

Laparoscopic esophagojejunostomy using the EndoStitch and a circular stapler under a direct view created by the ENDOCAMELEON

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Abstract Laparoscopic esophagojejunostomy using a circular stapler is associated with technical difficulties in the purse-string sutures used to insert the anvil head and in obtaining an adequate visual field to prevent rolling the mesentery and the wall of the jejunum on the mesenteric side into the anastomosis. To overcome these difficulties, we used the EndoStitch to create the purse-string suture and the ENDOCAMELEON to create the visual field to stretch the jejunum. After resecting the esophagus, purse-string sutures were placed using the EndoStitch. A total of five to six needle deliveries were performed. Next, the anvil head was inserted into the esophagus. The main unit of the EEA was inserted from the end of the resected jejunum. Then, the scope was changed to the ENDOCA-MELEON. The main unit was slowly moved toward the anvil head. After making sure that the mesentery and the wall of the jejunum on the mesenteric side were not rolled into the anastomosis under the visual field created by the ENDOCAMELEON, the main unit was then fired. Thereafter, esophagojejunostomy was successfully completed. This technique was applied in 20 patients between April 2010 and May 2012. Laparoscopic esophagojejunostomy after total gastrectomy for gastric cancer was completed in all 20 patients. No case required conversion to open surgery. Neither anastomotic leakage nor stenosis was

observed. This method is simple and useful for laparoscopic esophagojejunostomy after total gastrectomy for gastric cancer.

Keywords Laparoscopy · Esophagojejunostomy · Gastric cancer

Introduction

Compared to laparoscopy-assisted distal gastrectomy [1–5], the use of laparoscopic total gastrectomy is much less widespread, because of technical difficulties associated with esophagojejunostomy.

The standard procedure of esophagojejunostomy in open surgery involves the use of a circular stapler [6]. Some surgeons have reported the use of extracorporeal approaches through mini-laparotomy [7, 8], which may spoil the cosmetic benefits of laparoscopic surgery. Another approach involves side-to-side anastomosis using a linear stapler [9, 10].

Laparoscopic esophagojejunostomy using a circular stapler is associated with technical difficulties in the purse-string sutures used to insert the anvil head and in obtaining an adequate visual field to prevent rolling the mesentery and the wall of the jejunum on the mesenteric side into the anastomosis. The OrVil system (Covidien, Norwalk, CT, USA), which is used in place of purse-string sutures to insert anvil heads, is reported to be convenient [11–13]. However, double stapling at the anastomosis is unavoidable because the esophagus must be sealed by the stapler. Double stapling has a risk of inappropriate formation of the staple, which may cause leakage. Moreover, issues related to the visual fields have not been resolved in previous reports.

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Here we report a new technique to overcome these difficulties in laparoscopic esophagojejunostomy.

Procedures

Resection of the esophagus

A total of six trocars were placed in the following positions: bilateral subcostal, bilateral mid-abdominal, below the xiphoid, and at the umbilicus. To lift the left lobe of the liver, a Diamond-Flex Triangular Retractor (Snowden-Pencer MIS Products, Tucker, GA, USA) was inserted from a 5-mm trocar just below the xiphoid. The operator stood on the right side of the patient, the assistant surgeon stood on the left side of the patient, and the camera operator stood between the patient's legs. A straight scope with a 30° angle of view (Stryker Endoscopy, San Jose, CA, USA) was used for most procedures, whereas the ENDOCAMELEON was used for the anastomosis.

After finishing nodal dissection, the esophagus was clamped at the oral and anal side using an atraumatic intestinal clip (Aesculap, Tuttlingen, Germany). The esophagus was resected just above the forceps of the anal side using the HARMONIC ACE (Ethicon Endo-Surgery, Cincinnati, OH, USA). Subsequently, a small incision was made at the umbilicus. Then, the lap-disc (Hakko, Tokyo, Japan) was placed on the incision. After obtaining the

resected stomach, the anvil head of the circular stapler (DST Series EEA XL, 25 mm; Covidien, Norwalk, CT, USA) was placed into the abdomen.

Placement of the anvil head

The position of the surgeon was changed to the left side of the patient. The thread of the EndoStitch was cut at 17 cm and a lap-la tie was placed at 16 cm on the thread of the EndoStitch. Next, purse-string sutures were placed using the EndoStitch (Fig. 1a). A total of five to six needle deliveries were performed. The first surgical ligation was formed using the EndoStitch, and care was taken not to tighten the suture at this time (Fig. 1b). Then, the desorption forceps on the oral side were removed and the anvil head held by the anvil grasper (Ethicon Endo-Surgery, Cincinnati, OH, USA) was inserted into the esophagus in a manner similar to fastening a button (Fig. 1c). Thereafter, the first surgical ligation was tightened and a second ligation was formed and tightened (Fig. 1d).

Placement of the main unit into the jejunum

The lap-disc was opened. After performing jejunio-jejunostomy of Roux-en-Y reconstruction, the positions of the assistant surgeon and the camera operator were switched. The main unit of the circular stapler was inserted from the end of the jejunum. The end of the jejunum was fixed to the

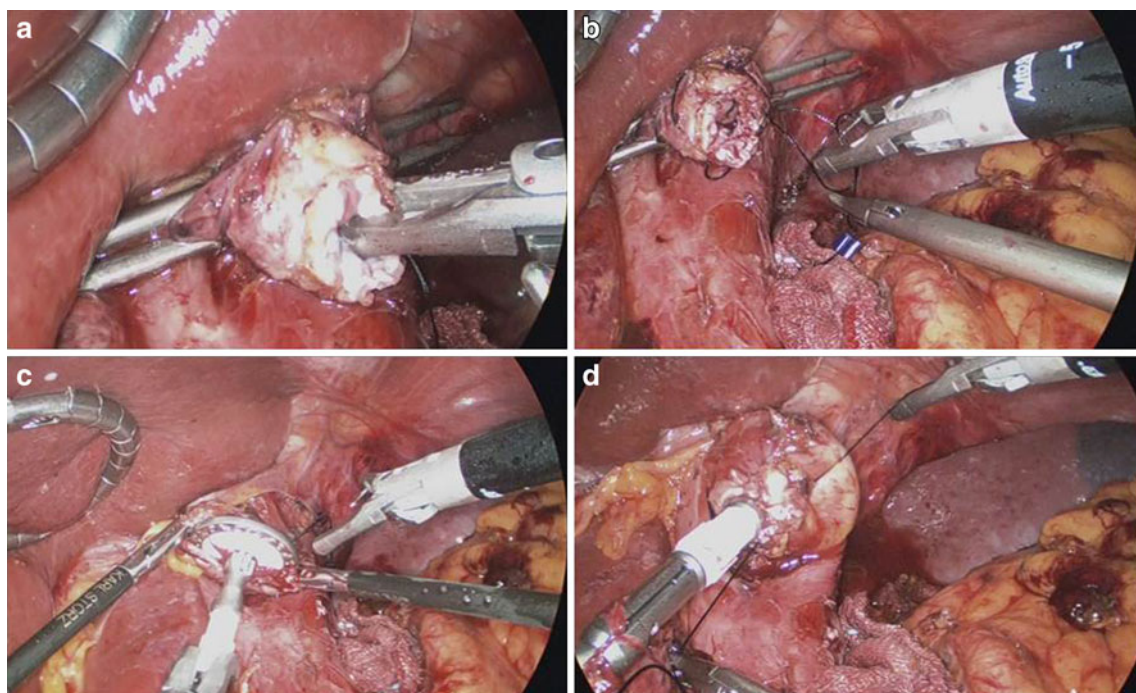
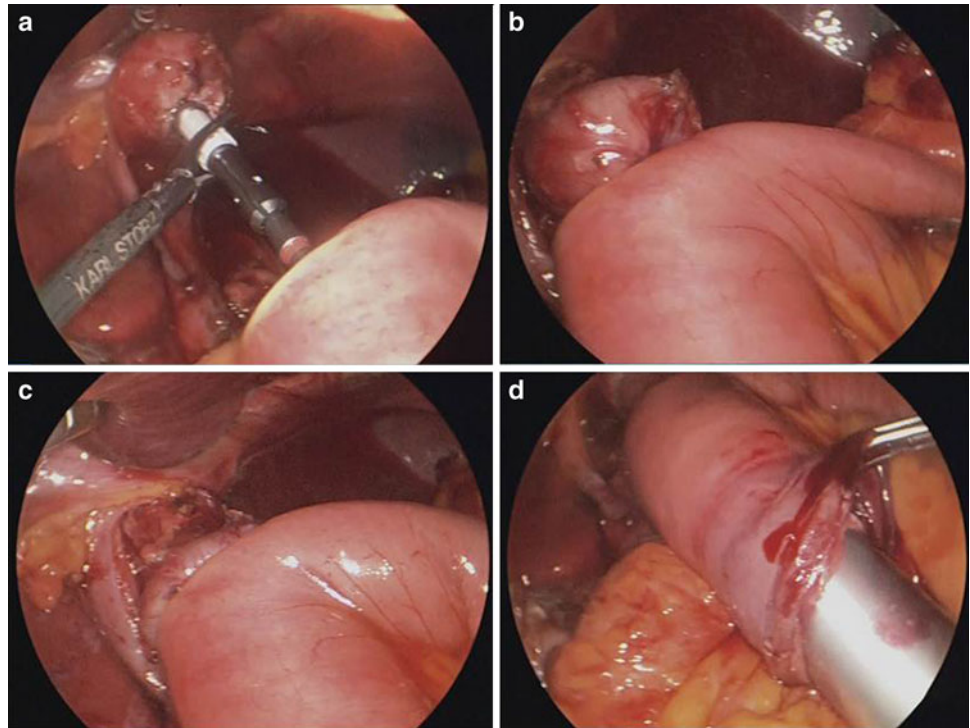


Fig. 1 **a** Purse-string suture is placed using the EndoStitch. **b** The first surgical ligation is formed using the EndoStitch, not tightening the suture. **c** The anvil head is inserted into the esophagus just like

fastening buttons on clothing. **d** The anvil head is inserted into the esophagus and the ligation is formed

Fig. 2 **a** The anvil head is held by the Maryland grasper, and the main unit is slowly moved toward the anvil head. **b** The anal side of the jejunum was stretched by the atraumatic grasper under the visual field by the ENDOCAMELEON to ensure that the mesentery and the jejunum were not rolled into the anastomosis. **c** The EEA is fired. **d** After the bowknot fixing the main unit and the jejunum was released, the main unit was taken from the jejunum



main unit by a bowknot to prevent separation. The hole of the lap-disc was coated by jelly to allow smooth movement of the main unit through the hole. The hole of the lap-disc was closed while maintaining the main unit through the hole, and the peritoneum was again inflated.

Connection and firing

The scope was changed to the ENDOCAMELEON, which was introduced from the lower right trocar. The jejunum end attached to the main unit was introduced through the port of the umbilicus and moved toward the back to create a space above the main unit through which the mesentery and jejunum could be seen directly by the ENDOCAMELEON. The anal side of the jejunum was stretched using two atraumatic graspers. Then, the lateral wall of the jejunum was pierced by a center rod. The anvil head was held by a Kelly grasper, and the main unit was moved toward the anvil head (Fig. 2a). After connecting the anvil head and the main unit, the main unit was closed to the anvil head and the jejunum was stretched using an atraumatic grasper under the visual field created by the ENDOCAMELEON (Fig. 2b). After ensuring that the mesentery and the wall of the jejunum on the mesenteric side were not rolled into the side of anastomosis, the main unit was fired (Fig. 2c). Next, the bowknot fixing the main unit and the jejunum was released and the main unit was removed from the jejunum (Fig. 2d). The end of the jejunum was closed using the linear stapler (Endo GIA

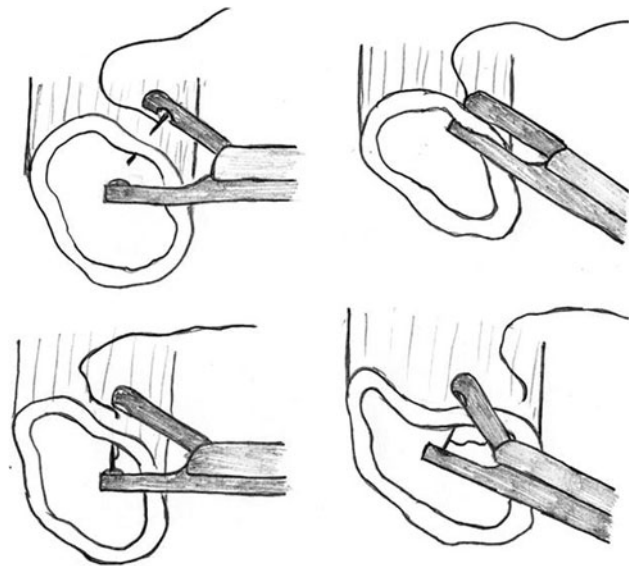


Fig. 3 The surgeon can easily sew the wall of the end of the resected esophagus from the adventitia side to the mucosal side and then from the mucosal side to the adventitia side simply by flipping the levers of the EndoStitch

Tri-Staple 60; Covidien). The reconstruction of the esophagojejunostomy was completed.

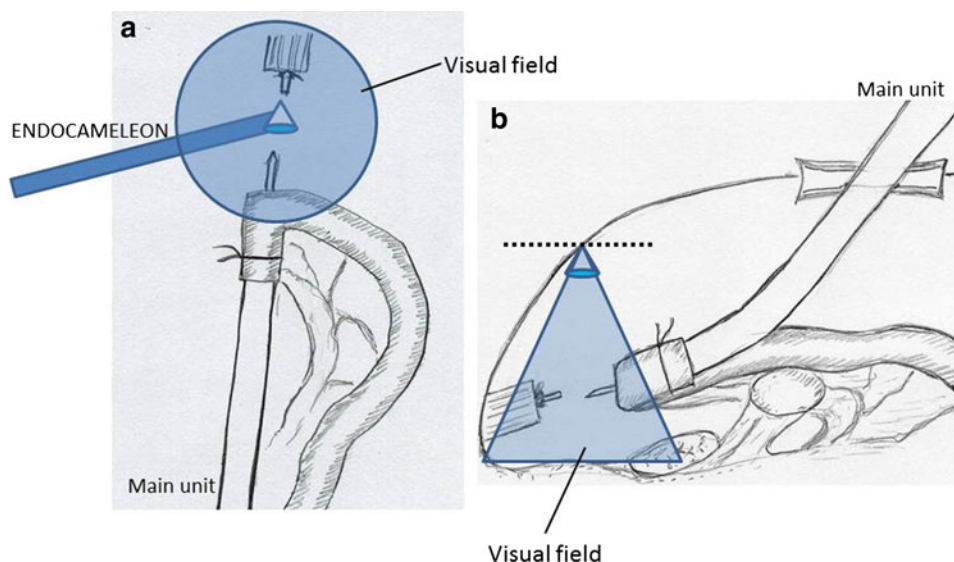
The results of pilot cases

A total of 20 consecutive patients underwent laparoscopic esophagojejunostomy using this technique between April

Table 1 Comparisons of reconstruction technique

	Linear stapler		Circular stapler				
	Overlap	Delta	OrVil	Closed by stapler after introduction of anvil head	Endo-PSI	Hand-sewn for purse-string suture	EndoStitch for purse-string suture
Double stapling	None	+	+	+	None	None	None
Anastomosis in mediastinum	+	+	None	None	None	None	None
Hiatus	Destroyed	Destroyed	Preserved	Preserved	Preserved	Preserved	Preserved
Hand-sawing	+ For entry hole	None	None	None	None	+	+
Anastomotic site	No restriction	No restriction	No restriction	No restriction	Not applicable to mediastinum	No restriction	No restriction
Other demerit			Injury of pharynx				

Fig. 4 Visual field obtained by ENDOCAMELEON (**a** anterior view; **b** lateral view). The eye of the ENDOCAMELEON is placed at a position close to the roof of the abdominal wall and provides a wide visual field by changing the direction of the eye, located at the end of the fixed scope, to more than 90°



2010 and March 2012. No case required conversion to open surgery. No anastomotic leakage or stenosis was observed. Mean operation time was 297.1 min (median, 300.5 min).

Discussion

The EndoStitch is a suturing device with two jaws. A sutured needle is held in one jaw that can be passed to the other jaw by closing the handles and flipping the toggle levers. The surgeon can easily sew the wall of the end of the resected esophagus from the adventitia side to the mucosal side and then from the mucosal side to the adventitia side simply by flipping the levers (Fig. 3). No special training is necessary to use this device. Ligation is completed by crossing the threads and passing the needle

from one jaw to the other through the hole of the crossed threads.

There are several tips to make purse-string suturing easy using the EndoStitch. First, we cut the esophagus using an ultrasonic cut and coagulation system before sewing the purse-string sutures, which helped to prevent bleeding from the submucosal layer. Second, the suture of the EndoStitch was cut at 17 cm. A suture that is too long twists, while using thread that is too short makes performing ligation difficult. Third, a lap-tie was placed at 16 cm on the thread of the EndoStitch, which helped to prevent thread cast-off and thus made performing ligation easier.

Several surgeons have previously reported using different approaches with circular stapler. Usui et al. [14] reported the use of an endoscopic purse-string suture instrument (EndoPSI, Hope Electronics, Chiba, Japan).

Fig. 5 Visual field obtained by a flexible scope (**a** anterior view; **b** lateral view). The eye of the flexible scope is placed at a position some distance below the roof of the abdominal wall to bend the scope, which reduced the visual field

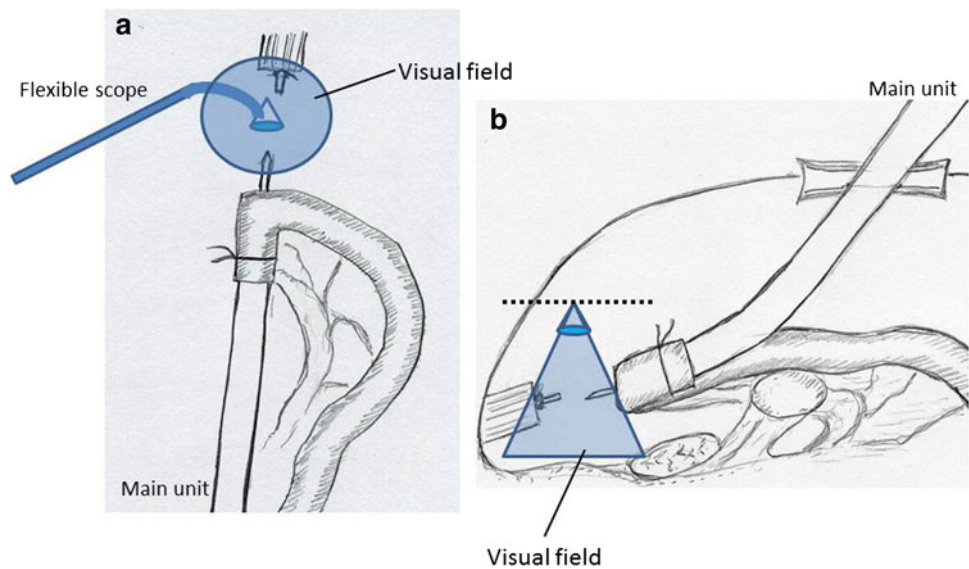
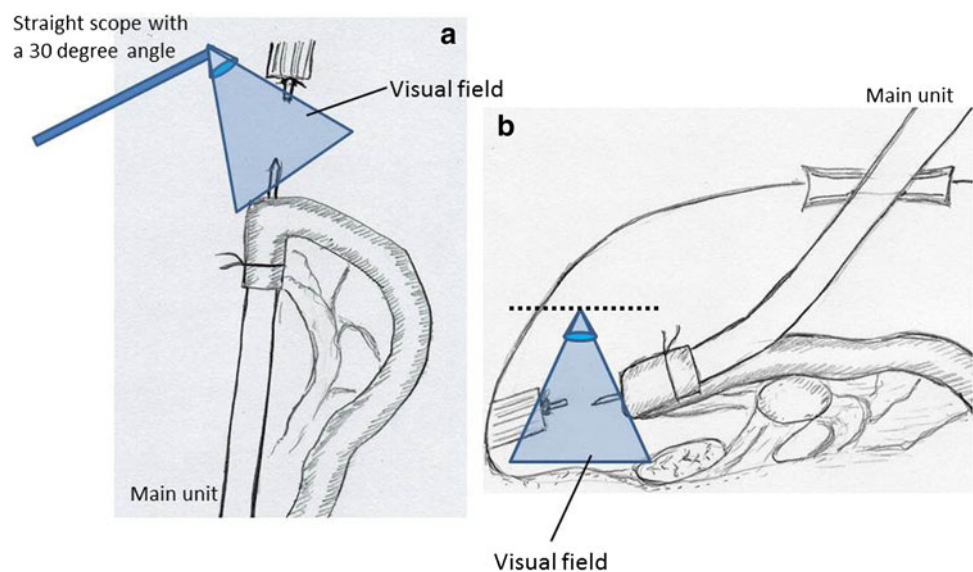


Fig. 6 Visual field obtained by a straight scope with a 30° angle (**a** anterior view; **b** lateral view). The eye of the straight scope with a 30° angle is placed at the right anterior oblique position some distance below the roof of the abdominal wall, which reduced the visual field



The anastomosis site using EndoPSI must locate just under the xiphoid because the jaw is vertically connected to the main shaft, which is one limitation associated with this method. Several different procedures for laparoscopic esophagojejunostomy are compared in Table 1. Our method using EndoStitch has the benefits that (1) no double stapling was required for anastomosis, (2) anastomosis is constructed only in the abdomen, (3) hiatus is preserved, and (4) no restriction of the anastomotic site; one demerit is that the hand-sewing technique by EndoStitch is necessary, although EndoStitch is easier than manual sewing.

In previous papers reporting the use of circular staplers, anastomosis was observed through the lateral side views [11, 12]. It would be difficult to assess rolling of the mesentery and the wall of the jejunum on the mesenteric

side into the anastomosis using this view. To obtain an adequate visual field to stretch the jejunum, we used the ENDOCAMELEON for anastomosis. The eye of the ENDOCAMELEON is attached at the end of the fixed scope; however, it moves with variable direction from 0° to 120°, allowing the surgeon to obtain an adequate view just below the fixed scope without much space (Fig. 4). In contrast, a flexible scope requires space to bend the fiberscope to obtain a view just under the scope (Fig. 5).

A straight scope with a 30° angle also does not provide enough visual field because the scope must be placed at the right anterior oblique position some distance below the roof of the abdominal wall (Fig. 6). Thus, ENDOCAMELEON provides a better visual field when esophagojejunostomy is constructed by circular stapler. Moreover, we

inserted the main unit of the curved 25 mm EEA into the jejunum with the convex part placed below by moving the jejunum toward the back side of the peritoneum, which therefore helped to create space above the main unit.

No surgical morbidity or mortality was observed in a pilot series of 20 initial cases. This method is simple and useful for laparoscopic esophagojejunostomy after total gastrectomy for gastric cancer.

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