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HOW I DO IT

y-shaped side overlap esophagogastrostomy in proximal gastrectomy

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Abstract

Several reconstruction methods are used in proximal gastrectomy. Esophagogastrostomy is the simplest and most physiological. The challenge in esophagogastrostomy is preventing reflux esophagitis. Various techniques have been developed to reduce reflux of gastric juice. Taking advantage of the usefulness of the recently reported modified side overlap with fundoplication by Yamashita (mSOFY) method, we developed a y-shaped mSOFY method that is simpler and has potential for a greater anti-reflux effect. Unlike the original mSOFY method, the pseudo-fornix does not go behind the esophagus and the axes of the esophagus and residual stomach are shifted by approximately 60° to form a "y" shape. In addition, fixation of the residual stomach and both sides of the esophagus and crus of the diaphragm is performed at the end of the procedure. We performed 12 cases of laparoscopic or robotic proximal gastrectomy with y-shaped mSOFY esophagogastric anastomosis located below the crus of the diaphragm for gastric or esophagogastric junction adenocarcinoma between August 2021 and March 2023. The median operative time and blood loss were 260 min and 5 mL, respectively. No postoperative complications of Clavien–Dindo classification grade II or higher occurred. No stenoses requiring balloon dilation occurred within 1 year after surgery, but endoscopy at 1 year after surgery revealed two cases (17%) of reflux esophagitis of Los Angeles grade B or higher. In conclusion, this y-shaped side overlap esophagogastrostomy method could be one of the recommended esophagogastrostomy procedures in proximal gastrectomy.

KEYWORDS
esophagogastrostomy, laparoscopic proximal gastrectomy, pseudo-fornix, robot-assisted proximal gastrectomy, robotic proximal gastrectomy

1 | INTRODUCTION

In recent years, the incidence of adenocarcinoma of the upper stomach or esophagogastric junction (EGJ) has been increasing in Japan.[1,2] Partial preservation of the stomach has been attracting attention because of advantages in terms of nutrition and quality of life compared with total gastrectomy.[3–5] There are several reconstruction methods used in proximal gastrectomy, such as the double-tract and

jejunal pouch interposition methods,[6–8] but esophagogastrostomy is the simplest and most physiological.[9] Prevention of reflux esophagitis is the challenge in esophagogastrostomy. Various techniques have been developed to reduce reflux of gastric juice.[10,11] However, the higher the anti-reflux effect, the more difficult the technique and the longer the operative time. Taking advantage of the usefulness of the recently reported modified side overlap with fundoplication by Yamashita (mSOFY) method,[12] we developed a y-shaped mSOFY method that is simpler and has potential for a greater anti-reflux effect. The unique point of our y-shaped mSOFY compared with the original one is that the axis of the residual stomach and esophagus are shifted to form a y-shaped anastomosis with the angle of His. This way, the residual stomach does not go behind the esophagus, and the pseudo-fornix is located below the left diaphragm.

2 | SURGICAL TECHNIQUE

When performing the y-shaped mSOFY method, the esophagus must be mobilized approximately 5 cm from the esophageal stump. However, unlike the original mSOFY method, the pseudo-fornix does not go behind the esophagus; thus, it is not necessary to mobilize the esophagus above the crus of the diaphragm more for gastric cancer without EGJ invasion. The esophagus is transected horizontally using a linear stapler. A small hole is then opened at the right lateral edge of the esophageal stump (Figure 1A). To avoid straying into the submucosa when inserting the stapler through the hole, all layers of the hole should be sutured with several stitches in all directions.

The small hole is opened closer to the greater curvature of the residual stomach so that there is approximately 5 cm of overlap with the esophagus (Figure 1B). The axes of the esophagus and residual stomach should be shifted by approximately 60° to form a "y" shape. The pseudo-fornix should be as large as possible to increase retention capacity. A small hole is often made slightly more caudally than the gastric angle. The cartridge side of the linear stapler is inserted through the hole in the anterior wall of the stomach. The anvil fork side of the linear stapler is inserted into the esophagus. The stapler is often inserted through a port on the left side of the patient to match the axis of the esophagus, but it can also be inserted through a port on the right side of the patient. The trick is to stop once the tip

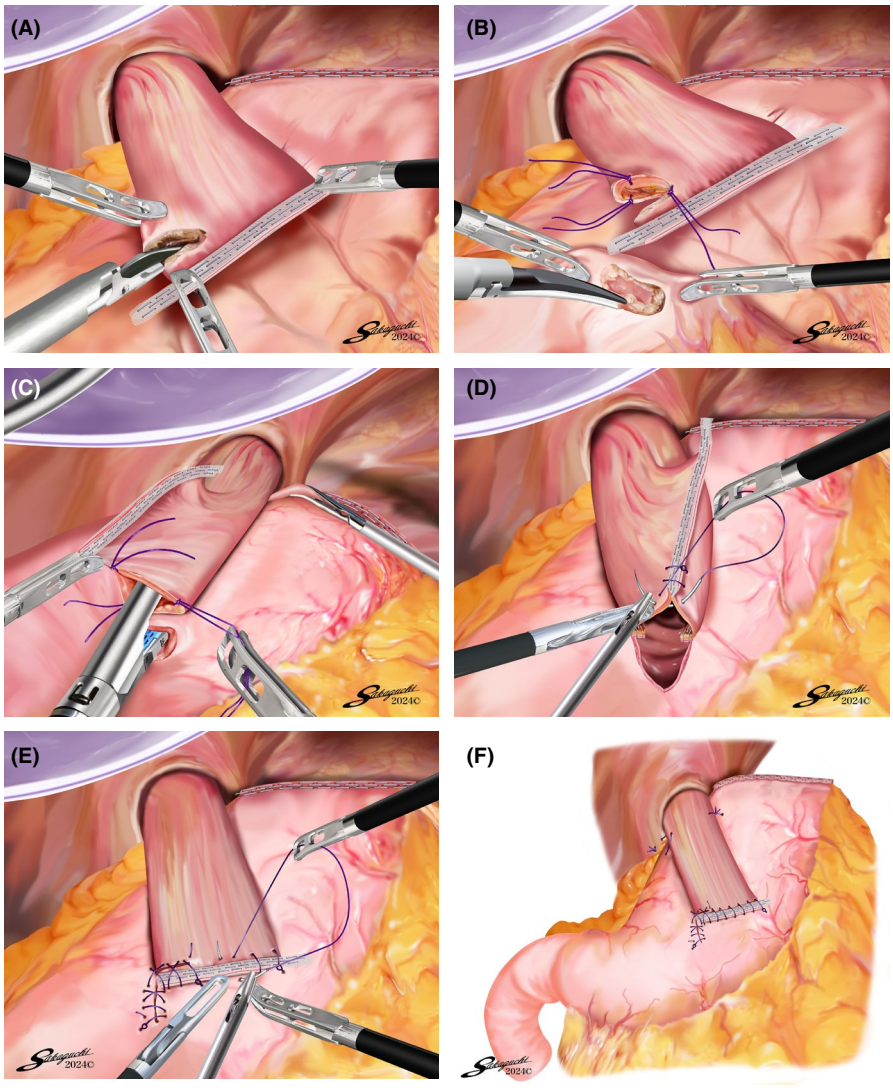

FIGURE 1 Schema of the y-shaped mSOFY method. (A) A small hole is opened at the right lateral edge of the esophageal stump. (B) A small hole is opened closer to the greater curvature of the residual stomach. (C) A linear stapler is inserted into the esophagus and stomach for side-to-side esophagogastrostomy. (D) The entry hole is sutured and closed using a barbed suture thread. (E) The left side of the esophageal stump is pulled near the greater curvature of the stomach, where it is fixed over and over with a barbed suture thread from the left side to the right side. (F) The left wall of the esophagus, anterior wall of the residual stomach, right wall of the esophagus, anterior wall of the residual stomach, and right crus of the diaphragm are fixed with one or two stitches each on the oral side of the esophagus as much as possible.

of the anvil fork is approximately 2 cm inside the esophagus. Rather than pushing the stapler into the esophagus, the anterior wall of the residual stomach is grasped with forceps and pushed toward the mediastinum while gradually sliding the stapler toward the oral side (Figure 1C). Care should be taken not to force the stapler into the esophagus, as the stapler can easily penetrate the esophageal wall. If the abdominal esophagus is not long enough, the left crus of the diaphragm will get in the way of pushing the anterior wall of the residual stomach toward the esophagus. Therefore, it is important to push the left crus of the diaphragm cranially as much as possible during anastomosis creation to ensure space for pushing in the residual stomach. Ideally, the entire length of a 45-mm linear stapler cartridge should be inserted. If this is not possible, insertion of 35 mm is sufficient. After insertion, the esophageal stump is grasped and turned up 90° so that it is vertical. Next, the right wall of the esophagus and the anterior wall of the residual stomach are clamped with the stapler and a side-to-side esophagogastrostomy is performed. If the stapler is inserted through a port on the right side of the patient, the anastomosis will be slightly oblique instead of entirely on the right wall of the esophagus, which is acceptable.

After confirming that there is no bleeding from the anastomosis, the entry hole is sutured and closed using a barbed suture thread (Figure 1D). Basically, the suture is sewn longitudinally from the ventral side to the dorsal side so that the anastomotic slit is closed. However, if there is a step at the anastomotic opening between the esophagus and the remnant stomach, it is easier and safer to suture horizontally than vertically.

The esophageal stump is then affixed flat to the anterior wall of the residual stomach. The left side of the esophageal stump is pulled near the greater curvature of the stomach and then fixed over and over with a barbed suture thread from the left side to the right side (Figure 1E). It is not necessary to sew so that the stapler's edge is buried. Finally, the left wall of the esophagus and the anterior wall of the residual stomach are fixed with one or two stitches, as are the right wall of the esophagus, the anterior wall of the residual stomach, and the right crus of the diaphragm, on the oral side of the esophagus as much as possible (Figure 1F). The left crus of the diaphragm is not fixed to the residual stomach or esophagus. In the original mSOFY method, these sutures are done before anastomosis creation, but it is easier to handle the residual stomach after anastomosis creation, which reduces the risk of esophageal wall penetration during insertion of the linear stapler. If the remnant stomach is placed in the thoracic cavity, only the fixation of both sides of the esophagus and the anterior wall of the residual stomach is performed. Finally, the residual stomach and the diaphragm are sutured to close the esophageal hiatus as much as possible to prevent internal hernia.

We strongly recommend performing an air leak test using an intraoperative endoscope as a final confirmation after anastomosis creation. Since air can be supplied at a higher pressure through an endoscope than through a nasogastric tube, even the smallest hole can be detected. After the air leak test, a few stitches with the greater omentum covering the anastomotic site might be helpful for recovering from anastomotic leakage. Figure 2 shows representative findings of gastrographin-enhanced fluoroscopy several days after surgery.

3 | RESULTS

We initiated y-shaped mSOFY esophagogastric anastomosis in April 2021. As part of the learning curve, it took four cases to make a series of minor modifications. Table 1 summarizes the background characteristics and short-term postoperative outcomes of the subsequent 12 patients who underwent laparoscopic or robotic proximal gastrectomy with y-shaped mSOFY esophagogastric anastomosis located below the crus of the diaphragm for gastric or EGJ adenocarcinoma between August 2021 and March 2023. All surgeries were performed by one of three primary surgeons (Y.K., T.S., or K.Y.). The median operative time and blood loss were 260 min and 5 mL, respectively. None of the patients had postoperative complications of Clavien–Dindo classification grade II or higher. No stenoses requiring balloon dilation occurred within 1 year after surgery, but endoscopy at 1 year after surgery revealed two cases (17%) of reflux esophagitis of Los Angeles grade B or higher. Figure 3 shows representative findings of endoscopic examinations at 1 year after surgery.

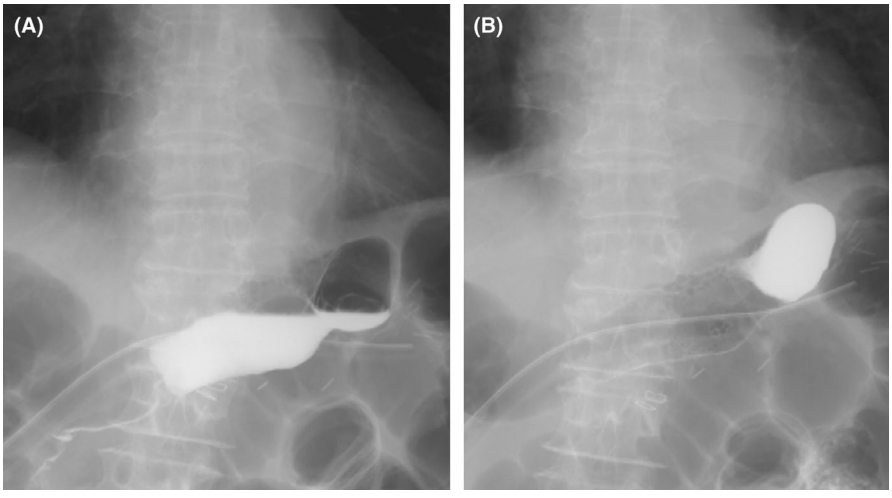

FIGURE 2 Representative findings of gastrographin-enhanced fluoroscopy several days after surgery. (A) Standing position. (B) Head-down position.

4 | DISCUSSION

The mSOFY method has been reported as a useful esophagogastrostomy procedure for preventing reflux esophagitis because the residual stomach is placed on the dorsal side of the esophagus like a pillow.[11,12] When the internal pressure of the stomach increases, the overlapping posterior wall of the esophagus is pushed up and the anastomotic opening closes like a valve. The larger the overlapping area, the better the anti-reflux performance, but there is often insufficient space to place a large residual stomach on the dorsal esophagus. Therefore, we developed a method in which the pseudo-fornix of the stomach is placed under the left diaphragm and the axis of the residual stomach and esophagus are shifted to form a y-shaped anastomosis with the angle of His. This method is thought to leave a large pseudo-fornix unobstructed and better maintain the retention capacity of the residual stomach. Reflux of gastric juice is most problematic when the patient is in the supine position. Oral contrast examination after reconstruction using the y-shaped mSOFY method revealed that when the patient is in the supine position, contrast agent flows into and stays in the pseudo-fornix. Since the pseudo-fornix is located away from the anastomosis, there is almost no reflux into the esophagus when the patient is in the head-down position. Thus, the y-shaped mSOFY method can maintain the spatial distance between the pseudo-fornix and the anastomosis, which has a retention capacity. We believe that it can have a greater anti-reflux effect than the original mSOFY method.

This y-shaped mSOFY method is much simpler and associated with shorter operative time than other reconstructive methods. The median operative time of the original mSOFY method was 302 min, which was 40 min longer than our procedure.[10] Another commonly used esophagogastrostomy method, the double-flap technique, required a median operation time more than 80 min longer than our procedure.[8] Of course, not everyone can perform our y-shaped mSOFY method safely during the first case; a learning curve of several cases might be needed to learn the tricks and pitfalls.

TABLE 1 Background characteristics and postoperative outcomes of 12 patients with y-shaped mSOFY esophagogastric anastomosis located below the crus of the diaphragm.

Number of patients	12
Age, median (range)	79 (52–83)
Sex (male/female)	8/4
Location (stomach/EGJ)	11/1
cTNM stage (I/II/III)	10/1/1
Preoperative chemotherapy (no/yes)	11/1
Approach (laparoscopic/robotic)	8/4
Operation time (min), median (range)	260 (219–289)
Estimated blood loss (mL), median (range)	5 (0–60)
Postoperative complications (C–D grade II ≤)	0
Stenosis requiring balloon dilation within 1 year after surgery	0
Reflux esophagitis (LA grade B ≤) at 1 year after surgery	2

Abbreviations: C–D, Clavien–Dindo; EGJ, esophagogastric junction; LA, Los Angeles.

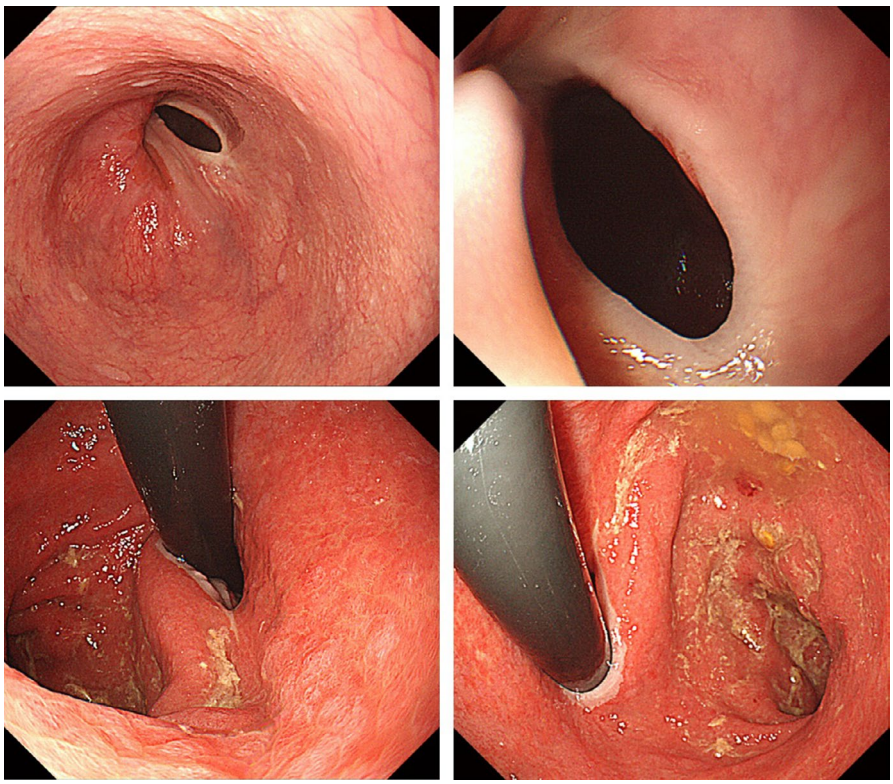

FIGURE 3 Representative findings of endoscopic examinations at 1 year after surgery.

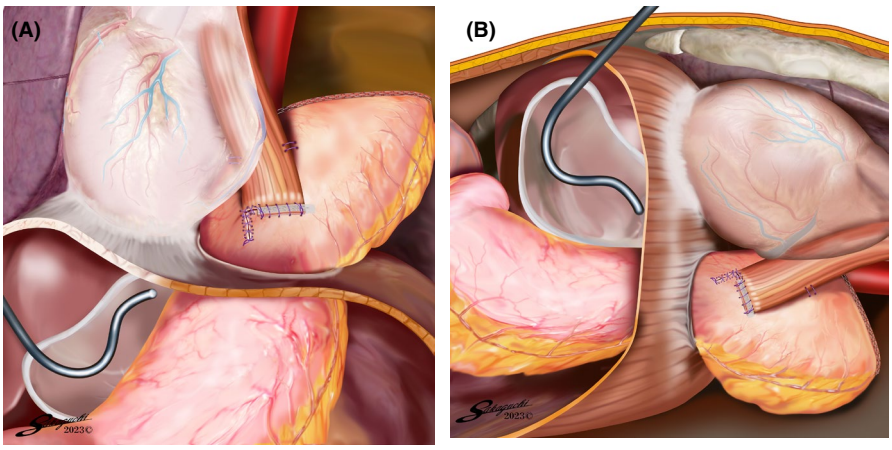

FIGURE 4 Schema of the y-shaped mSOFY method performed in the lower mediastinum for esophagogastric junction cancer. The left pleura is incised and the residual stomach is placed in the left thoracic cavity. (A) Front view. (B) Side view.

When anastomosis is performed in the lower mediastinum for EGJ cancer, the left pleura is incised and the residual stomach is placed in the left thoracic cavity, allowing safe transhiatal anastomosis creation with a good view (Figure 4A). If the original mSOFY method is performed in the inferior mediastinum without incising the left pleura, a large residual stomach would fill a rather small space, and the anastomosis would have to be created in a rather poor visual field. Another advantage of this method is its ability to prevent reflux in the supine position. In the supine position, gastric contents often accumulate in the pseudo-fornix due to gravity and negative pressure in the thoracic cavity. However, because the esophagogastric anastomosis is located more ventral to the residual stomach and there is a large height difference, there is little backflow into the esophagus (Figure 4B). Indeed, this method is still under development, and its usefulness should be evaluated through a series of cases in the future.

In conclusion, this y-shaped side overlap esophagogastrostomy method could be one of the recommended esophagogastrostomy procedures in proximal gastrectomy. However, this method only has confirmed short-term results in a small number of cases. We hope to generalize this method after confirming long-term results with more patients.

AUTHOR CONTRIBUTIONS

Y. Kurokawa designed the study and drafted the paper. T. Saito collected data from all patients. Y. Kurokawa, T. Saito, and K. Yamamoto recruited the patients for the study. All authors revised the paper and approved the final version.

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CONFLICT OF INTEREST STATEMENT

Y. Kurokawa is an Associate Editor of the *Annals of Gastroenterological Surgery* and has received lecture fees from Johnson & Johnson and Medtronic. Y. Doki is an Editorial Board member of the *Annals of Gastroenterological Surgery*. All remaining authors have declared no conflicts of interest.

ETHICS STATEMENT

Approval of the research protocol: This trial was approved by the institutional review boards of Osaka University Hospital (nos. 15312-2, 24043).

Informed consent: Written informed consent was obtained from all patients before treatment. Consent to participate in this retrospective study was not considered necessary.

Registry and the registration No. of the study/trial:

Animal Studies: N/A.

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