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HOW TO DO IT

Intracorporeal overlap gastro-gastrostomy for solo single-incision pylorus-preserving gastrectomy in early gastric cancer

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Abstract

This report discusses the technique of solo single-incision pylorus-preserving gastrectomy (SIPPG) for early gastric cancer. To overcome difficulties regarding lymph node dissection (LND), a scope holder and an energy device were used, allowing fine dissection in a fixed field of view. The overlap gastro-gastrostomy technique was used for anastomosis. Seventeen patients underwent solo SIPGG. The mean operation time was 150.1 ± 28.7 min, and no patients developed postoperative complications or delayed gastric emptying within 30 days of the operation. Using scope holders and performing fine dissection with the energy device, challenges regarding LND in SIPPG can be overcome. INTACT anastomosis was initially used; however, due to its inconsistency and the high degree of surgical skill required, it was changed to the overlap method. Solo SIPPG with overlap gastro-gastrostomy may be safe and feasible with good cosmetic results and fast patient recovery.

Keywords Stomach · Stomach neoplasm · Laparoscopic surgery

Introduction

Single-incision laparoscopic surgery (SILS) may be technically challenging, but the dawn of advanced surgical devices allows for several types of operations such as appendectomy [1], sleeve gastrectomy [2], cholecystectomy [3], and hemicolectomy [4]. Omori et al. [5] first described a case of transumbilical single-incision distal gastrectomy (SIDG) for early gastric cancer in 2011. Since then, several reports on the safety and feasibility of SIDG, and even single-incision total gastrectomy (SITG) have been reported [6, 7]. Cases of totally laparoscopic PPG (TLPPG) have been reported in recent years [8–10]; however, there have been no reports regarding the application of SILS in PPG. This is due to the complex surgical procedure of PPG, especially regarding the meticulous dissection of LN number 6, and the difficulty in performing intracorporeal gastro-gastrostomy (G-Gstomy) anastomosis.

Due to a limited range of motion, SILS often requires a highly skilled scopist to maintain a stable field of view. There have been several studies on the use of scope holders, as a measure to overcome the lack of experienced scopists [1, 11] and limited operating space. This technical report describes how single-incision pylorus-preserving gastrectomy (SIPPG) can be safely and consistently performed by a single surgeon using a scope holder. To our knowledge, this is the first report of solo single-incision pylorus preserving gastrectomy for early gastric cancer.

Methods/patient selection

Seventeen patients underwent solo SIPPG from October 2016 to March 2018. The indication for solo SIPPG was EGC located in the middle stomach with preoperative-stage cT1N0M0. The patients were diagnosed based on computed tomography scans and evaluation by endoscopy, and endoscopic ultrasonography. The proximal and distal margins of the tumor were marked with endoscopic clips. Two of the patients underwent endoscopic submucosal dissection, which showed a positive margin and submucosal

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tumor invasion and were, therefore, referred for surgery. The mean age of the patients was 61.5 ± 14.5 years, and the average body mass index was 23.1 ± 2.2 kg/m^2. The other patient characteristics are summarized in Table 1. All of the operations were performed by a single surgeon who had performed > 300 SIDG operations. All of the patients who underwent solo SIPPG were asked to provide their written informed consent after receiving a thorough explanation from the operator. The study protocol was approved by the institutional research committee (B-1806-472-104) and it was in accordance with the 1964 Helsinki declaration.

Surgical technique

Patient preparation and port insertion

The patient was placed under general anesthesia in lithotomy in the reverse Trendelenburg position. A passive manual scope holder (Laparostat; CIVCO Medical Solutions, Kalona, IA, USA) was fixed on the left side of the patient, and was covered by sterile plastic sleeves (Sani Sleeve™, Dasol Int Co. Ltd, Gwangju, Korea). The surgeon sat between the patient's legs, facing towards the cephalad side. A vertical transumbilical incision of 2.5 cm was made on the skin, and after dissection, the fascia was opened 4 cm more than the skin incision. Then, a 4-hole single port (Gloveport; Nelis, Bucheon, Korea) was inserted, and pneumoperitoneum (13 mmHg) was induced. A 10-mm HD flexible scope (Olympus, Tokyo, Japan) or a 3D flexible scope (Olympus, Tokyo, Japan) was inserted and fixed to the previously installed scope holder. Thunderbeat (Olympus, Tokyo, Japan)—an instrument with both ultrasonic and bipolar activities—was chosen as the energy device. There was no scopist or assistant during the surgery. Instead, laparoscopic devices, such as intra-abdominal organ retractors (FJ Clip, Charmant, Japan) and articulating graspers (Artisential, Livsmed, Korea) were used to create a good operating field (Fig. 1a). After inducing pneumoperitoneum, intraoperative endoscopy was routinely performed, and dye was injected to determine the precise proximal and distal rejection margins.

Table 1 Patient characteristics and operative outcomes ($n = 17$)

Age (years)	61.5 ± 14.5
Gender	
Male	10 (58.8%)
Female	7 (41.2%)
Body mass index (kg/m^2)	23.1 ± 2.2
ASA score	
ASA score 1	8 (47.1%)
ASA score 2	8 (47.1%)
ASA score 3	1 (5.8%)
Operation time (min)	150.1 ± 28.7
Blood loss (mL)	24.1 ± 32.1
Preservation of the vagus nerve	
Hepatic branch only	1 (5.8%)
Both hepatic branch and celiac branch	16 (94.2%)
Pathologic T stage	
T1a	9 (52.9%)
T1b	6 (35.3%)
T2	2 (11.8%)
Pathologic N stage	
N0	14 (82.4%)
N1	1 (5.8%)
N2	2 (11.8%)
Retrieved lymph nodes	52.4 ± 24.9
Proximal margin (cm)	3.0 ± 3.4
Distal margin (cm)	4.1 ± 2.4
Mean time until first flatus (postoperative days)	2.9 (2–3)
Mean time to first semi-fluid diet (postoperative days)	2.3 (2–3)
Mean hospital stay (postoperative days)	4.8 (3–7)
Number of additional analgesics given	0.6 (0–2)

Values are presented as either mean ± SD or mean (range) or as the number of patients (%) unless otherwise stated

Liver retraction

A 2-0 prolene suture thread was inserted into the abdomen using a straight needle. The suture liver retraction method was used, as described in our previous report [12]. It was performed carefully, to avoid damaging the hepatic branch of the vagus nerve.

Partial omentectomy and D1+ lymphadenectomy

After obtaining pneumoperitoneum, the gastrocolic ligament was divided 3–4 cm distal to the greater curvature of the stomach using Thunderbeat. D1+ lymphadenectomy was performed according to the fourth Japanese Gastric Cancer Association (JGCA) treatment guidelines for PPG [13]. For lymphadenectomy, The Hit and Away technique [14] was used as the LN dissection (LND) mode of the energy device. Small bites of less than 3–4 mm were made, and the energy device was not activated more than three times per bite during LND. LN no. 4sb was dissected as the left gastroepiploic vessels were identified and ligated.

The infrapyloric artery and vein were both identified and preserved. The vessels were traced retrograde, and depending on the variation of the infrapyloric artery [15], the right gastroepiploic artery was divided and ligated (Fig. 1o). Due to the variations, dissection of the LN No. 6 is complex and requires careful small-bite dissection. The No. 5 LN and the right gastric vessels were left as they would be for conventional PPG, to preserve the hepatic branch of the vagus nerve and the blood supply of the pylorus (Fig. 1d). After the

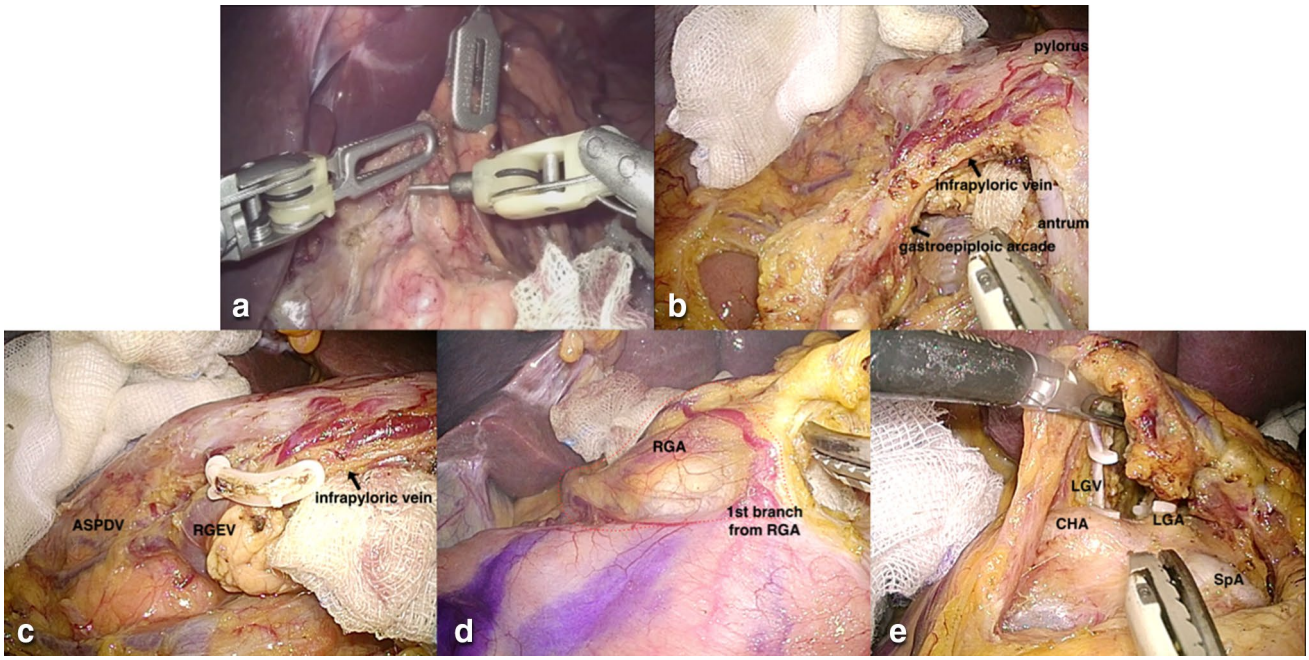

Fig. 1 Lymph node (LN) dissection. **a** Organ retractors and articulated graspers. **b** dissection of LN no. 6. **c** Ligation of the RGEV while preserving the infrapyloric vein. **d** LN no. 5 is left and the RGA is preserved. **e** Ligation of the left gastric vessels. *RGEV* Right gastroepiploic vein, *ASPDV* anterior superior pancreaticoduodenal vein, *RGA* right gastric artery, *LGV* left gastric vein, *LGA* left gastric artery, *CHA* common hepatic artery, *SpA* splenic artery

clearance of the antrum, the distal stomach was transected 4–6 cm from the pylorus using an automatic stapler (60 Purple, Covidien, Mansfield, MA). The left gastric vessels were identified then ligated, along with LN Nos. 7, 8a, and 9 (Fig. 1e). The celiac branch of the vagus nerve was also saved in all but one of the patients. Once lymphadenectomy had been completed, the proximal part of the stomach was transacted with automatic staplers (60 Purple). The specimen was removed through the transumbilical port without creating a further incision.

Intracorporeal gastro-gastrostomy

Patients underwent a novel method for G-Gstomy in which the overlap method was applied. This method was previously used for the formation of the esophagojejunostomy during total gastrectomy [16]. Entry holes were made in the middle of the distal stomach and on the middle portion of the stapler line of the proximal stomach (Fig. 20). One side of the automatic stapler (45 Purple) was inserted into the distal stomach. Next, it was pulled up until the other side of the stapler could be fully inserted into the entry hole of the proximal stomach. To efficiently perform this process without an assistant, a stay suture was placed on the nearer side of the proximal stomach. The G-Gstomy was made and the common entry hole was either closed with another automatic stapler (60 Purple) using the unaided stapling method [17] (Fig. 20), or closed using a barbed suture material (3–0 V-Loc, 23 cm, absorbable, Covidien, Mansfield, MA). In this method, the antrum lies on the posterior part of the remnant stomach (Fig. 2e). After anastomosis, the fascia was closed with interrupted sutures. After intradermal suturing, ropivacaine was injected into the wound, and surgical glue was applied on the skin. No drains or Levin tubes were inserted. Figure 3a shows the postoperative wound, while Fig. 3b, c show the upper gastrointestinal image series obtained four months after surgery.

Results

The average operation time was 150.1 ± 28.7 min, and the average estimated blood loss (EBL) was 24.1 ± 32.1 mL. There was no conversion to an open surgery, and the average number of retrieved lymph nodes was 52.4 ± 24.9. Nodal metastasis was observed in three patients, and the celiac branch of the vagus nerve was preserved in all but one patient. Patients had their first semi-fluid diet an average of 2.3 ± 0.5 (2–3) days after surgery, and patients had their first flatus on an average 2.9 ± 0.6 (2–3) POD. No patients developed postoperative complications, and the mean postoperative hospital stay was 4.8 ± 1.2 (3–7) days. Additional analgesics (other than the patient controlled anesthesia), mostly opioids (e.g., fentanyl) were administered an average of 0.6

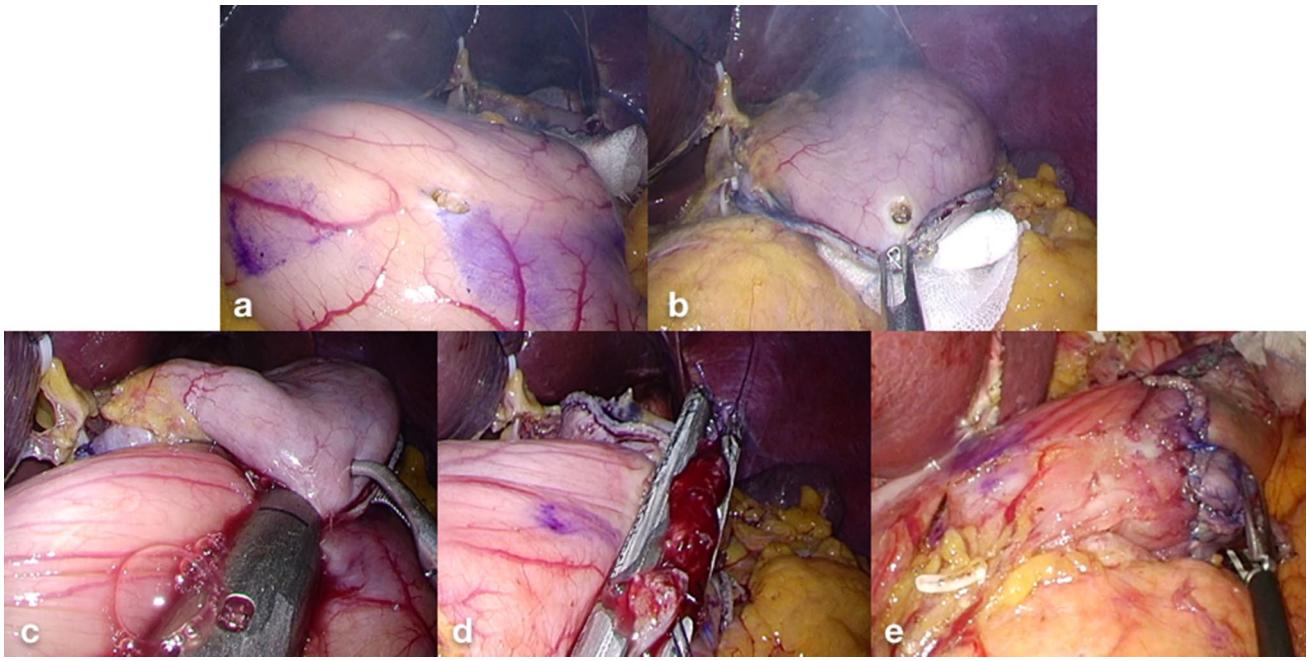

Fig. 2 Using the overlap method for anastomosis. **a** An entry hole is made in the middle of the anterior wall of the distal stomach. **b** Another entry hole is made in the proximal stomach near the stapler line. **c** Anastomosis is performed with an automatic stapler. **d** The common entry hole is closed with a stapler. **e** The final shape of the overlap gastro-gastrostomy

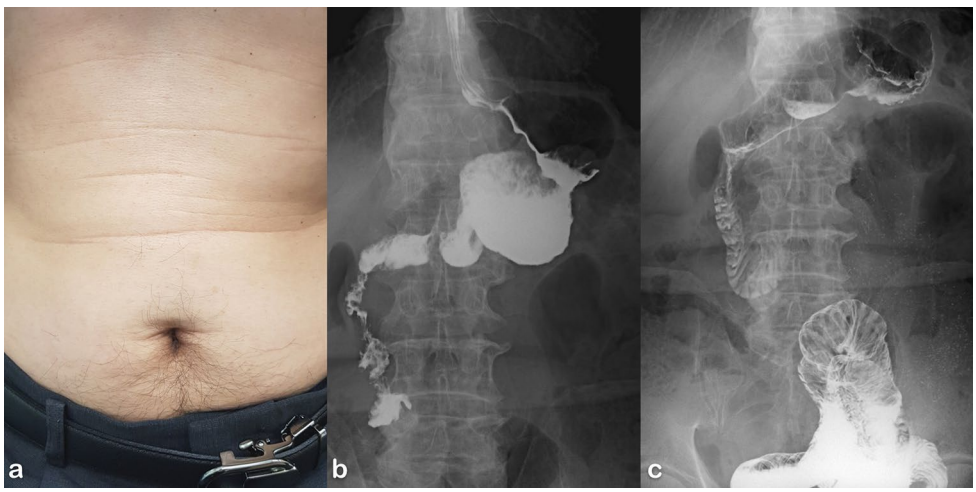

Fig. 3 Postoperative images obtained four months after surgery. **a** The postoperative wound. **b** An upper gastrointestinal series 2 min after barium intake. **c** An upper gastrointestinal series 60 min after barium intake

(0–2) times. None of the patients suffered from wound complications, and there were no other complications occurred within the first 30 days after surgery, including delayed gastric emptying.

Discussion

In this study, 17 patients underwent solo single-incision pylorus-preserving surgery—to the best of our knowledge, this is the first time in the world that this procedure has been performed. The operation time was comparable to that of reports of other laparoscopic PPG procedures [18, 19], and was in line with the operative times of laparoscopic PPG performed in our center. The number of retrieved lymph nodes was also considered sufficient in comparison to other reports on laparoscopic PPG [9, 18]. The reason why a sufficient number of lymph nodes can be retrieved is that we perform ex vivo lymph node dissection according to the stations, which has been reported to increase the number of lymph nodes scavenged by the pathologist [20]. Despite numerous attempts at single-incision gastrectomy for gastric cancer [5, 21–23], SILS has not been popularly applied for PPG due to the complex dissection of LN no. 6 and the high

degree of surgical skill required for creating intracorporeal G-Gstomy anastomosis. In our cases, SIPPG was made feasible, with no immediate complications due to the following reasons: solo surgery with the use of a scope holder, the LND mode of the energy device, and the application of the overlap method for G-Gstomy.

Single-incision laparoscopic surgery is technically difficult, not only due to the limited range of motion for the operator, but also because it requires a highly skilled scopist to provide a stable view for the operator [1, 24]. It is more difficult to provide a steady view in SILS than in other multiport laparoscopic operations, and the unstable view quickly brings fatigue and results in poorer goal-directed movements from the operator [24–26]. The use of the above-described passive scope holder (Laparostat; CIVCO Medical Solutions, Kalona, IA, USA) achieves a steady field of view with better vision of the tissues, allowing us to make very fine dissection.

Dissection was facilitated by the use of a potent energy device, organ retractors, and articulating laparoscopic instruments. Through the Hit and Away technique [14] for LN dissection, dissection can be performed while maintaining the surgical plane. Only small bites are made with less than three activations per bite—allowing fine dissection without causing damage to the major vessels. Since it is difficult to use assistants in single-incision laparoscopic surgery, organ retractors (FJ clip, Charmant, Japan) and articulating graspers (Artisential, Livsmed, Korea) were used to expose the field of view with less device collision.

Saving the infrapyloric vein is very important for avoiding delayed gastric emptying [27]. The LND mode of the energy device allowed us to identify and isolate the infrapyloric vessels, including the vein, with retrograde tracing. The use of retrograde dissection, allows the origin of the infrapyloric vessels to be more easily identified and saved irrespective of the type of vessel variation.

Lastly, to overcome the difficulty associated with intracorporeal gastro-gastrostomy anastomosis, we also used the INTACT method on three patients. The INTACT method was first described by Omori et al. [28] based on their clinical experience in SIDG. This method created a patent and functional G-Gstomy, but the technique required high degree of surgical skill and was shown to be inconsistent between cases.

The overlap method was then applied to SIPPG. The overlap method is commonly reported as a method of esophagojejunostomy anastomosis in laparoscopic total or proximal gastrectomy [16, 29, 30]. As previously described, the use of this method brings the antrum of the remnant stomach posterior to the site of anastomosis. This allows for better movement of food down the remnant stomach, and the procedure is easier and more replicable than the INTACT procedure. This allowed for consistency in the operations. It is noteworthy that there were no anastomotic complications in the 30 days after the operation. This method is more feasible for cases in which much of the proximal stomach requires removal, since it is difficult to pull down the short proximal segment for a usual G-Gstomy. On the other hand, since the entry hole has to be made in the middle of the antrum of the distal stomach, the distal remnant stomach that is left must be sufficient for anastomosis.

Not only is single-incision laparoscopic surgery good for cosmesis, it is shown to be associated with less postoperative pain [3, 31]. The local injection of ropivacaine is performed before wound closure [32]. With less postoperative pain, the patient is more willing to exercise ambulation and lung care. This leads to faster recovery, a shorter hospital stay, and lower cost [6, 33]. The use of surgical glue is also convenient for the patient, as it allows them to shower on the day after surgery.

With all of these benefits, SIPPG may be beneficial to the patient, and allow for a fast recovery. However, with the current laparoscopic devices, it is still technically challenging to perform SIPPG. The improvement of vision through developments such as 3D 4K imaging, and the use of angled graspers for single-incision surgery may allow more surgeons to become competent in the performance of SILS. Furthermore, an accident or an unexpected event is always possible. In our institution, a training surgeon observes the operation from behind—like watching robot surgery—and may be called upon to help during unpredicted events. Lastly, all operations in this study were performed by an experienced surgeon. A sufficient level of laparoscopic skill is required to perform SIPPG safely.

Conclusion

In this report, solo single-incision laparoscopic pylorus-preserving using the overlap G-Gstomy was found to be a feasible and safe method that did not increase the operative time.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest in association with the present study.

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