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Modified π-shaped Esophagojejunostomy in Totally Laparoscopic Total Gastrectomy: a Report of 40 Consecutive Cases From a Single Center

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Abstract

Background: Intracorporeal esophagojejunostomy remains a challenging technique in totally laparoscopic total gastrectomy (TLTG) without established standard anastomosis method. π-shaped esophagojejunostomy in TLTG was reported to be safe and feasible. Therefore, this study aimed to depict our modified π-shaped esophagojejunostomy in TLTG and evaluate its short-term surgical outcomes.

Methods: From April 2018 to October 2019, 40 patients with gastric cancer who underwent TLTG by the same surgeon with modified π-shaped esophagojejunostomy were enrolled. Clinicopathologic data including age, gender, body mass index, American Society of Anesthesiologists score, tumor size, tumor location, depth of tumor invasion, number of harvested lymph nodes, nodal metastasis and TNM stage, operative time, estimated blood loss, time to resume diet, postoperative hospital stays, complication, and mortality were collected and retrospectively analyzed.

Results: The mean operative time and estimated blood loss were 264.6 ± 56.9 min and 68.5 ± 53.3 mL, respectively. Postoperative flatus occurred at 4.6 ± 1.7 days. The mean time to resume diet was 7.4 ± 1.7 days postoperatively. One patient was diagnosed with anastomotic leakage and managed with conservative therapy. Pleural effusion, occurring in 4 (10%) patients, was the most common complication. One patient experienced intra-abdominal bleeding requiring reoperation. Other complications were atrial fibrillation and wound infection. No mortality occurred during the 6-month follow-up.

Conclusions: Modified π-shaped esophagojejunostomy is a safe and feasible method for intracorporeal anastomosis in TLTG, which showed favorable surgical outcomes.

Background

In recent years, intracorporeal anastomosis during laparoscopic gastrectomy has been increasingly known.[1, 2] Compared with extracorporeal anastomosis, intracorporeal anastomosis has the advantage of not only reducing postoperative pain, lesser wound complication, and smaller incision but also better visual operation field during the procedure.[3] However, intracorporeal esophagojejunostomy in totally laparoscopic total gastrectomy (TLTG) is still considered technically challenging. Anastomosis with circular stapler that resembles conventional open gastrectomy is associated with advanced technical demands in complex purse-string suture and anvil placement during a laparoscopic procedure, although various methods have been introduced.[4, 5] In contrast, linear stapler has proven to be more handler-friendly with favorable clinical outcomes in safety and feasibility.[6] To date, there is still no standard esophagojejunostomy anastomosis method for TLTG using linear staplers. Ryu et al.[7] first reported π-shaped esophagojejunostomy, a simple procedure even for unexperienced surgeons. This method allows an adequate operative visualization and avoids incomplete stapling while closing the common opening, which is considered to be the most challenging procedure in laparoscopic anastomosis. Zhang et al.[8] reported 11 patients who underwent robotic total gastrectomy with π-shaped esophagojejunostomy and

achieved satisfying short-term clinical outcomes. However, evidence on safety and feasibility of this novel approach is still limited.

This study introduced our 40 consecutive patients who underwent TLTG with modified π-shaped esophagojejunostomy. We aimed to demonstrate that modified π-shaped esophagojejunostomy is a safe and feasible approach in TLTG.

Methods

Patients

A total of 40 patients with gastric cancer who underwent TLTG with modified π-shaped esophagojejunostomy between April 2018 and October 2019 in our department were enrolled in this retrospective study. Written informed consent of all patients were obtained before participation and data collection and analysis were approved by Review Board of Beijing Cancer Hospital. All patients were histologically confirmed with gastric cancer in the mid- or upper stomach. Surgeries in this study were performed by one surgeon. Demographic and clinicopathologic data including age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) score, tumor size, tumor location, depth of tumor invasion, number of harvested lymph nodes, nodal metastasis and TNM stage, operative time, estimated blood loss, time to resume diet, postoperative hospital stays, complication, and mortality were collected. All patients were followed up in the outpatient department at 1, 3, and 6 months postoperatively.

Surgical techniques

Patients were placed in supine position with legs apart. The operator stood on the left side of patients, the assistant stood opposite to the operator, and the cameraman stood between the patients' legs. A 10-mm camera port was introduced 2 cm below the umbilicus using the Veress needle or open technique. The carbon dioxide pressure was up to 13 mmHg, and then other four ports were introduced: a 10-mm trocar was inserted in the left anterior axillary line, 2–3 cm below the costal margin as a major operation port. A 5-mm trocar was inserted contralaterally as the main assistant port. Two 5-mm trocars were inserted in the right and left midclavicular lines at the umbilical level as the accessory port. A Nathanson liver retractor was placed for liver traction.

Gastric mobilization and lymph node dissection were performed laparoscopically in accordance to the Japanese Gastric Cancer treatment guidelines. The abdominal esophagus was fully mobilized for anastomosis (Fig. 1). The duodenum was intracorporeally transected 2 cm distal to the pylorus using a 60-mm linear stapler. Jejunal mesentery at 50 cm distal to the ligament of Treitz was adequately divided to avoid possible tension during esophagojejunostomy. The esophagogastric junction was constricted by a nylon band to prevent gastric content spillage and subsequently retracted downward by the assistant. A small incision was made on the right side of the abdominal esophagus. An enterotomy was created on the antimesenteric side of the jejunum 50 cm distal to the ligament of Treitz, and the cartridge fork of

stapler was inserted in the distal direction. Then, an anvil fork of stapler was introduced into the incision on the abdominal esophagus with the guidance of a nasogastric tube inserted by the circulating nurse. The stapler was maneuvered to construct a side-to-side esophagojejunostomy in an antecolic fashion (Fig. 2). The mucosal side hemorrhage of anastomosis was examined through the common opening. A 60-mm stapler was inserted via the previously made division on the jejunal mesentery. After ensuring that both the anterior and posterior sides of the common opening were completely served, the common opening closure, the esophageal division, and the jejunal division were completed in one stapling (Fig. 3). One more stapling or clipping was required in some patients during this procedure. Continuous sutures at this stapling line were added for reinforcement due to the existence of overlapped stapling and the esophagojejunostomy was accomplished (Fig. 4).

A previously formed entry hole and a small segment of the proximal jejunum were transected, and the specimen was extracted via the small laparotomy. A side-to-side jejunojejunostomy between the proximal jejunal limb and location of the jejunum 50 cm distal to the esophagojejunostomy was made. Then, the common opening of jejunojejunostomy was closed using a 60-mm stapler.

Results

The clinicopathological data of all patients are shown in Table 1. This study included 24 male and 16 female patients with the median age and BMI of 63 years and 22.8 kg/m^2, respectively. The ASA score of 2 was the most common preoperative assessment, followed by ASA score of 1. The mean tumor size and number of harvested lymph nodes was 3.5 ± 1.5 cm and 30.5, respectively. A total of 28 (70%) patients were diagnosed with cancer in the middle-third of the stomach and 12 (30%) were diagnosed with upper-third stomach cancer. Tumors invaded the mucosal layer in 13 (32.5%), submucosal layer in 5 (12.5%), proper muscle in 11 (27.5%), and serosa in 11 (27.5%) patients. A total of 20 (50%) patients were pathologically diagnosed to have no nodal metastasis, the most common finding. According to TNM stages, stage I was found to be the most common (37.5%), followed by stage II (35%) and stage III (27.5%).

Table 1
Clinicopathological characteristics of all patients

Variable	Value
Mean age (years; median)	63 (21–81)
Gender	
Male	24 (60%)
Female	16 (40%)
BMI (kg/m^2; median)	22.8
ASA score	
1	4 (10%)
2	36 (90%)
3	0
Tumor size (cm; mean ± SD)	3.5 ± 1.5
Tumor location	
Upper	12 (30%)
Middle	28 (70%)
Lower	0
Depth of tumor invasion	
T1	13 (32.5%)
T2	5 (12.5%)
T3	11 (27.5%)
T4	11 (27.5%)
No. of harvested lymph nodes (median)	30.5
Nodal metastasis	
N0	20 (50%)
N1	10 (25%)
N2	5 (12.5%)
N3	5 (12.5%)
TNM stage	

Variable	Value
I	15 (37.5%)
II	14 (35%)
III	11 (27.5%)

The surgical outcomes of patients are summarized in Table 2. The mean operative time and estimated blood loss were 264.6 ± 56.9 min and 68.5 ± 53.3 mL, respectively. On average, postoperative flatus occurred at 4.6 ± 1.7 days. Mean time to resume diet was 7.4 ± 1.7 days postoperatively. The mean postoperative hospital stays were 9.0 ± 1.3 days. One patient had anastomotic leakage of esophagojejunostomy diagnosed by upper gastrointestinal radiography. The patient did not experience any symptoms and was managed with conservative therapy. Pleural effusion, observed in 4 (10%) patients, was the most common postoperative complication. One patient had intrabdominal bleeding (bleeding in the inferior pole of the spleen), which required reoperation. Other complications were atrial fibrillation and wound infection. No anastomotic stricture was observed in the postoperative radiography. No patient died during the 6-month follow-up.

Table 2
Surgical outcomes of all patients

Variable	Value
Operative time (min; mean ± SD)	264.6 ± 56.9
Estimated blood loss (mL; mean ± SD)	68.5 ± 53.3
Time to first flatus (d; mean ± SD)	4.6 ± 1.7
Time to resume diet (d; mean ± SD)	7.4 ± 1.7
Postoperative hospital stays (d; mean ± SD)	9.0 ± 1.3
Complication	
Anastomotic leakage	1 (2.5%)
Duodenal stump leakage	0
Intraabdominal bleeding	1 (2.5%)
Luminal bleeding	0
Pancreatic fistula	0
Mechanical ileus	0
Lymphatic leakage	0
Pleural effusion	4 (10%)
Atrial fibrillation	1 (2.5%)
Wound problem	1 (2.5%)
Mortality	0

Discussion

TLTG is a widely known procedure in recent years due to its own advantages, such as better visual field, shorter operation time, and shorter hospital stay.[9–11] During the TLTG procedure, esophagojejunostomy is even more important as its complications may cause high morbidity rate and poor prognosis.[12] In this study, a modified π-shaped esophagojejunostomy has been used to complete this procedure, showing esophagojejunal anastomosis-related complications as 2.5%, which is comparable to that of previous published studies,[9, 13, 14] initially proving the safety of this procedure.

In esophagojejunostomy using the linear stapler, overlap and functional method were the two major approaches.[15, 16] Several studies have shown that the esophagojejunal anastomotic complication ranged from 0 to 6.45% in the functional method,[17, 18] whereas few reports have illustrated the use of the overlap method.[19, 20] In our perspective, modified π-shaped anastomosis, an alternative form of the

functional method, has its own advantages theoretically. First, during the common entry hole closure, hand-sewing technique was usually practiced in overlap method, which may result not only in the increasing risk of anastomotic leakage and bleeding but also extend the learning curve. In modified π-shaped anastomosis, after closing the common entry using linear staplers, several additional sutures were added at the stapling line to prevent minor bleeding and potential leakage due to overlapped stapling. Second, the functional method or the original π-shaped anastomosis results in kinking or narrowing of the lifted efferent loop just below the anastomotic site, which may result in increased incidence of esophagojejunal anastomotic stricture. In our modified approach, the jejunal mesentery at 50 cm distal to the ligament of Treitz was adequately divided to prevent possible tension during esophagojejunostomy, thus avoiding possible anastomotic stricture. Besides, adequate mesentery division can also ensure a tension-free anastomosis to prevent possible leakage.

In our study, the operative time was 264.6 ± 56.9 min, which is slightly longer than that of previously published studies,[13, 21, 22] mainly because dividing the jejunal mesentery is time consuming. Besides, the estimated blood loss, postoperative flatus, and postoperative hospital stays were all comparable to that of the above-mentioned previous studies, which also initially proved that this approach is feasible. Anastomotic stenosis is a common complication in esophagojejunal anastomosis, especially when using a circular stapler. In our modified π-shaped anastomosis, 60-mm linear stapler was used both for the anastomosis and common entry hole closure as in the traditional π-shaped anastomosis.[7] This procedure can prevent the stenosis maximally, which was also confirmed in our findings that no stenosis was observed in postoperative radiography. Several studies have also reported that surgeon's experiences is also an important factor in the incidence of complications.[23–25] In this study, only one well-experienced surgeon with similar surgical team performed surgeries for all 40 patients. This quality control may be a possible reason for the low incidence of complications, especially for esophagojejunal anastomotic complications. Based on this viewpoint, we recommend that the surgeon and the surgical team who perform this approach should be well experienced.

However, this approach also has some drawbacks. First, the division of jejunal mesentery in some patients with high BMI are difficult and inefficient. Second, jejunal mesenteric division may result in inadequate blood supply at the proximal part of the division area, i.e., the anastomotic site in the next step. The application of indocyanine green injection to examine the blood supply in the jejunal loop may help prevent this situation.[26, 27]

This study also has limitations associated with its retrospective, small-volume, and single-arm design. Well-designed studies are needed to confirm the application of this approach in TLTG in the future.

Conclusions

Modified π-shaped esophagojejunostomy is safe and feasible for intracorporeal anastomosis in TLTG with favorable short-term clinical outcomes.

Abbreviations

TLTG: totally laparoscopic total gastrectomy

BMI: body mass index

ASA: American Society of Anesthesiologists

Declarations

Ethics approval and consent to participate

This study was approved by the Review Board of Beijing Cancer Hospital (2020KT61), and the procedures were in accordance with the Helsinki Declaration. Written informed consent forms about the procedure were obtained for all patients preoperatively.

Consent for publication

Not applicable

Availability of data and materials

All the data are available without restriction. The data can be obtained by contacting with the corresponding author.

Competing interests

None.

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Authors' contributions

XS designed the study. JX, KX, ML, MC, CZ, HY, ZY and NZ performed the data collection and analysis. KX and PG accomplished the statistical analysis and data explanation. JDX and FT prepared the manuscript. All the authors have read and approved the final manuscript.

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Figures

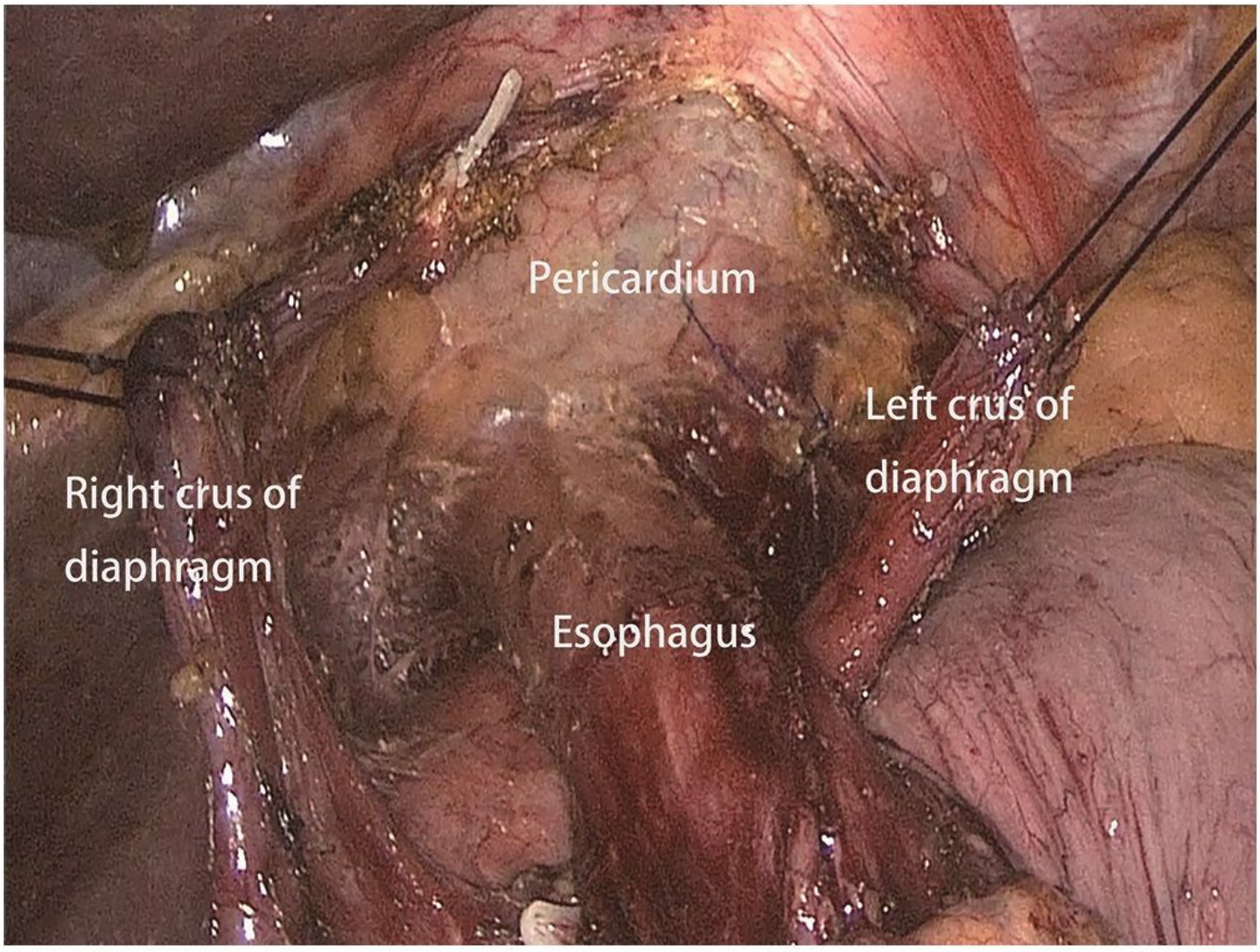

Figure 1

The abdominal esophagus was adequately detached from the surrounding tissues for esophagojejunostomy.

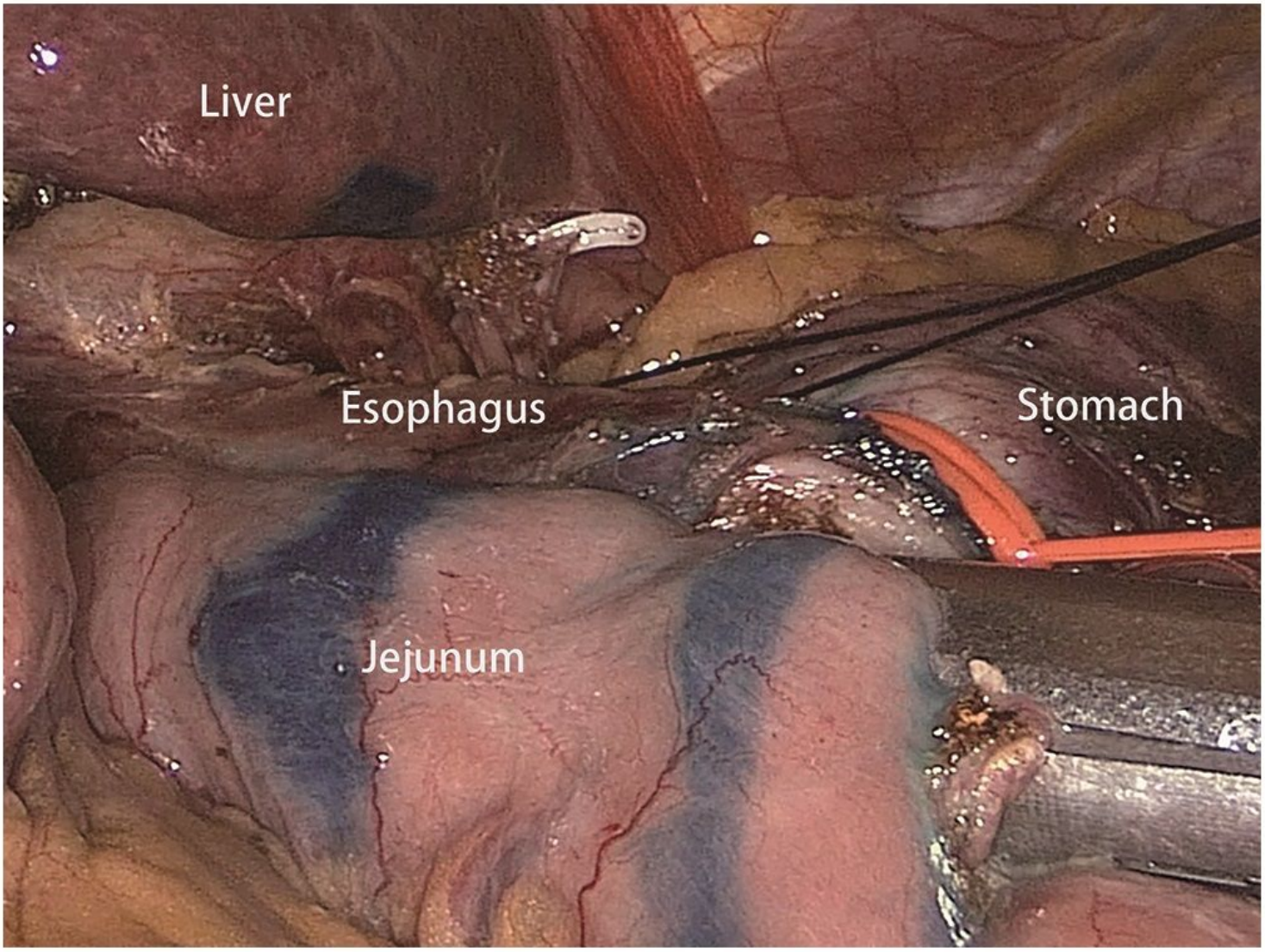

Figure 2

A side-to-side esophagojejunostomy was formed using a 60-mm stapler.

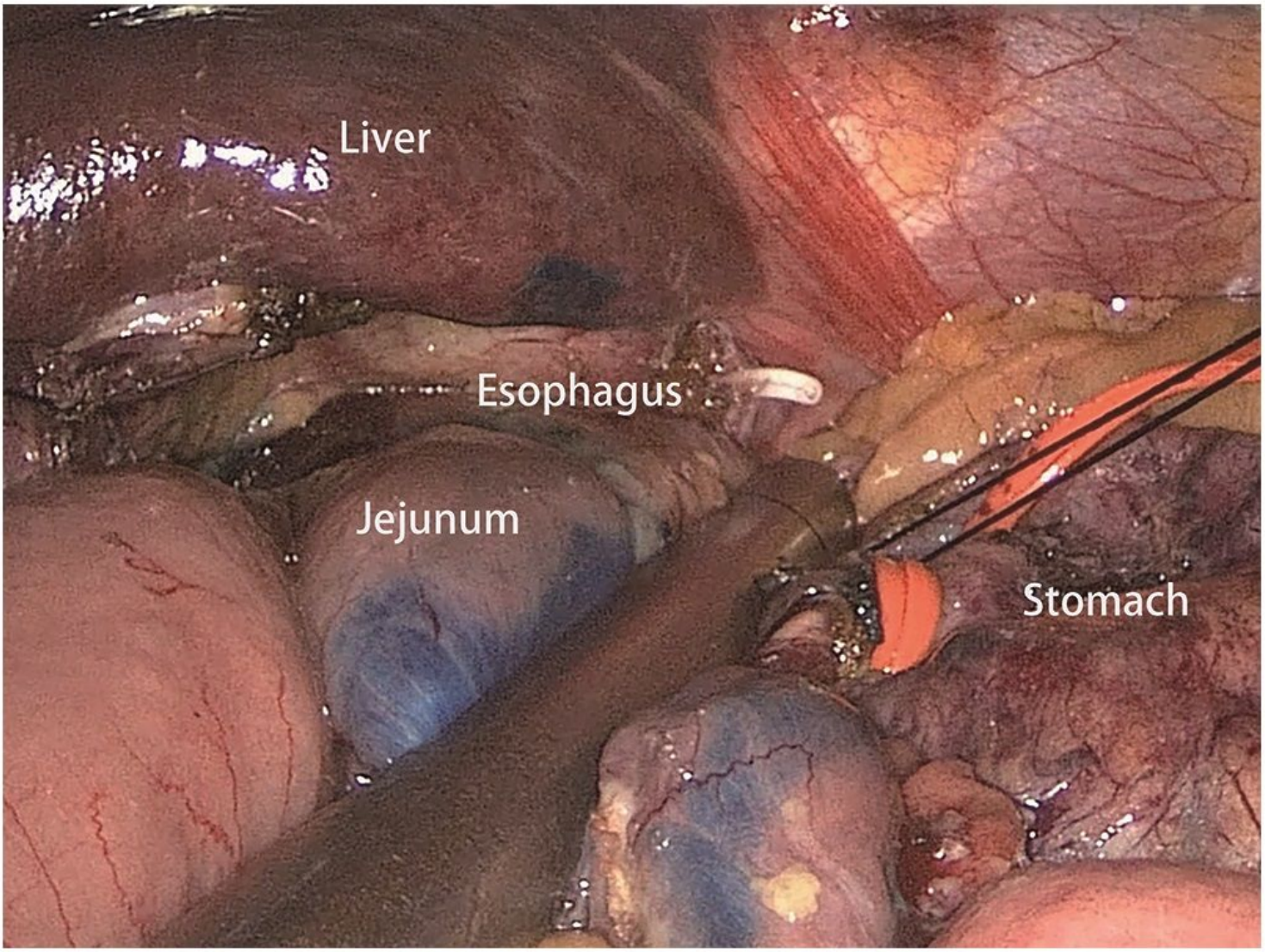

Figure 3

The common opening was closed using a linear stapler and the division of esophagus and jejunum was completed at the same stapling.

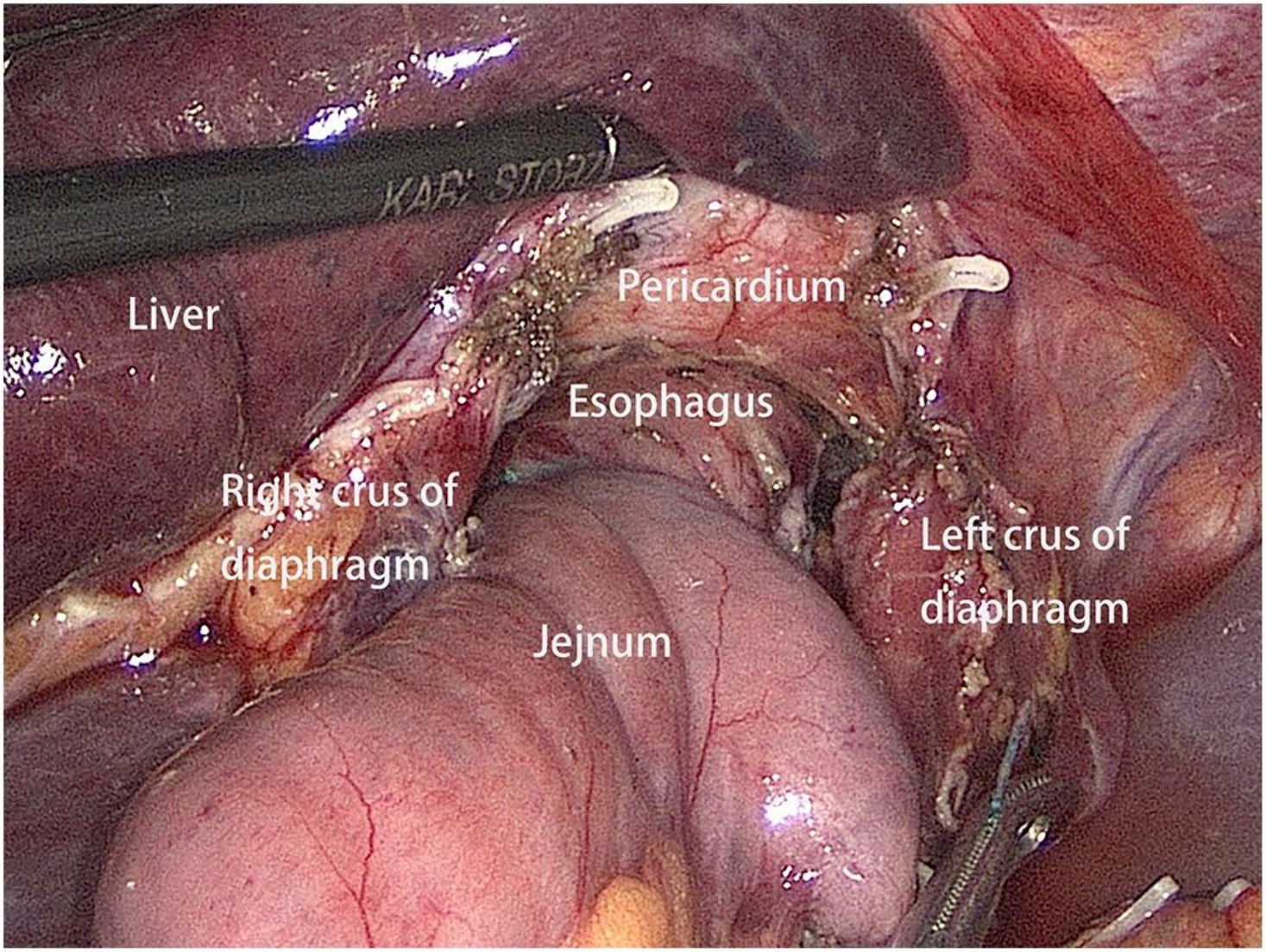

Figure 4

The actual anastomosis after esophagojejunostomy.