

# A modified efficient purse-string stapling technique (mEST) that uses a new metal rod for intracorporeal esophagojejunostomy in laparoscopic total gastrectomy

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**Abstract:** Intracorporeal esophagojejunostomy after laparoscopic total gastrectomy is technically difficult because this procedure should be performed in a narrow surgical field in the upper abdomen even when completely laparoscopic approaches are used. The placement of the anvil of a circular stapling device into the esophagus and connection the instrument to the anvil are extremely difficult steps in this surgery. Therefore, we developed a simple technique for intracorporeal esophagojejunostomy using hemi-double stapling technique; we named this technique the efficient purse-string stapling technique (EST). More recently, we have developed a modified EST (mEST) that utilizes a new stainless steel anvil rod instead of a plastic rod. Relative to the plastic rod, the steel rod is reusable and shorter; thus, it was easier to perform anvil placement into the esophagus with the steel rod. Anvil preparation for mEST: a stainless steel rod is attached to the shaft of the anvil, and the needle and thread are sutured to the tip of the rod. After complete insertion of the anvil into the esophageal cavity, the needle and thread are used to penetrate the anterior esophageal wall, and the esophagus is then clamped using a linear stapler just distal to the site penetrated by the thread. The linear stapler is fired, and anvil placement in the esophagus is simultaneously accomplished. After the rod is removed from the anvil, the instrument is intracorporeally connected to the anvil and then fired to complete the gastrojejunostomy. This technique is simple and facilitates intracorporeal reconstruction procedures in laparoscopic total gastrectomy.

**Keywords:** Laparoscopic total gastrectomy; gastric cancer; circular stapling device; efficient purse-string stapling technique (EST); hemi-double stapling technique

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Since laparoscopic distal gastrectomy was first reported by Kitano *et al.*, laparoscopic approaches have been widely used to treat early gastric malignancies (1). Such approaches have been applied to total gastrectomy for the treatment of gastric cancers located in the upper third of the stomach. In laparoscopically assisted total gastrectomy, reconstruction procedures have commonly been performed using a circular stapling device under direct vision via a

small upper-abdominal laparotomy (2), which is sometimes difficult, particularly in cases involving obese patients with thick abdominal walls. Therefore, surgeons have been eager to perform intracorporeal anastomosis (3). However, esophagojejunostomy in Roux-en-Y reconstruction after laparoscopic total gastrectomy is technically demanding because this procedure should be performed in a narrow surgical field in the upper abdomen, even when completely

laparoscopic approaches are used. Therefore, we developed a simple technique for intracorporeal esophagojejunostomy using a circular stapling device; we named this approach the efficient purse-string stapling technique (EST) (4-7). We first reported this original technique for laparoscopic Billroth I gastrectomy in 2005 (4). Subsequently, this technique was applied to Roux-en-Y reconstruction in laparoscopic distal or total gastrectomy with a hemi-double stapling technique in 2007 (5,6). In addition, we applied the EST to single-incision laparoscopic Billroth I gastrectomy (7). The application of EST has been extended to laparoscopic colorectal surgery (8,9). More recently, in 2013, we developed a modified EST (mEST) involving the use of a newly created metal device (Endo Mini Rod, Takasago Medical Industry, Tokyo, Japan). In this paper, we describe the technical details of this procedure, including relevant skills and pitfalls.

## Surgical Techniques

### *Patient positioning and OR setting*

The patient was placed in the supine position with the legs opened. The surgeon, the first assistant, and the scope assistant were positioned on the right side of the patient, the left side of the patient, and between the patient's legs, respectively. The nurse stood near the patient's left leg. A laparoscopic unit with a monitor was located above the patient's shoulders.

### *Port setting*

An umbilical laparotomy through a 2.5- to 3.0-cm vertical skin incision in the umbilicus was made using the open method. A mini-laparotomy was made using a wound sealing device (Lap protector, Hakko, Nagano, Japan), which was covered by an access port (EZ access; Hakko, Nagano, Japan) with a trocar for insertion of the laparoscope. A 12-mm trocar was inserted into the anterior axillary line of the right subcostal space, a 5-mm trocar was inserted into the right lateral abdomen for the main surgeon, and 5-mm trocars were inserted into the left subcostal space and left lateral abdomen for the first assistant.

### *Technique*

The patient was placed in the reverse Trendelenburg position with the legs apart. During the procedure,

pneumoperitoneum was established with carbon dioxide insufflations at a pressure level of approximately 8 to 12 mmHg, based on the patient's body type. A 10-mm flexible high-definition scope (Endoeye flexible HD camera system; Olympus Medical Systems Corp.) was used to visualize surgical fields. The greater curvature was dissected, and the left gastroepiploic vessels were clipped and divided for the dissection of station 4sb lymph nodes. The gastrosplenic ligament was divided using laparoscopic coagulating shears for the dissection of station 4sa lymph nodes. The right gastroepiploic vein and artery were transected for the dissection of station 6 lymph nodes.

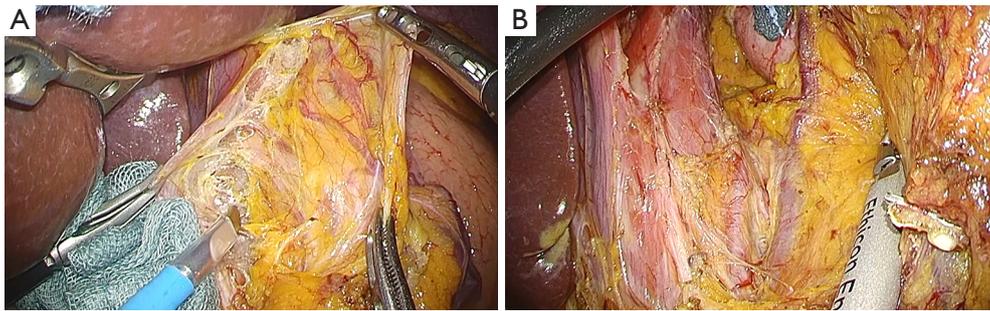
### *Suprapancreatic lymph node dissection using the cranial approach*

We commonly use the cranial-to-caudal approach (the cranial approach) in multiport laparoscopic gastrectomy as well as single port laparoscopic gastrectomy (10), in which the stomach and the distal pancreas are first mobilized from Gerota's fascia prior to the lymphadenectomy procedure.

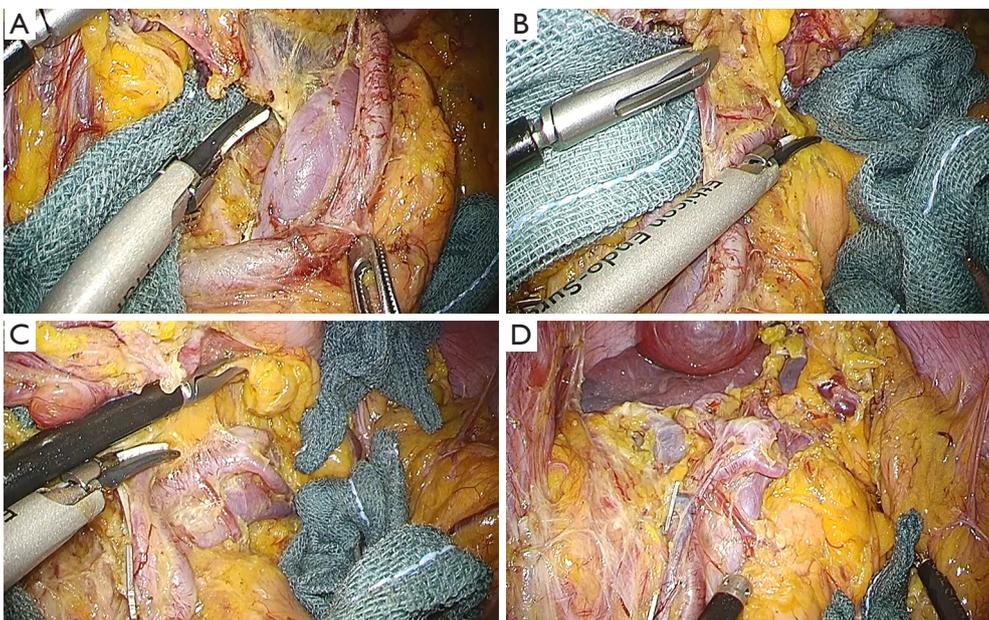
During dissection at stations 8a and 12a, the common hepatic artery, the bifurcations of the proper hepatic and gastroduodenal arteries, and the portal vein were exposed along the plane of the periarterial plexus for lymph node dissection. After the dissection of lymph nodes at stations 5, 8a, 9, and 12a, the peritoneum was incised at the level of the right crus of the diaphragm, and the left gastric artery was then clipped and divided (*Figure 1A*). The mesogastrium was retracted anteriorly to dissect the plane between Gerota's fascia and Toldt's fusion fascia laterally and caudally (*Figure 1B*). Subsequently, the esophagus was transected using a linear stapling device (ECELON FLEX Powered ENDOPATH Stapler, Ethicon Endosurgery, Cincinnati, OH, USA). This full mobilization of the splenic artery (mesenterization) allowed for the easy dissection of 11p/11d lymph nodes under excellent surgical views. Lymph nodes at station 11p were dissected in the dorsal plane, where the splenic vein or pancreas could be identified (*Figure 2A*). Posterior gastric vessels were identified and divided after clipping (*Figure 2B*). Dissection of 11d lymph nodes was performed along the distal pancreatic artery toward the splenic hilum (*Figure 2C,D*). The resected specimen was then extracted through a small incision.

### *Anvil placement into the proximal esophagus using the EST*

The placement of the anvil of a circular stapling device (ECS



**Figure 1** Cranial approach. (A) The peritoneum was cut along the right crus of the diaphragm; (B) completion of the cranial approach. The splenic artery and vein were completely mobilized from Gerota's fascia.



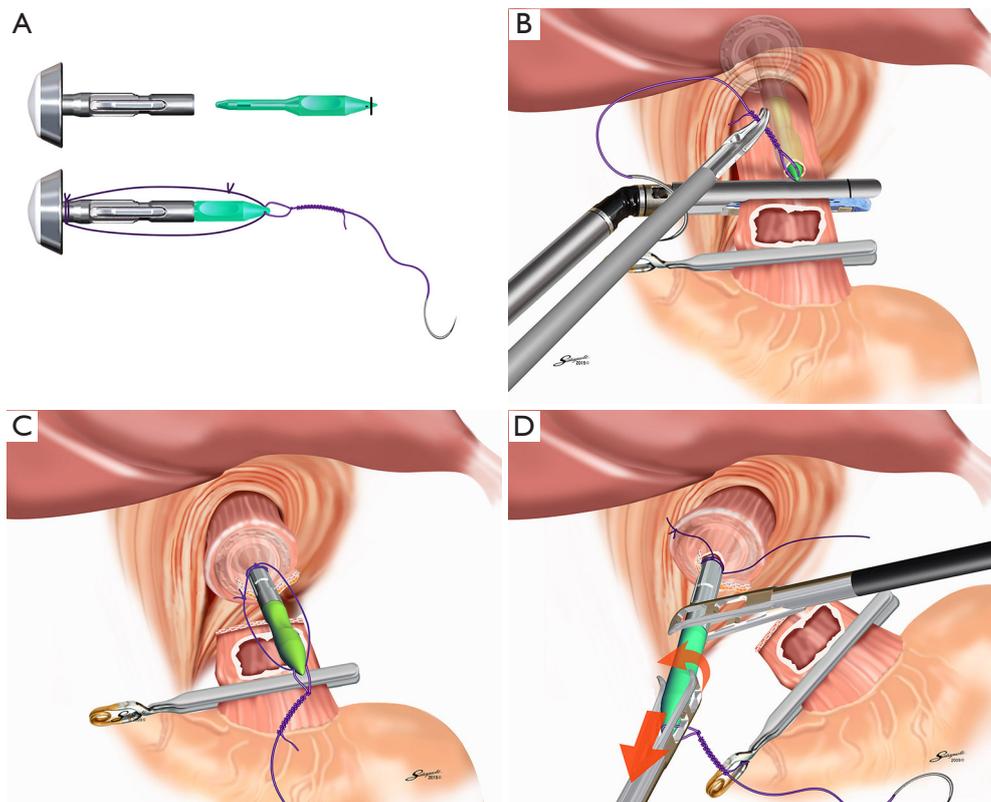
**Figure 2** Suprapancreatic lymph node dissection (at station 11). (A) Dissection of station 11p. The splenic vein, a landmark of the dorsal plane, was clearly exposed; (B) the posterior gastric artery and vein were identified and transected by clipping; (C) dissection of station 11d was performed until the bifurcations of the splenic artery and the distal splenic vein were exposed; (D) completion of dissection of station 11p/11d. The ventral side of the splenic hilum lymph nodes was partially dissected.

25, Ethicon Endosurgery, Cincinnati, OH, USA) into the esophagus is one of the most difficult steps in this surgery. We have commonly used our original technique, the EST, for this anvil placement (5). In this technique, the anvil with a green plastic rod sutured to a needle and thread (Figure 3A) is completely inserted into the esophagus. The needle and thread are used to penetrate the anterior wall of the esophagus (Figure 3B). Finally, the esophagus is transected using a linear stapling device with a 60-mm blue cartridge (ECELON FLEX Powered ENDOPATH Stapler, Ethicon

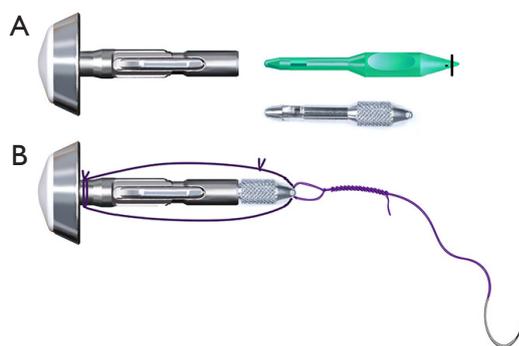
Endosurgery, Cincinnati, OH, USA) just distal to the needle penetration site (Figure 3C), and the anvil placement procedure is completed after the removal of the rod from the anvil (Figure 3D).

#### *Insertion of the anvil into the esophagus*

In preparation for this procedure, a stainless steel rod (Endo Mini Rod, Takasago Medical Industry, Tokyo, Japan) was attached to the shaft of the anvil, and a

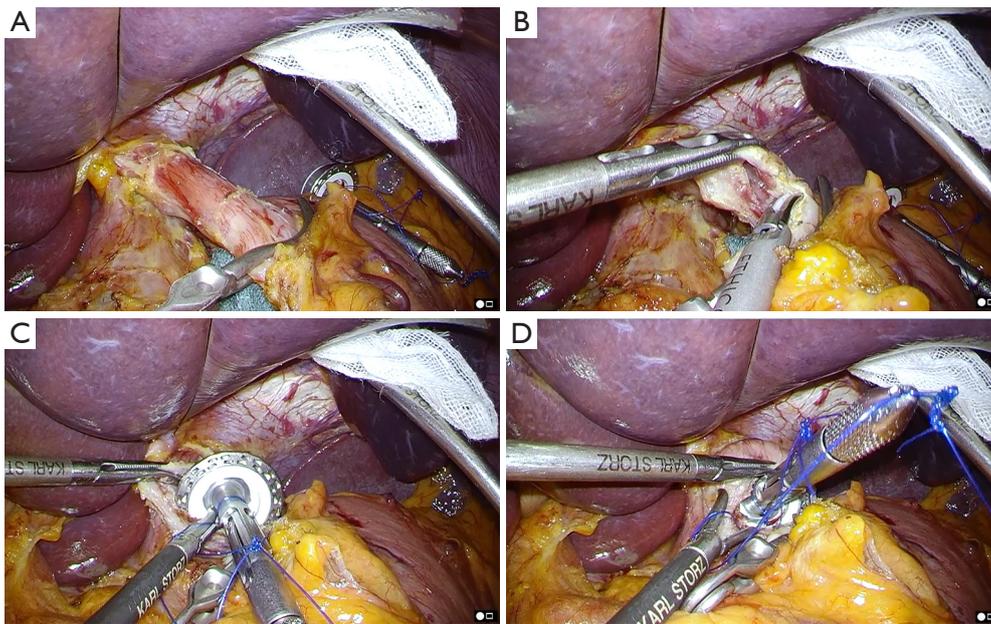


**Figure 3** Anvil preparation for the EST (5). (A) The tip of a green plastic rod is tapered to blunt the tip. The rod is attached to the shaft of the anvil, and the needle and thread are sutured to the tip of the rod. Another thread is tied at the neck of the shaft; (B) after complete insertion of the anvil, the needle and thread are used to penetrate the anterior esophageal wall, and the esophagus is then clamped using a linear stapler just distal to the site penetrated by the thread; (C) the linear stapler is fired, and anvil placement in the esophagus is simultaneously accomplished; (D) rod removal. The rod is rotated and pulled to remove it from the anvil. EST, efficient purse-string stapling technique.

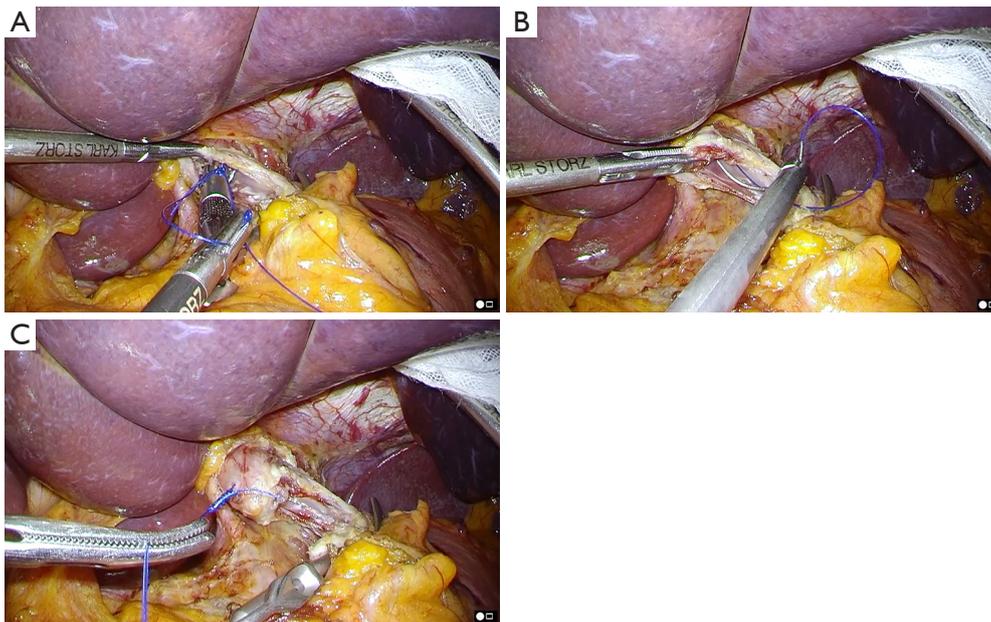


**Figure 4** Anvil preparation for the modified EST. (A) The Endo Mini Rod is composed of stainless steel, and it is clearly shorter than the green plastic rod used in the EST; (B) the Endo Mini Rod with a needle and thread was attached to the anvil shaft.

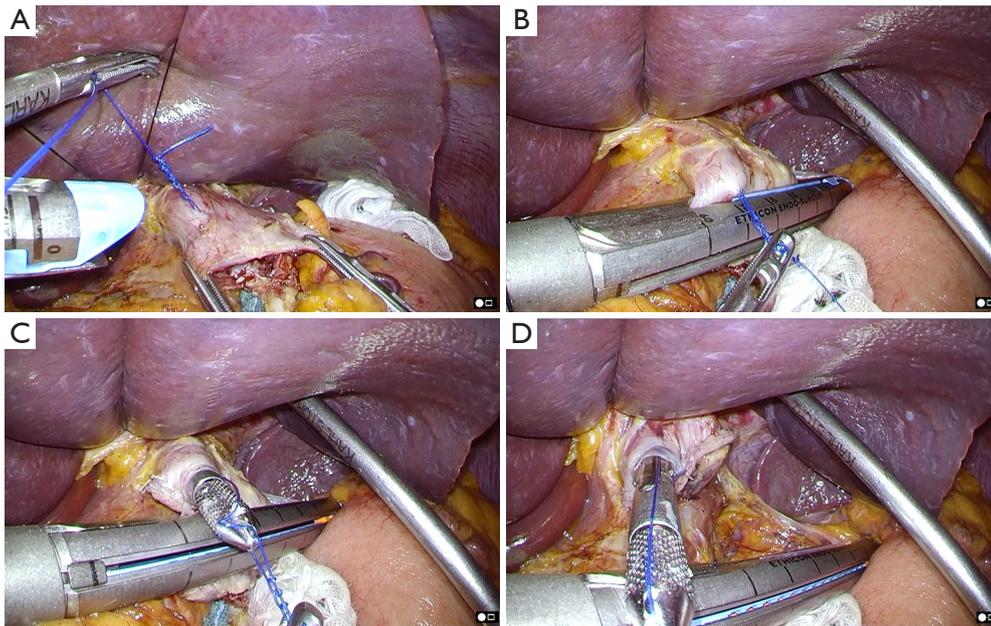
thread with a needle was then sutured to the tip of the rod. We used a stainless steel rod instead of a green plastic rod. Relative to the plastic rod, the steel rod is reusable and shorter; thus, it was easier to perform anvil placement into the esophagus with the steel rod (Figure 4). After the distal esophagus was clamped using a detachable intestinal holder forceps (Figure 5A), a hemicircumferential esophagotomy was performed on the anterior esophagus (Figure 5B). The anvil head was placed over the window (Figure 5C), and the anterior wall of the esophagus was fixed by covering it with the anvil head (Figure 5D). The anvil with the rod was pushed cranially along the esophageal cavity and completely inserted into the esophagus (Figure 6A).



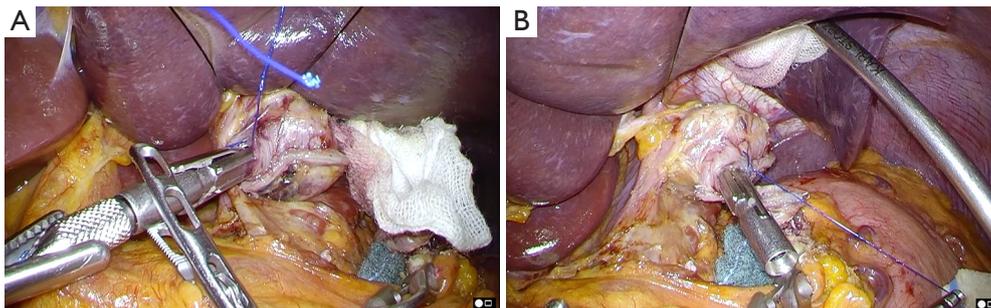
**Figure 5** Placement of the anvil head on the esophagus. (A) The distal esophagus was clamped using a detachable gastrointestinal forceps; (B) creation of the semi circumferential esophagotomy; (C) the anvil head was placed over the window; (D) fixation of the anvil head on the esophagus.



**Figure 6** Insertion of the anvil into the esophagus. (A) The anvil with the rod was fully inserted into the esophagus; (B) needle penetration of the anterior esophageal wall; (C) the knot was entirely exteriorized from the esophageal cavity.



**Figure 7** Fixation of the anvil in the esophagus. (A) The thread was held and retracted ventrally by the main surgeon's left hand, and the bilateral side of the esophageal window was held by the first assistant; (B) the esophagus was clamped using a linear stapling device just distal to the site penetrated by the thread; (C) the esophagus was transected by firing the stapling device, and the thread was simultaneously pulled to exteriorize the anvil rod; (D) the anvil was fixed in the esophagus.



**Figure 8** Removal of the rod from the anvil. (A) The rod was rotated and then pulled to remove it from the anvil shaft; (B) completion of anvil placement into the esophagus.

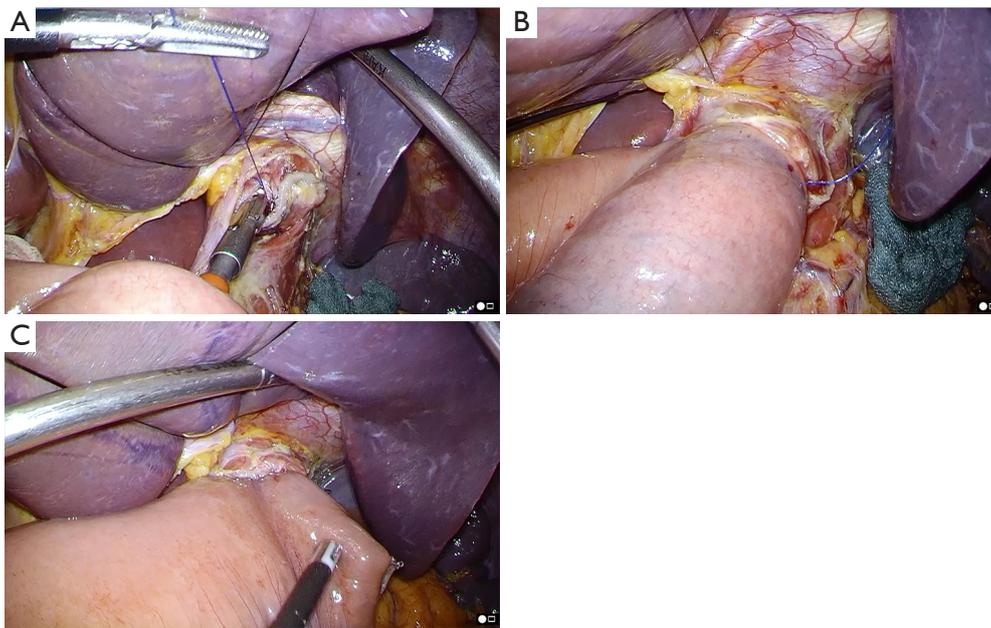
### *Placement of the anvil in the esophagus*

The needle penetrated the anterior wall of the esophagus 1 cm proximal to the esophagotomy (Figure 6B), and the thread was pulled out until the ligation knot was exteriorized from the esophageal cavity (Figure 6C). The proximal esophagus was transected using a linear stapling device (ECELON FLEX Powered ENDOPATH Stapler, Ethicon Endosurgery, Cincinnati, OH, USA) just distal to the site penetrated by the thread, and anvil placement in the

esophagus was simultaneously completed (Figure 7).

### *Esophagojejunostomy*

After the body of the instrument was inserted into the umbilical wound via the EZ access port, CO<sub>2</sub> insufflation was re-established. After the rod was removed from the anvil (Figure 8), the instrument was intracorporeally connected to the anvil and then fired to complete the gastrojejunostomy (Figure 9). The stump of the jejunum was



**Figure 9** Connection between the anvil and the circular stapling device. (A) The trocar of a circular stapling device was connected to the anvil. The retraction of the thread was useful for upholding the anvil; (B) the instrument was fired to create the esophagojejunostomy; (C) completion of anastomosis.

closed using a linear stapling device (*Figure 9*).

### Comments

In this paper, step-by-step procedures for laparoscopic total gastrectomy with Roux-en-Y reconstruction using the mEST were described. This technique is simple and may facilitate intracorporeal reconstruction procedures in laparoscopic total gastrectomy. In addition, mEST can be applied to all reconstructive procedures for laparoscopic gastrointestinal surgery.

### Acknowledgements

None.

### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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