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Stenosis after esophagojejunostomy with the hemi-double-stapling technique using the transorally inserted anvil (OrVil™) in Roux-en-Y reconstruction with its efferent loop located on the patient's left side following laparoscopic total gastrectomy

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Abstract

Background The drawback of intracorporeal esophagojejunostomy with the double-stapling technique (DST) using a transorally inserted anvil (OrVil™, Covidien, Mansfield, MA, USA) following laparoscopic total gastrectomy (LTG) is not only the high incidence of stenosis but also the presence of intractable stenosis that is refractory to endoscopic treatments.

Methods From November 2013 to December 2016, 24 patients with gastric cancer underwent intracorporeal circular-stapled esophagojejunostomy with the hemi-double-stapling technique (hemi-DST) using the OrVil™ in antecolic Roux-en-Y reconstruction with its efferent loop located on the left side of the patient following LTG to prevent twisting of the esophagojejunostomy and lifted jejunum, which might cause intractable stenosis of the esophagojejunostomy.

Results In this patient series, no twisting of the esophagojejunostomy and lifted jejunum was encountered intraoperatively or postoperatively. Two stenoses of the esophagojejunostomy occurred. Because neither was involved with twisting and both were localized at the anastomotic plane, endoscopic treatments including balloon dilation and electrocautery incisional therapy were successful in both cases. There were no patients with intractable stenosis in this series.

Conclusions Intracorporeal esophagojejunostomy with the hemi-DST using the OrVil™ in antecolic Roux-en-Y reconstruction with its efferent loop located on the left side of the patient can be one option for a circular stapling technique in LTG due to its prevention of intractable stenosis of the esophagojejunostomy that is refractory to endoscopic treatments.

Keywords Gastric cancer · Laparoscopic total gastrectomy · Roux-en-Y reconstruction · OrVil™ · Twisting of the esophagojejunostomy · Intractable stenosis

In contrast to laparoscopic distal gastrectomy, laparoscopic total gastrectomy (LTG) has not become widespread because of the technical difficulties with the intracorporeal esophagojejunostomy in Roux-en-Y reconstruction. As esophagojejunostomy using the circular stapler has been commonly performed with favorable results in open total gastrectomy, several techniques for creation of the intracorporeal circular-stapled esophagojejunostomy in LTG have been reported [1–17].

Of these, in the esophagojejunostomy using a transorally inserted anvil (OrVil™, Covidien, Mansfield, MA, USA), there is no need to place the purse-string suture at the esophageal stump and insert the anvil head into the transected esophageal lumen laparoscopically [4, 5, 7, 8, 11, 12, 14]. However, the drawback of the intracorporeal esophagojejunostomy created with the double-stapling technique (DST) using the OrVil™ is not only the high incidence of stenosis but also the occurrence of intractable stenosis that is refractory to endoscopic treatments [11]. However, twisting of the circular-stapled esophagojejunostomy and the lifted jejunum, which might cause intractable stenosis of the esophagojejunostomy, are often encountered in Roux-en-Y reconstruction after LTG because application of the shaft is restricted laparoscopically [14].

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Since November 2013, we have carried out intracorporeal circular-stapled esophagojejunostomy with the hemi-double-stapling technique (hemi-DST) using the OrVil™ in antecolic Roux-en-Y reconstruction with its efferent loop located on the left side of the patient following LTG to prevent twisting of the esophagojejunostomy and lifted jejunum [14]. Here, to verify whether the occurrence of intractable stenosis of the esophagojejunostomy can be prevented with this reconstruction technique, the outcomes associated with esophagojejunostomy in this patient series are described.

Methods

Patients

The indication for LTG at our institution is T1N0M0 gastric cancer, as classified by the Japanese classification of gastric carcinoma [18], that is located in the upper, upper to middle, or entire stomach. From November 2013 to December 2016, 24 patients (19 men and 5 women) with gastric cancer underwent LTG and Roux-en-Y reconstruction whose efferent loop is located on the left side of the patient with the hemi-DST technique using OrVil™. This procedure was approved by the Institutional Review Board of the Otori Stomach and Intestines Hospital. Following obtaining written informed consent from the patients, LTG with Roux-en-Y reconstruction was performed.

All patients were followed regularly in the outpatient clinic after discharge. The patients with no symptoms were examined with a 9.6-mm-diameter endoscope (EG-590WR2; FUJIFILM Co., Ltd., Tokyo, Japan) 1 year after the operation. If the patients complained of dysphagia, endoscopic examination was performed as soon as possible by a surgeon. Endoscopic balloon dilation (EBD) was performed by a surgeon when the endoscope could not pass through the anastomotic site and stenosis of the esophagojejunostomy was diagnosed. For patients in whom EBD was not effective, endoscopic electrocautery incisional therapy was carried out by a surgeon.

Surgical procedure

Patients were placed in the reverse Trendelenburg position with legs apart. The operator stood between the patient's legs, with the first assistant operating a flexible laparoscope on the left side and the second assistant on the right side. After five ports were placed in the upper abdomen including the umbilicus, a Nathanson's retractor was inserted from just below the xiphoid process to elevate the round ligament and the lateral segment of the liver. LTG with lymphadenectomy based on the Japanese treatment guidelines was performed under a pneumoperitoneum [19]. The duodenal bulb was transected using an endoscopic linear stapler during lymphadenectomy. The abdominal esophagus was obliquely transected from the right to the left side after lymphadenectomy. The umbilical wound was extended longitudinally to a length of 4.5 cm, and a wound retractor (Alexis Wound Retractor S, Applied Medical, Rancho Santa Margarita, CA, USA) was inserted. The specimen was pulled out extracorporeally through the minilaparotomy and the proximal margin was evaluated.

A surgical glove was attached to the wound protector, and pneumoperitoneum was re-established.

Antecolic Roux-en-Y reconstruction with the OrVil™ system (DST EEA 21 or 25; Covidien) was performed in this patient series. A DST EEA 21 or 25 was used for the male patients referring to their physique and esophageal diameter, and a DST EEA 21 was used for the female patients. A small hole was made on the right side of the abdominal esophageal stump and the orally inserted OrVil™ was pulled out through it (Fig. 1). The jejunum was grasped intracorporeally so that the distal side was located on the left side of the patient, a portion 20 cm from the ligament of Treitz and the mesentery was marked with dye, and the mesentery was dissected along the jejunum from the 20-cm mark to the 30-cm point (Fig. 2A). Similarly, the jejunum was pulled out through the minilaparotomy such that the distal side was located on the left side of the patient, and a 20-cm portion was transected using a linear stapler (Fig. 2B). A DST EEA XL™ shaft (Covidien) passing through a surgical glove was inserted into the distal jejunum toward a point 31 cm from the ligament of Treitz and tied with a rubber band (Fig. 2C). The jejunum with the shaft was re-introduced into the abdominal cavity, and pneumoperitoneum was re-established.

After introducing a flexible laparoscope via the left lower port, the jejunum with the shaft was lifted up cranially, and the intracorporeal esophagojejunostomy was

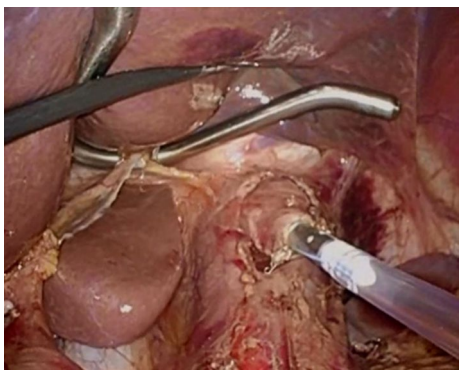

Fig. 1 The OrVil™ orogastric tube is pulled out into the abdominal cavity through a hole made on the right side of the abdominal esophageal stump

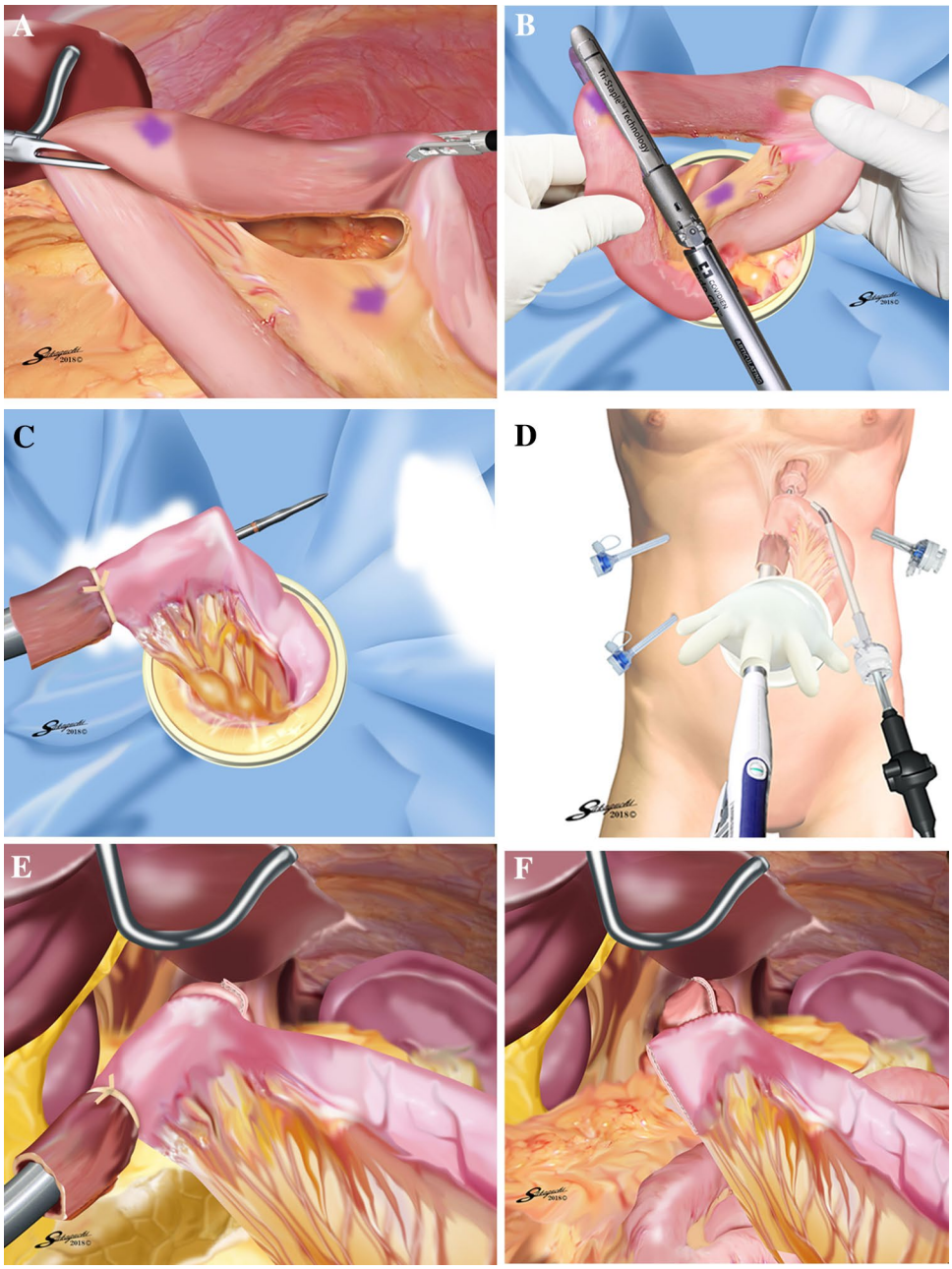

Fig. 2 Steps of the intracorporeal esophagojejunostomy in Roux-en-Y reconstruction with its efferent loop located on the left side of the patient. **A** The jejunum is grasped intracorporeally with the distal side located on the left side of the patient, a portion 20 cm from the ligament of Treitz and the mesentery is marked with dye, and the mesentery is dissected along the jejunum from the 20-cm mark to the 30-cm point. **B** The jejunum is pulled out through the minilaparotomy at the umbilical site such that the distal side is located on the left side of the patient, and a portion 20 cm from the ligament of Treitz is transected using one linear stapler. **C** A DST EEA XL™ shaft passed through a surgical glove is inserted into the distal jejunum toward a point 31 cm from the ligament of Treitz and tied with a rubber band. **D** The jejunum with the shaft is lifted up cranially, and the intracorporeal esophagojejunostomy is performed after introducing a flexible laparoscope via the left lower port. There is no twisting of the lifted jejunum **E** during and **F** after performing the esophagojejunostomy

performed (Fig. 2D). No twisting of the lifted jejunum which was located on the distal side after transecting the jejunum was confirmed while performing the esophagojejunostomy (Fig. 2E). After the sacrificed jejunum was transected using a linear stapler, the esophagojejunostomy was accomplished with the hemi-DST. Again, no twisting of the lifted jejunum was confirmed after performing the esophagojejunostomy (Fig. 2F). A side-to-side jejunojejunostomy was performed extracorporeally to create a 40-cm Roux-en-Y limb. No stitches needed to be made in the duodenal stump and the antimesenteric side of the lifted jejunum. Petersen's defect and the mesenteric gap were closed intracorporeally with interrupted sutures. Finally, the antecolic Roux-en-Y reconstruction with its efferent loop located on the left side of the patient following LTG was completed.

Postoperative complications

Postoperative complications were classified by the Clavien-Dindo classification [20], and those of more than grade II were recorded.

Results

Patient characteristics and operative findings are shown in Table 1. LTG was successfully performed with this reconstruction technique in all 24 patients. No twisting of the esophagojejunostomy and lifted jejunum was encountered intraoperatively (Fig. 3). The median follow-up period was 42.6 ± 13.6 (18.1–57.2) months. There was no clinical fallout in this patient series and the overall survival rate was 100%. In all the patients, the efferent loop was confirmed to be located on the left side of the patient by endoscopic examination 1 year after the operation, and it was confirmed that no twisting of the esophagojejunostomy and lifted jejunum had occurred postoperatively (Fig. 4).

Postoperative complications are shown in Table 2. Among the complications related to the anastomosis, 1 patient (4.1%) had anastomotic leakage and 2 patients (8.3%) had anastomotic stenosis. Grade IIIa anastomotic leakage requiring right pleural drainage occurred in Case 22 (male), but anastomotic stenosis was not present in this patient. Grade IIIa anastomotic stenosis occurred in Case 19 (female) with a DST EEA 21 and Case 18 (male), also with a DST EEA 25. In case 19, stenosis was diagnosed endoscopically, and EBD was performed on postoperative day (POD) 43. A balloon catheter (CRE Wireguided; Boston Scientific, Natick, MA, USA) was inserted through the endoscope, and the 10/12-mm-diameter balloon was gradually filled with air and maintained at an adequate pressure for 1 min. After the dilation, the endoscope was confirmed to easily pass through the anastomotic site without pressure. This patient has had neither dysphagia nor endoscopic recurrence for 33.3 months from the EBD to the present.

A stenosis was also diagnosed endoscopically in case 18, and EBD was performed on POD 238 in the same manner.

Table 1 Patient characteristics and operative findings ($n = 24$)

Characteristic	Value
Age (years)	66.8 ± 11.4
Sex	
Male	19
Female	5
Body mass index (kg/m^2)	23.6 ± 2.6
Operative time (min)	378 ± 56
Blood loss (mL)	91 ± 59
Clinical stage[a]	
IA	24
Lymph node dissection[b]	
D1	3
D1+	21
Number of dissected lymph nodes	35 ± 10
Size of the OrVil™ system	
21 mm	10
25 mm	14

[a]According to the Japanese classification of gastric carcinoma, 3rd English edition [18]

[b]According to the Japanese gastric cancer treatment guidelines 2014 (ver. 4) [19]

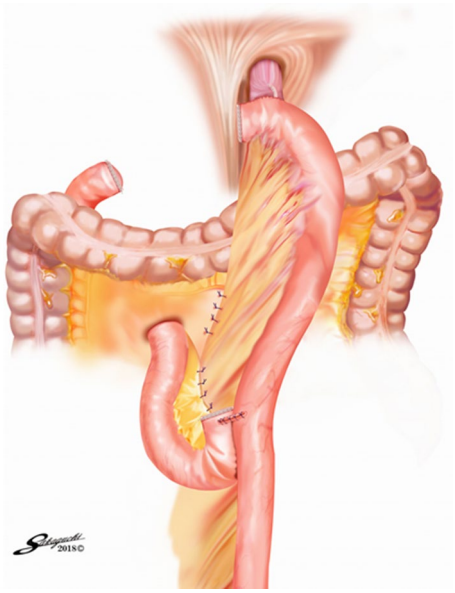

Fig. 3 Antecolic Roux-en-Y reconstruction with its efferent loop located on the left side of the patient following laparoscopic total gastrectomy. There is no twisting of the esophagojejunostomy and lifted jejunum intraoperatively

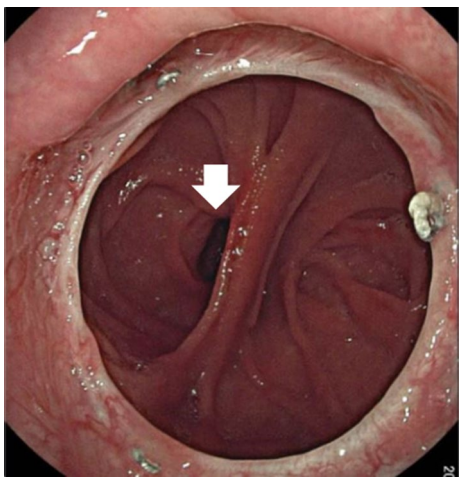

Fig. 4 Endoscopic view of the esophagojejunostomy 1 year after the operation. The efferent loop (white arrow) is located on the left side of the patient, and there is no twisting of the esophagojejunostomy and lifted jejunum postoperatively

Table 2 Postoperative complications ($n=24$)

Complication	Number (%)
Anastomotic leakage	
Grade II[a]	0
Grade IIIa/b	1 (4.1)/0
Anastomotic stenosis	
Grade II	0
Grade IIIa/b	2 (8.3)/0
Pancreatic fistula	
Grade II	1 (4.1)
Grade IIIa/b	0/0
Intraabdominal bleeding	
Grade II	1 (4.1)
Grade IIIa/b	0/0
Internal hernia	
Grade II	0
Grade IIIa/b	0/2 (8.3)

[a]Grading of complications was based on the Clavien-Dindo classification [20]

However, the endoscope could not pass through the anastomotic site after the dilation.

Although this patient could ingest component nutrients, dysphagia was not improved completely. Endoscopic electrocautery incisional therapy using an insulated-tip knife (IT knife) (Olympus Optical Co., Ltd., Tokyo, Japan) with a transparent hood was carried out on POD 336. The IT knife was introduced through the endoscope, and two radial incisions were performed, followed by cutting away of the granulation tissue between the incisions. After the procedure, the endoscope was confirmed to easily pass through the anastomotic site without pressure. This patient has had neither dysphagia nor endoscopic recurrence for 24.3 months from the electrocautery incisional therapy to the present. 1 (4.1%) instance of grade II pancreatic fistula, 1 (4.1%) instance of grade II intraabdominal bleeding, and 2 (8.3%) instances of grade IIIb internal hernia requiring reoperation were encountered; otherwise, there were no other complications.

Discussion

To perform a circular-stapled esophagojejunostomy with the single-stapling technique in LTG, an anvil head needs to be inserted into the esophagus and fixed using a purse-string suture intracorporeally [1, 2, 6, 10, 13, 15, 17]. These procedures in laparoscopic surgery are even more difficult than in open surgery and in particular, inserting the anvil head into the transected esophageal lumen laparoscopically may cause mucosal injury leading to anastomotic leakage [9]. To eliminate these processes, some authors reported esophagojejunostomy with the hemi-DST [3, 9, 16, 17]. They mentioned that the anvil head was inserted into the esophagus from the opening on the anterior wall, and it was pulled down after transecting the esophagus using the linear stapler. However, in these techniques, accurate evaluation of the oral margin of the esophagus before insertion of the anvil was impossible. In the OrVil™ system, the anvil head is inserted toward the esophageal stump after transecting the esophagus. This makes the precise evaluation of the proximal margin before insertion of the anvil head possible, although difficulties are sometimes encountered in introducing the anvil head into the esophageal stump because of narrowing at locations such as the larynx and the esophagus at the level of the tracheal bifurcation [4, 5, 7, 8, 11, 12, 14]. In this patient series, a DST EEA 21 or 25 was used, and no injuries of the larynx and esophagus were encountered.

Zuiki et al. reported that the drawback of intracorporeal esophagojejunostomy with DST using the OrVil™ was not only the high incidence of stenosis but also the presence of intractable stenosis refractory to endoscopic treatment [11]. They indicated that ischemia at the site where the staple lines meet might cause fibrosis and could lead to the development of anastomotic stenosis. In the present patient series, we adopted the hemi-DST, thus reducing the sites of overlapping staple lines.

Twisting of the circular-stapled esophagojejunostomy and lifted jejunum, which might cause intractable stenosis of esophagojejunostomy, is often encountered in Roux-en-Y reconstruction following LTG because application of the shaft is restricted laparoscopically [14]. Because the abdominal esophageal stump is located in the left upper abdominal cavity, the direction of shaft insertion is defined as the left side of the patient when the shaft is introduced via the minilaparotomy at the umbilical site. Thus, twisting of the lifted jejunum when performing esophagojejunostomy is prevented with the efferent loop located on the left side because the shaft is inserted into the lifted jejunum from the oral to anal side. In addition, because the jejunal arteries diverge from the superior mesenteric artery toward the left side of the patient, it is physiological that the anal side of the jejunum is located on the left side. Thus, twisting of the lifted jejunum after performing esophagojejunostomy is prevented when the efferent loop is located on the left side. Therefore, when the shaft is introduced via the umbilical site, it is assumed that twisting of the circular-stapled esophagojejunostomy and lifted jejunum is prevented intraoperatively and postoperatively in Roux-en-Y reconstruction with its efferent loop located on the left side. In this patient series, no twisting of the esophagojejunostomy and lifted jejunum was encountered intraoperatively or postoperatively. Because neither of the two stenoses of the esophagojejunostomy were involved with twisting and both were localized at the anastomotic

plane, endoscopic treatments were successful in both cases. Endoscopic electrocautery incisional therapy is considered to be effective in the short-segment stenosis, which is refractory to EBD [21–23], as in our Case 18. At result, in this patient series, there were no incidences of intractable stenosis of the esophagojejunostomy refractory to endoscopic treatments.

Positioning of the flexible laparoscope during the intracorporeal esophagojejunostomy is very important in this reconstruction system. Because the shaft of the circular stapler is introduced through the umbilical site and there is sufficient working space in the left upper abdominal cavity to bend a flexible laparoscope when the round ligament and the lateral segment of the liver are elevated by a Nathanson's retractor, it is advisable that a flexible laparoscope be introduced via the left lower port when performing esophagojejunostomy. In addition, when the efferent loop in the Roux-en-Y reconstruction is located on the left side, intracorporeal esophagojejunostomy can be monitored clearly through a laparoscope introduced via the left lower port.

This study had some limitations. First, it was a single-institution study with a small sample size. Second, this intracorporeal esophagojejunostomy was not compared to other anastomotic methods. Third, the incidence of anastomotic stenosis in this series was relatively high (8.3%) and was equivalent to that reported in a systematic review (8.8%) [24]. There are several factors associated with stenosis of the esophagojejunostomy, including anastomotic leakage and tension in the anastomosis. Two stenoses occurred in this series, but leakage was not present in either patients. This suggested that the tension in the anastomosis when performing the intracorporeal circular-stapled esophagojejunostomy might be one of the main causes. Several methods to alleviate the tension in the circular-stapled esophagojejunostomy need to be devised, including lengthening of the sacrificed jejunum and division of the marginal and jejunal artery in the mesojejunum.

Several authors described the overlap method in which the intracorporeal side-to-side esophagojejunostomy is performed using a linear stapler following LTG [25–27]. Because the tip of the cartridge inserted into the lifted jejunum is positioned at the end of the lumen, the lifted jejunum is straightened during stapling of the left side of the esophagus and the antimesenteric side of the lifted jejunum [25]. The entry hole was closed using an intracorporeal interrupted hand-sewn technique. Therefore, it was concluded that twisting of the lifted jejunum when performing esophagojejunostomy is prevented in this procedure. In addition, the authors indicated that after performing esophagojejunostomy, two or three stitches were placed in the duodenal stump and the antimesenteric side of the lifted jejunum to prevent the jejunum falling into the space of the left dorsal subphrenic area. Thus, in this reconstruction, it is assumed that twisting of the esophagojejunostomy and lifted jejunum is prevented intraoperatively and postoperatively.

In conclusion, intracorporeal esophagojejunostomy with the hemi-DST using the OrVil™ in Roux-en-Y reconstruction with its efferent loop located on the left side of the patient can be one option for a circular stapling technique in LTG due to its prevention of intractable stenosis of the esophagojejunostomy that is refractory to endoscopic treatments.

Compliance with ethical standards

Disclosures Drs. Takaya Tokuhara, Eiji Nakata, Toshiyuki Tenjo, Isao Kawai, Keisaku Kondo, Hirofumi Ueda, and Atsushi Tomioka have no conflicts of interest or financial ties to disclose.

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