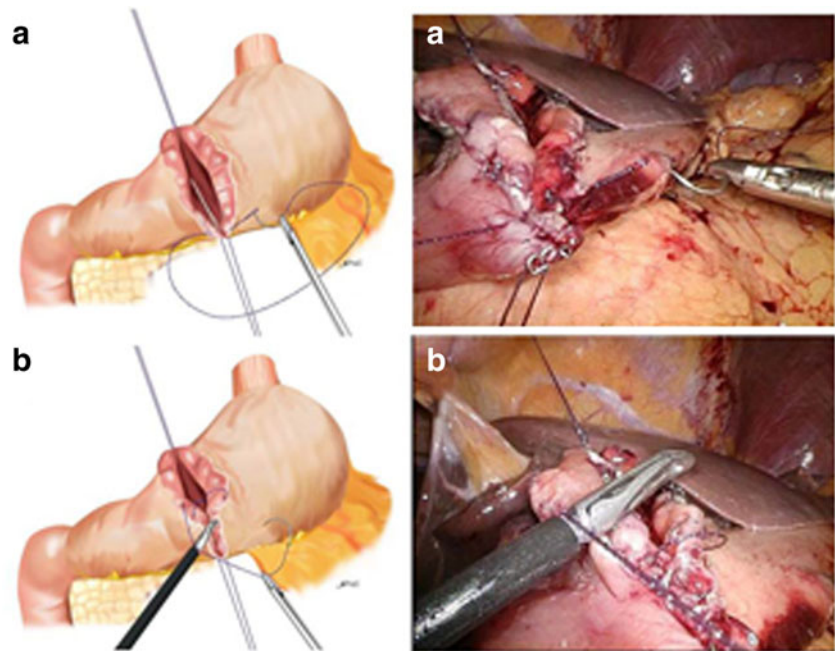
**Fig. 4** **a** All three staple lines of the anterior wall are removed by laparoscopic coagulation shears. **b** Stay sutures are placed on both sides of the greater and lesser curvatures



From January 2013 to March 2015, 16 patients underwent TLPPG in the Department of Surgery at Iwate Medical University Hospital, Morioka, Japan. All patients had been diagnosed with mucosal or submucosal gastric cancer, without lymph node metastasis and located within the middle third of the stomach. Two patients were indicated for surgery after endoscopic submucosal dissection because of a histological diagnosis of submucosal invasion. We are prepared to change the operative procedure if we observe massive tumor invasion or visible lymph node metastasis by intraoperative findings. In the present series,



**Fig. 5** **a, b** Inner-layer hand-sewn anastomosis is made from the greater curvature toward the lesser curvature with continuous suturing by V-Loc

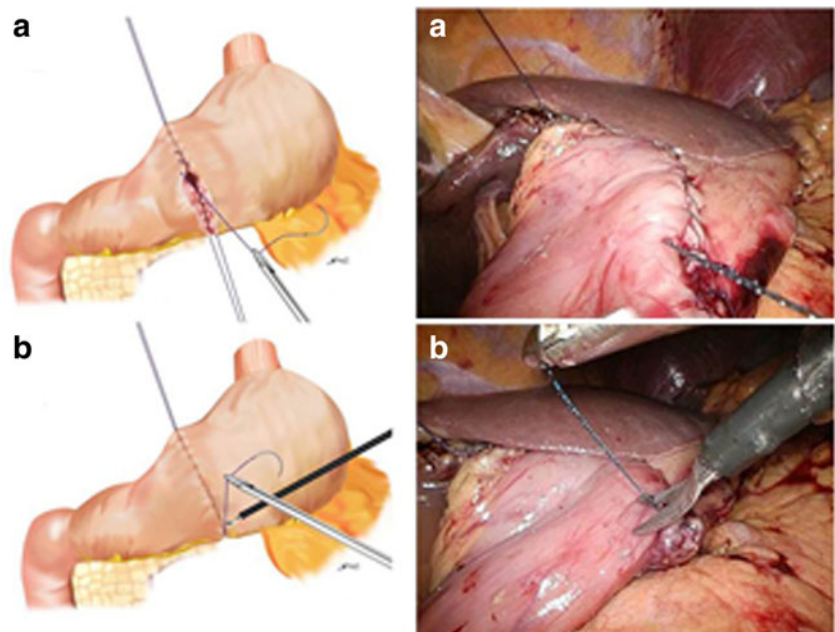


all patients underwent D1+ lymph node dissection according to the Japanese treatment guidelines for gastric cancer (version 3) [4].

All patients underwent intracorporeal gastro-gastric reconstruction. The mean operative time was 275 min (range 217–341 min) and mean blood loss 21 g (range 6–52 g). Fifteen patients were discharged uneventfully between postoperative days 8 and 11 (mean length of postoperative hospital stay, 10 days); the remaining patient developed a

gastric stasis and temporarily had to stop oral intake. This patient was discharged on postoperative day 36 with sufficient oral intake. No cases of recurrence were observed in this short follow-up period. Figure 7 shows an upper gastrointestinal examination on postoperative day 3. A good passage of Gastrografin was observed, without gastric stasis. Gastric fiberoscopy, performed 1 year after surgery, revealed an intact anastomosis line and an absence of food residue in the remnant stomach (Fig. 8).

**Fig. 6** **a** Second seromuscular layer is turned back toward the greater curvature. **b** After the last stitch, the suture is simply cut without any knots



**Table 1** Patients' characteristics, short-term surgical outcomes, and pathological findings

| Parameters   | N = 16                  |
|--|-------------------------|
| Age (years), mean                                    | 62 (41–77)              |
| Sex (M/F)  | 7/9                     |
| Operative time (min), mean                           | 275 (217–341)           |
| Blood loss (g), mean                                 | 21 (6–52)               |
| Postoperative complication                           | 1 (6 %), gastric stasis |
| Mortality  | 0 (0 %)                 |
| Length of postoperative hospital stay (days), median | 10 (8–36)               |
| T factor (T1a/T1b)                                   | 8/8                     |
| N factor (N0/N1)                                     | 12/4                    |

## Discussion

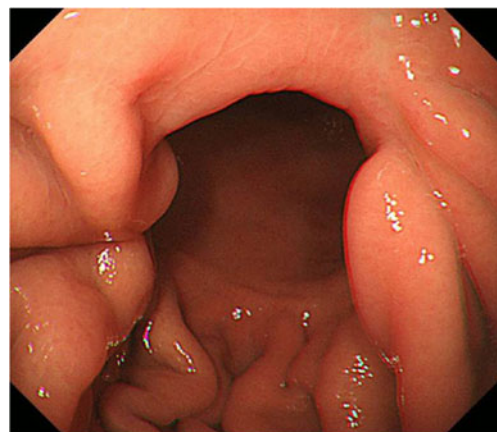
Pylorus-preserving gastrectomy (PPG), a function-preserving procedure to prevent both dumping syndrome and alkaline reflux, has become one of the surgical options for EGC. LAPPG has several advantages over conventional PPG, especially regarding early surgical outcomes, namely, reduction of intraoperative blood loss and postoperative pain, and acceleration of recovery of bowel function and oral intake, with consequent shorter postoperative stay in hospital [5–7]. Recently, the usefulness of totally laparoscopic reconstruction relative to the conventional approach has been reported in terms of smaller wound size, minimal invasiveness, and safer anastomosis independently of the patient's body habitus [8]. More recently, intracorporeal stapled anastomosis following TLPPG was reported by Lee et al. [9] and Kumagai et al. [10]. Their technique is a modification of the delta-shaped anastomosis that is one of the types of Billroth-I reconstruction reported by Kanaya et al. [11]. This method needs a side-to-side gastro-gastrostomy, and involves the remnant antrum via the first stapling. There is a concern when using this approach that gastric stasis may occur because of obstruction of antral

gastric motility. Therefore, the question arises as to what extent an end-to-end gastro-gastrostomy can be performed through a totally laparoscopic approach. To answer this question, we have developed a hybrid technique that uses both a linear stapler and manual suturing performed intracorporeally. We first tried a purely manual anastomosis, whereby it was extremely difficult to achieve an anastomosis of sufficient size because of contraction of the stomach wall. By using a linear stapler, we are able to maintain an adequate length of posterior wall. Once the back wall is fixed, it is straightforward to create the front wall by manual suturing. The handsewn anastomosis enables us to reduce the cartridge number, resulting in lower operative costs. We adopted the V-Loc for suturing when closing the anterior wall. The safety and efficacy of the V-Loc for intracorporeal reconstruction after totally laparoscopic gastrectomy has been reported by Lee et al. [12]. This device enables the surgeon to work efficiently with both hands and to focus exclusively on subsequent stitch placement, without the need to maintain tension on preceding throws to prevent slippage.

One drawback of intracorporeal reconstruction is exposure of the gastric lumen in the operative field, leading to a concern for micro-dissemination of free cancer cells in the remnant



**Fig. 7** Upper gastrointestinal examination on postoperative day 3. A good passage of Gastrografin is observed, without gastric stasis



**Fig. 8** Gastric fiberoscopy, performed 1 year after surgery, revealed an intact anastomosis line and an absence of food residue in the remnant stomach

gastric lumen [13]. To maintain oncologic safety, we place stay sutures on both sides of the greater and lesser curvature, and pull the stitches upward through the abdominal wall. The anastomosis is then turned along the ventral side, thus preventing the gastric contents being shed.

In terms of postoperative outcomes, one patient developed postoperative gastric stasis, requiring a postoperative stay in hospital of 36 days. Because this patient had diabetes, diabetic nephropathy, and a duodenal ulcer, we considered that the gastric motility and pyloric function of this patient had worsened before the operation. The remaining patients had no postoperative complications. Previous reports have stated that postoperative gastric stasis is the most frequent complication, occurring in 7.8–15 % of patients [5–7, 10, 11, 14], whereas the incidence in our series was only 6.3 %. However, our patient cohort was small; moreover, the preserved infrapyloric artery and vein (which prevents gastric congestion) as well as an end-to-end hybrid anastomosis might have contributed to the low incidence of gastric stasis. We expect to improve the patient's quality of life (QOL) by this procedure. We have already started to evaluate the postoperative QOL using a recently developed scale (PGSAS-45) [15].

In conclusion, our novel hybrid technique for totally intracorporeal end-to-end anastomosis can be safely performed and achieved without mini-laparotomy. Further clinical observations are required with larger cohorts and a prospective study to demonstrate the safety of this procedure, as well as the potential benefit over conventional techniques.

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**Authors' contributions** Study conception and design: Koeda  
Acquisition of data: Koeda, Chiba, Noda, Nishinari, Segawa, Akiyama, Iwaya  
Analysis and interpretation of data: Koeda, Nishizuka, Nitta, Otsuka  
Drafting of manuscript: Koeda  
Critical revision: Sasaki

#### Compliance with ethical standards

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**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** Informed consent was obtained from all individual participants included in the study.

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