8 Reconstruction of the Digestive Tract After Laparoscopic Gastrectomy for Gastric Cancer

Reconstruction of the digestive tract after laparoscopic gastrectomy for gastric cancer is an important aspect of clinical efficacy, which concerns postoperative recovery and quality of life. With prolonged survival of patients with gastric cancer, the postoperative quality of life deserves more attention. Researchers have paid increasing attention to reconstruction methods. As a result of the widespread application of laparoscopic techniques, reconstruction of the digestive tract after laparoscopic gastrectomy has become a research focus in surgery.

8.1 Outline of Reconstruction After Laparoscopic Radical Gastrectomy

8.1.1 Reconstruction Approach After Laparoscopic Gastrectomy

Laparoscopic gastrectomy is superior to conventional open gastrectomy because it is less invasive, which may lead to smaller wounds, faster recovery, fewer complications, and better cosmetic results. In addition, better clinical efficacy is achieved [1–4]. Currently, reconstruction of the digestive tract following laparoscopic gastrectomy is mostly divided into two categories: laparoscopy-assisted reconstruction and totally laparoscopic reconstruction. With laparoscopy-assisted gastrectomy (LAG), mobilization of the digestive tract, vascular ligation, and lymph node dissection are performed laparoscopically, while resection of the specimen and reconstruction of the digestive tract are performed under direct view through a minilaparotomy made on the epigastrium. The resected specimen mostly has to be removed via the minilaparotomy made on the epigastrium. Furthermore, the anastomosis can be performed with less difficulty, shorter operating time, and lower cost when surgery is performed through minilaparotomy, and this is a safe and feasible method. Thus, LAG has become a common approach in laparoscopic surgery.

Laparoscopic techniques were developed to achieve a radical cure with minimal invasion and to improve postoperative quality of life. Compared with LAG, totally laparoscopic gastrectomy (TLG) is considered to be more minimally invasive and has several superiorities in vision and tension, particularly for obese patients. Therefore, researches on the application of TLG have never stopped.

In 1996, Ballesta-Lopez et al. first reported Billroth-II anastomosis in totally laparoscopic distal gastrectomy (TLDG) for gastric cancer [5]. Uyama et al. first described totally laparoscopic side-to-side esophagojejunostomy after total gastrectomy in 1999 [6]. A method for intracorporeal Billroth-I anastomosis, called delta-shaped gastroduodenostomy (DSG) and using only endoscopic linear staplers, was first reported in 2002 by Kanaya et al. [7]. In 2005, Takaofi et al. proposed

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a secure technique of intracorporeal Roux-Y reconstruction after laparoscopic distal gastrectomy using linear staplers [8]. Intracorporeal circular stapling esophagojejunostomy using the transorally inserted anvil (OrVil™; Covidien) after laparoscopic total gastrectomy was reported in 2009 by Jeong et al. [9]. With improvements of surgical skills and dedicated intracorporeal devices, such as linear staplers and ultrasonic scalpels, Billroth-I, Billroth-II, and Roux-en-Y reconstruction, which are usually performed by open surgery, can all be performed laparoscopically.

8.1.2 Technical Tips of Reconstruction After Laparoscopic Radical Gastrectomy

8.1.2.1 Pay Attention to Operational Details and Avoid Unnecessary Injury

The details should be noted during the operation to avoid rework or contamination of the operating field, thus avoiding unnecessary trauma. For example, the gastric tube set up before surgery should be positioned at the appropriate location before anastomosis to prevent it being severed by the linear stapler. The specimen should be placed in a plastic specimen bag to ensure aseptic and tumor-free conditions. The principle of aseptic technique should be followed during making incisions in the digestive tract, and the digestive juice can be aspirated clearly using an aspirator inserted into the incisions before anastomosis.

8.1.2.2 Ensure Quality of the Anastomosis and Reduce the Postoperative Complications

At present, anastomosis-related complications mainly include anastomotic leakage, hemorrhage, and stenosis. Adequate blood supply to the tension-free anastomosis is the key to prevention of anastomotic leakage. However, the formation of scar tissues after healing of the intestinal wall or too much stitching is a common cause of anastomotic stenosis. With respect to the prevention of anastomotic hemorrhage, a common stab incision is created during anastomosis using a linear stapler; the anastomosis should be checked for bleeding or mucosal damage via the common stab incision. After anastomosis, the integrity of the stapler nails should be checked, including whether the anastomotic stoma and resected tissue are a complete circle in the circular stapler. If the anastomosis is not satisfactory or there is oozing of the blood, manual sutures can be added for reinforcement. The surgeon must carefully operate step-by-step to ensure that each stage in the anastomosis is practical and reliable. Thus, better postoperative quality of life can be achieved.

8.1.2.3 Familiarity with Instruments' Use to Reduce Trauma

A variety of instruments are needed to assist in the completion of totally laparoscopic reconstruction of the digestive tract, so it is necessary to be familiar with the performance of all kinds of laparoscopic instruments and techniques to avoid trauma from the instruments themselves. In the process of using the instruments, the following points should be noted: (1) cartilage-type staplers should be adapted to the thickness of the tissue; (2) the diameter of the stapler should be adapted to the diameter of the intestinal canal; (3) the gastric tube should be pulled out before firing the stapler, and overall inspection should be conducted to make the anastomosis site appropriate and prevent the stapler from clamping other structures; (4) after firing the stapler, the handle should be firmly squeezed for >15 s to expel the interstitial fluid, thus achieving a better stapling result; (5) the stapler should be fired completely, therefore, and the firing shaft will touch the closing shaft to stop the stapler from mistakenly firing or locking; and (6) during transection of specific positions such as the duodenum, the flexible stapler can be used to facilitate operation, and at this moment, the jaws should be opened because the stapler cannot bend at the tip if the jaws are closed.

8.2 Reconstruction of the Digestive Tract After LAG

Laparoscopy-assisted distal gastrectomy (LADG) is the earliest laparoscopic procedure in the field of gastric surgery. Currently, this procedure has been the most commonly performed for gastric cancer. With the increasing incidence of proximal gastric cancer and application of laparoscopic techniques for treatment of advanced gastric cancer, laparoscopy-assisted total gastrectomy (LATG) has gradually become popular. Here, we introduce Billroth-I anastomosis in LADG and Roux-en-Y anastomosis in LATG.

8.2.1 Technical Tips of Billroth-I Anastomosis in LADG

Mobilization of the stomach and lymph node dissection should be carried out completely by laparoscopy to prepare for successful reconstruction of the digestive tract through minilaparotomy. One should try to avoid other redundant operations through the minilaparotomy.

After the distal stomach is freed and the lymph nodes (LNs) are dissected, the intra-abdominal gas is expelled from the trocar, and the laparoscopic instruments are removed. A 5–7-cm midline incision below the xiphoid is made in the epigastrium as an accessory incision. The abdominal cavity is entered layer-by-layer, and the wound protector is placed in position. After complete retrieval of the duodenum from the abdominal cavity, a purse-string clamp is applied to the duodenum 3 cm distal to the pylorus. A Kocher clamp is applied just proximal to the purse-string clamp, and the duodenum is transected between the two clamps. The anvil of a disposable 28- or 29-mm circle stapler is inserted into the disinfected duodenal stump (Fig. 8.1), and a purse-string suture is tied over the anvil. Gastrotomy is performed on the anterior wall 5 cm away from the tumor edge and the shaft of the circular stapler is introduced into the stomach through the gastrotomy. The center rod of the stapler is advanced to penetrate the posterior wall at the greater curvature side of the stomach (Fig. 8.2) and then connected to the anvil placed in the duodenal stump, completing the end-to-side gastroduodenostomy between the duodenal stump and the gastric posterior wall (Fig. 8.3). After checking and

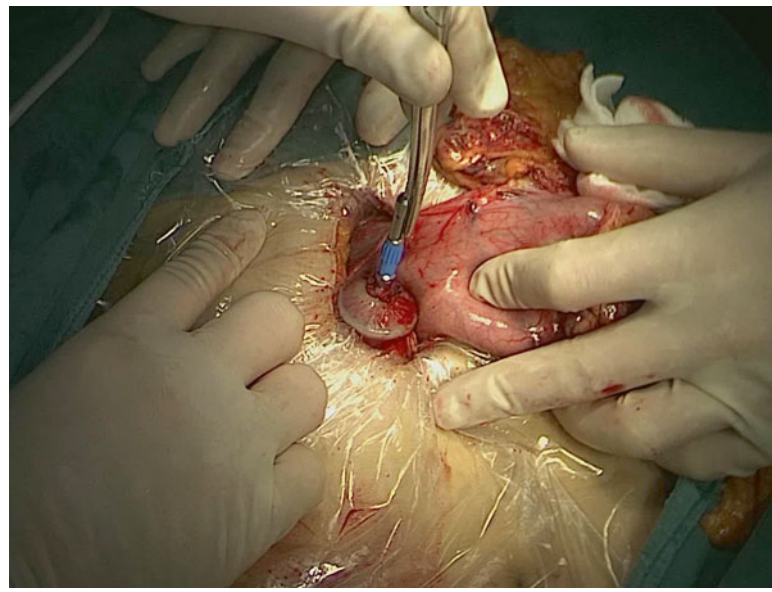

Fig. 8.1 The anvil of a disposable circle stapler is inserted into the duodenal stump

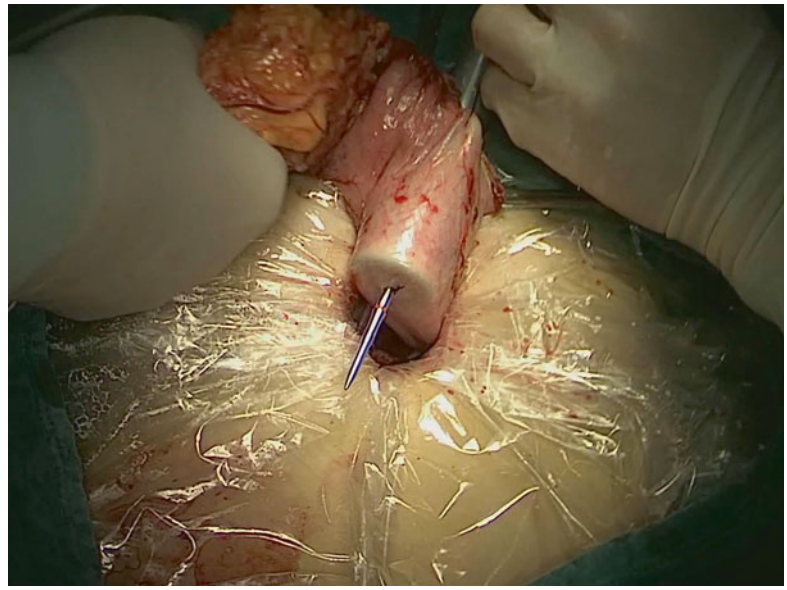

Fig. 8.2 The center rod of the stapler is advanced to penetrate the posterior wall at the greater curvature side of the stomach

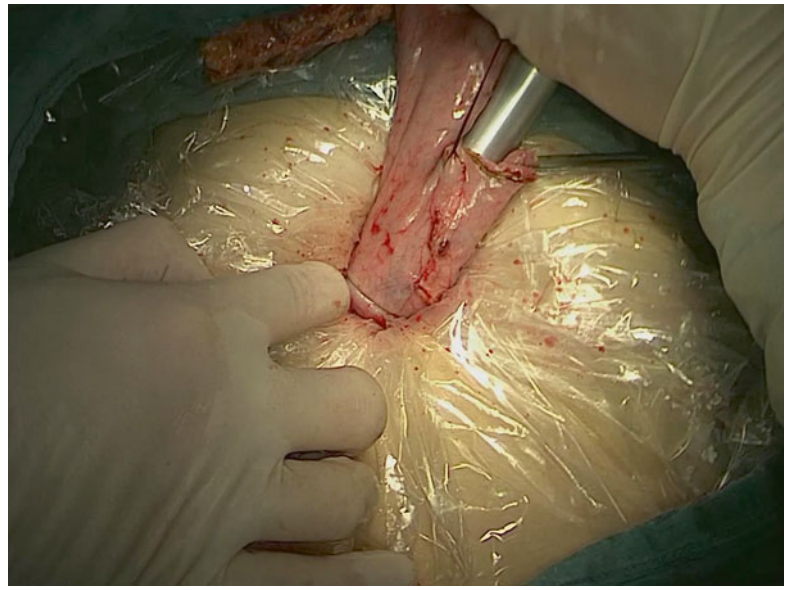

Fig. 8.3 The end-to-side gastroduodenostomy is performed

confirming the quality of the anastomosis through the gastrotomy under direct view, the stomach is closed 5 cm away from the tumor edge using the extracorporeal linear stapler (Fig. 8.4). The resected distal gastric specimen is sent for histopathological examination. Thus, Billroth-I reconstruction is accomplished (Fig. 8.5). Although the visual field and working space are narrow during laparoscopy-assisted reconstruction, every step of the procedure should be completed under direct view, which avoids iatrogenic injury or uncertain anastomosis caused by blind operation.

8.2.2 Technical Tips of Roux-en-Y Anastomosis in LATG

After completing lymph node dissection and mobilization of the stomach laparoscopically, the duodenal bulb is transected 3 cm distal to the

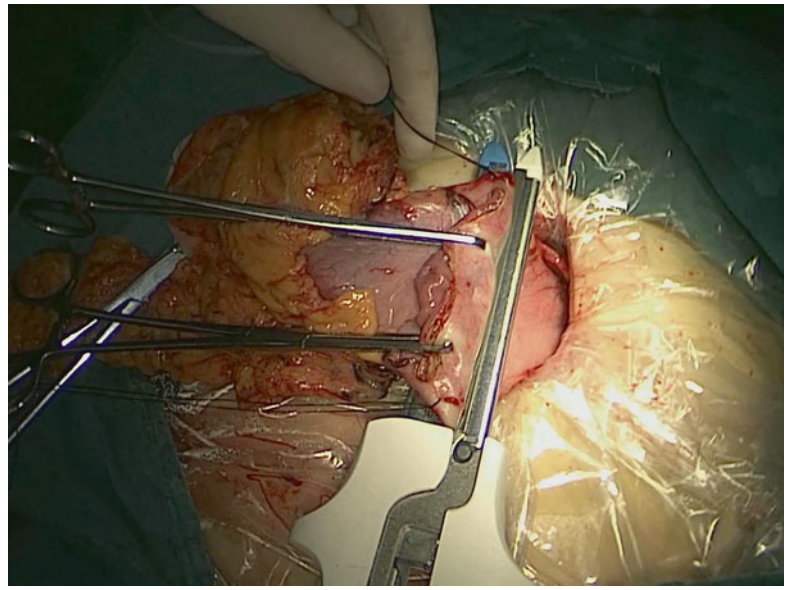

Fig. 8.4 The anterior and posterior walls of the stomach are closed 5 cm away from the tumor edge using the extracorporeal linear stapler

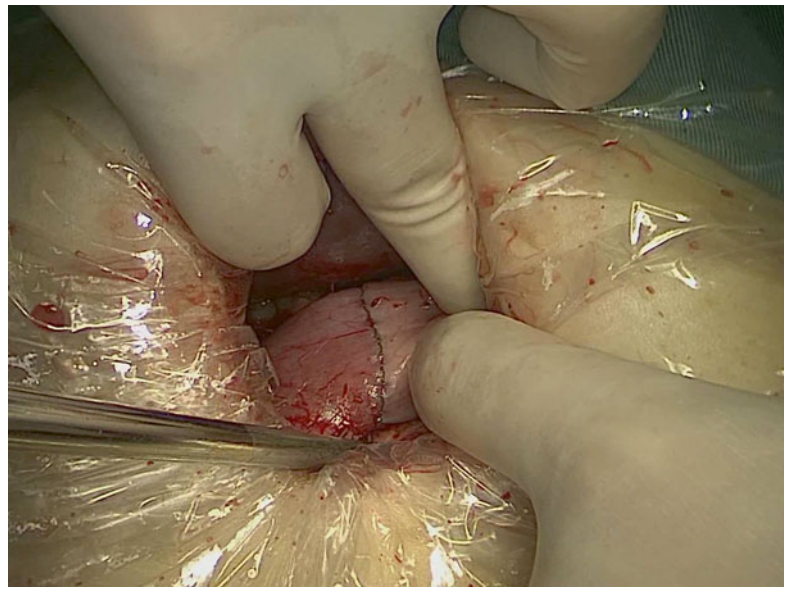

Fig. 8.5 Billroth-I reconstruction is accomplished

pylorus using the intracorporeal linear stapler, and the duodenal stump is closed. The laparoscopic instruments are removed, and a 5–7-cm upper midline abdominal incision below the xiphoid is made as an accessory incision. The abdominal cavity is entered layer-by-layer, and the wound protector is placed in position. A purse-string clamp is applied to the distal esophagus 5 cm away from the cardia and the esophagus is transected. Thereafter, a purse-string suture is placed in the disinfected esophageal stump. Once the frozen section confirms negative margins, the anvil of a disposable 25-mm circular stapler is inserted into the esophageal stump (Fig. 8.6), and the purse-string suture is tied over the anvil. The entire gastric specimen is delivered out through the minilaparotomy. The jejunum and the mesentery are cut off 15–20 cm distal to the ligament of Treitz. The body of the circular stapler is inserted into the distal limb of the jejunum, and this section

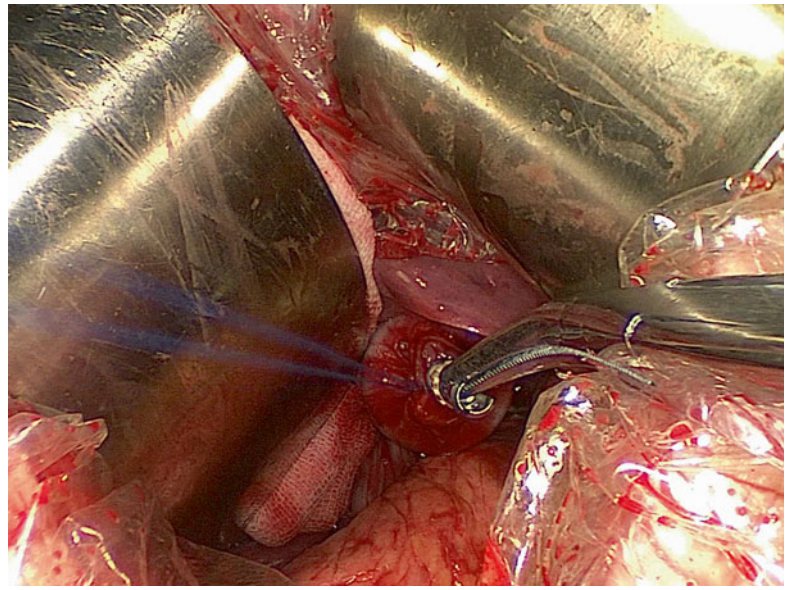

Fig. 8.6 The anvil of a disposable 25-mm circular stapler is inserted into the esophageal stump

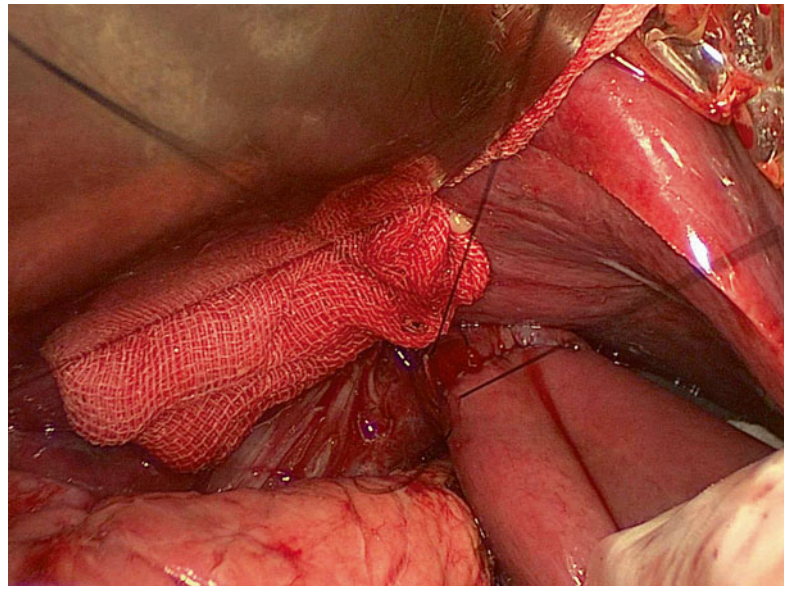

Fig. 8.7 The end-to-side esophagojejunostomy is performed

of jejunum is brought up in antecolic fashion to meet the lower end of the esophagus, creating the end-to-side esophagojejunostomy with the jejunum configured in a "J" fashion (Fig. 8.7). The stumps of distal and proximal jejunum are closed respectively using the linear stapler. A side-to-side jejunojejunostomy is performed 40 cm distal to the J-shaped anastomosis under direct view using a linear stapler or hand-sewn suture (Fig. 8.8). The proximal and distal end of the mesojejunum should not be reversed and the mesentery should be maintained without tension, to prevent improperly clamping the surrounding tissues and foreign object. The cutting edge of mesojejunum can then be closed to accomplish the entire procedure of reconstruction.

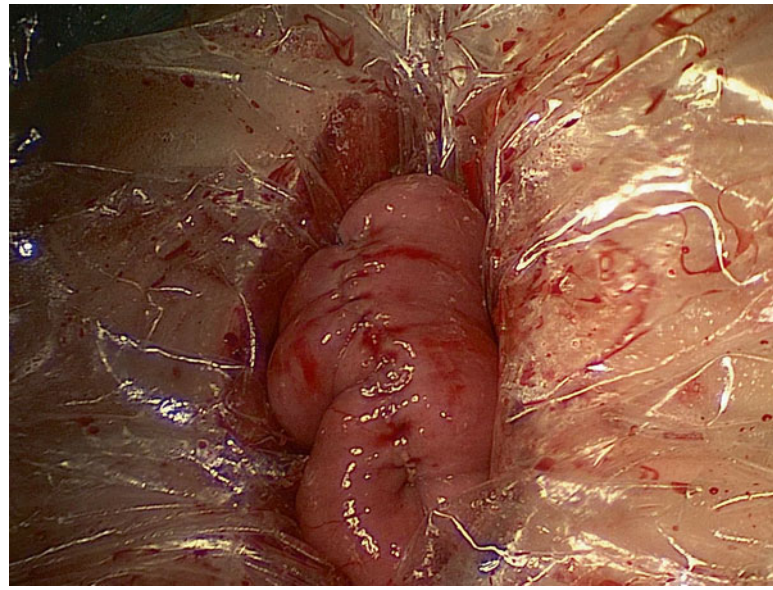

Fig. 8.8 The side-to-side jejunojejunostomy is accomplished

8.3 Reconstruction of the Digestive Tract After TLG for Gastric Cancer

8.3.1 Characteristics of Reconstruction After TLG

8.3.1.1 Superiorities of TLG for Gastric Cancer

Surgical treatment of gastric cancer has improved as a result of the emergence of reconstruction after TLG. The superiority of laparoscopic reconstruction is related to its smaller incisions and less touch and surgical trauma. Related reports indicate that TLG has several advantages over LAG in terms of short-term outcomes, such as less intraoperative blood loss, smaller wounds, earlier recovery of gastrointestinal function with time to first flatus shortened, and shorter hospital stay [1, 10–13]. The operating time is shorter because of accumulated surgical experience [14, 15]. There are no significant differences between TLG and other procedures [10, 11]. In terms of perioperative and long-term complications, TLG does not increase the incidence of major complications (e.g., hemorrhage, anastomotic leakage, and stump leakage) and minor complications (e.g., incision infection and lymphatic leakage) [10, 16–20]. The superiority of TLG for obese patients is also supported by results from multicenter studies. The advantages of TLG mainly include more convenient anastomosis, better visualization, and better quality of life [16, 21, 22]. Additionally, TLG ensures adherence to the principals of tumor resection, such as the no-touch technique and no extrusion. Stomach resection and anastomosis are performed in situ, which reduces anastomotic trauma and additional pulling on the remnant stomach. Therefore, laparoscopic surgeons are increasingly focusing on reconstruction of digestive tract in total laparoscopy.

8.3.1.2 Influence of the Staplers for Anastomosis on Laparoscopic Reconstruction of the Digestive Tract

The widespread application of laparoscopic appliances has become an indispensable factor in the advancement of laparoscopic surgery for gastric cancer. Continuous improvement of the staplers for anastomosis has simplified reconstruction of the digestive tract, and the time for anastomosis has been shortened. Anastomosis using staplers, which is technically safe and feasible, has similar results and complication rates to anastomosis

using hand-sewn sutures. Furthermore, in TLG, the application of the staplers has shortened the time for anastomosis. The complex operative manipulations due to the difficult exposure and limited work space are also made easier. Laparoscopic anastomosis is simplified, and the contamination of the abdominal cavity and the surgical trauma are reduced, which improves the efficacy of surgical treatment. Novel stapler production offers new techniques for laparoscopic reconstruction, for example, the transorally inserted anvil (OrVil™) is used in esophagojejunostomy for Roux-en-Y anastomosis after laparoscopic total gastrectomy. Anastomosis using staplers has the following advantages: (1) small vessels can pass through the intervals between the staplers, so as not to affect the blood supply of the anastomotic site and its distal end; (2) the stapler is made of titanium or tantalum; therefore, tissue reactions are reduced compared with hand-sewn anastomosis; and (3) the staplers are neatly arranged at equal intervals, which ensures good tissue healing.

8.3.2 Indications for Totally Laparoscopic Reconstruction of the Digestive Tract

Reconstruction of the digestive tract should be performed within a certain distance of the normal tissues. The normal tissues at a certain distance from the proximal or distal border of the tumor must be resected according to tumor location and TNM staging. Preoperative laparoscopic exploration is performed first to confirm the tumor site. Patients with T4b tumor, peritoneal implantation, or liver metastasis should be excluded. If it is difficult to identify the tumor site in early tumors during total laparoscopy, intraoperative gastroscopy can be used for accurate positioning to ensure R0 resection of the tumor. Transection of the duodenum, stomach, or esophagus should ensure not only R0 tumor resection but also appropriate anastomotic tension. The resected margins should be confirmed as tumor free, and the margin of the removed specimen must be sent for frozen section analysis prior to proceeding with anastomosis.

8.3.2.1 Reconstruction of the Digestive Tract After Distal Gastrectomy

The delta-shaped Billroth-I anastomosis may be more suitable for patients diagnosed with early primary distal gastric cancer, whereas it may be used for clinical investigation in patients with locally advanced gastric cancer [23, 24]. When a tumor has invaded the pyloric canal or duodenum, Billroth-II anastomosis can be performed to achieve R0 resection [25]. In distal gastrectomy, two-thirds to three-quarters of the distal stomach should be resected, including the distal gastric body, antrum, pylorus, and proximal duodenal bulb. The line between the right side of the first descending branch of the left gastric artery (LGA) and the left side of the lowest vertical branch of the left gastroepiploic artery (LGEA) can be used to mark the extent of gastric resection. The greater curvature of the stomach should be denuded, preserving two to three branches of short gastric arteries and the posterior gastric artery (SGAs and PGA) to ensure the blood supply for the remnant stomach, reduce the anastomotic tension, and facilitate anvil of the linear stapler insertion.

8.3.2.2 Reconstruction of Digestive Tract After Total Gastrectomy

Laparoscopic total gastrectomy with functional end-to-end esophagojejunostomy is more suitable for patients with non-cardia upper or middle gastric cancer. Laparoscopic total gastrectomy can also be performed for patients with early cardial cancer or localized cardial cancer invading the abdominal esophagus <1–2 cm, with the secure cutting line of the esophagus under the esophageal hiatus [26]. Anastomosis using OrVil™ is appropriate for patients with laparoscopically resectable early proximal gastric carcinoma, which invades the distal esophagus within 3 cm above the gastroesophageal junction (visualized by preoperative X-ray barium meal) and has no obvious external invasion in the preoperative evaluation of the tumor [27]. For patients with a tumor of the non-cardia proximal stomach or gastric body, only the abdominal esophagus should be freed. When the tumor is located at the cardia or

invades the distal esophagus, it must be removed. The esophageal hiatus can be adequately extended by incising the diaphragm at the vault of the esophageal hiatus 4–5 cm in the ventral direction. The left triangular ligament can be severed to facilitate the exposure. The middle to lower part of the crus of the diaphragm is transected on both sides, and the pleura is pushed toward both sides to extend fully the space of the posterior mediastinum; thus, the jejunum can be sent into the posterior mediastinum for anastomosis with the esophagus.

8.3.3 Procedures of Reconstruction After TLG

Currently, there are a variety of reconstruction methods after TLG for gastric cancer, including Billroth-I anastomosis, Billroth-II anastomosis, and Roux-en-Y reconstruction after TLDG, and functional side-to-side esophagojejunostomy, OrVil™-assisted anastomosis, and overlap anastomosis after totally laparoscopic total gastrectomy (TLTG). Here, the more mature techniques of delta-shaped Billroth-I anastomosis and Billroth-II anastomosis after TLDG, functional side-to-side esophagojejunostomy, and OrVil™-assisted anastomosis after TLTG are described. The patient's position, surgeons' locations, and location of trocars are identical to those during the process of lymph node dissection (described in Chap. 3).

8.3.4 Delta-Shaped Billroth-I Anastomosis After TLDG

8.3.4.1 Anastomosis Method

The DSG is a functional end-to-end anastomosis between the posterior wall of the stomach and that of the duodenal bulb, using endoscopic linear staplers. The anastomosis is finished with an internal delta-shaped stapling line, hence the name. DSG after LDG has been widely performed and yielded good therapeutic efficacy since it was first reported by Kanaya et al. in 2002.

8.3.4.2 Technical Tips

After completing laparoscopic lymph node dissection, a linear stapler is inserted through the left upper major trocar, positioned across the duodenum vertical to the long axis in the predetermined position, and fired to transect the duodenum by rotating 90° from back to front (Fig. 8.9). The stomach is resected from the greater to the lesser curvature with two staplers

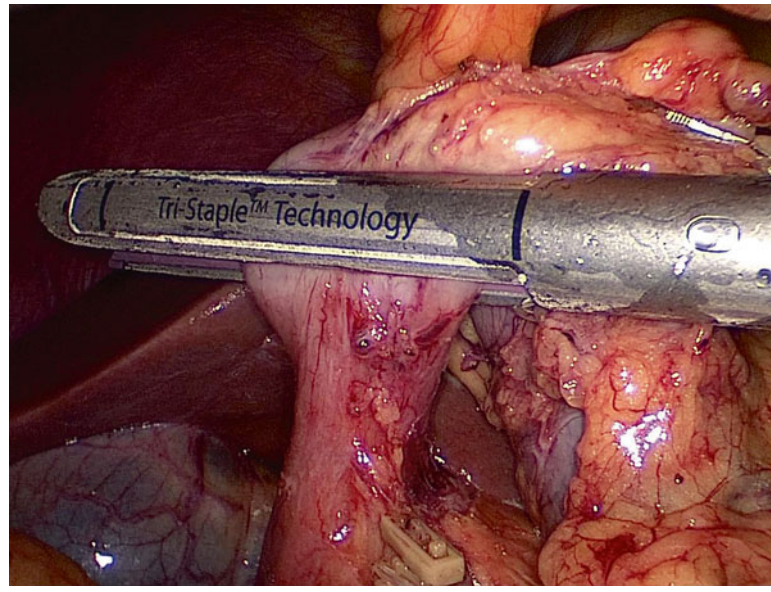

Fig. 8.9 The duodenum is transected using a linear stapler

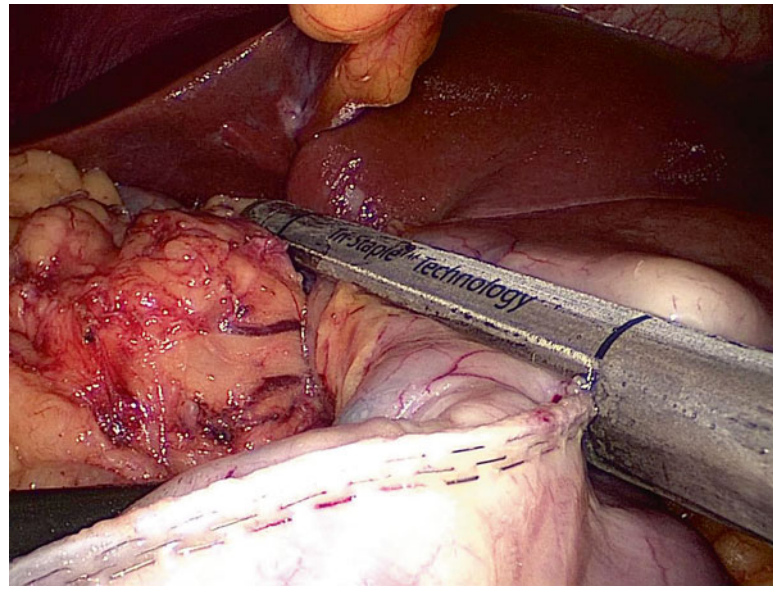

Fig. 8.10 The stomach is resected using the linear stapler

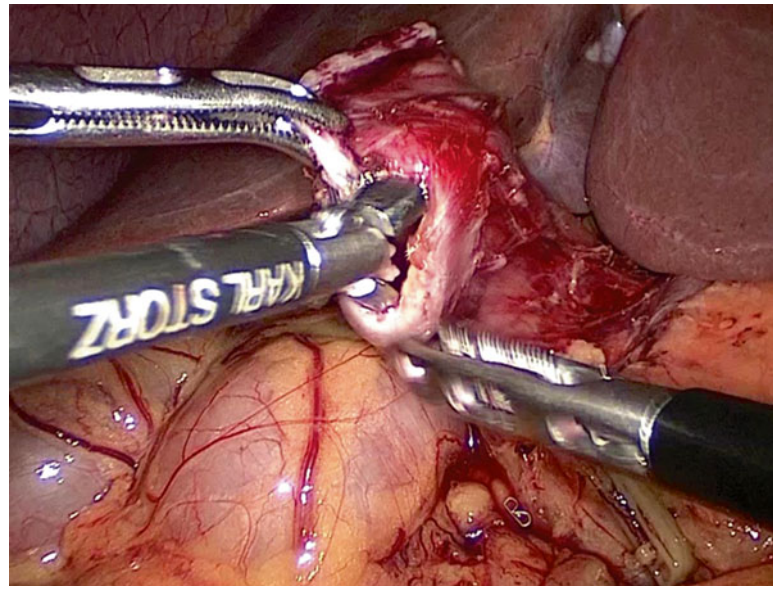

Fig. 8.11 A small incision is created on the posterior side of the duodenum

(Fig. 8.10). The specimen is placed in a plastic bag, and small incisions are created on the greater curvature side of the remnant stomach and the posterior side of the duodenum (Figs. 8.11 and 8.12). Due to the greater mobility of the stomach, one limb of the stapler is first inserted into the incision on the greater curvature side of the remnant stomach, and the predetermined anastomotic site on the posterior wall should be 2 cm away from the cutting edge. Another limb of the stapler is positioned on the posterior side of the duodenum, and the cutting edge of the duodenum is rotated 90° in the anticlockwise direction. The posterior side of the duodenum is anastomosed to the remnant stomach (Fig. 8.13). After confirming the quality of the anastomosis via the common stab incision (Fig. 8.14), three sutures are added to each end of the common stab incision

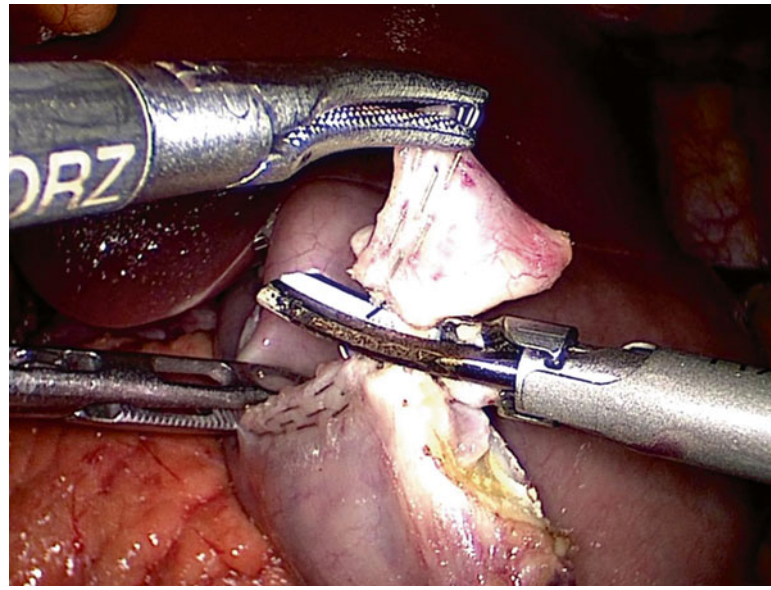

Fig. 8.12 A small incision is created on the greater curvature side of the remnant stomach

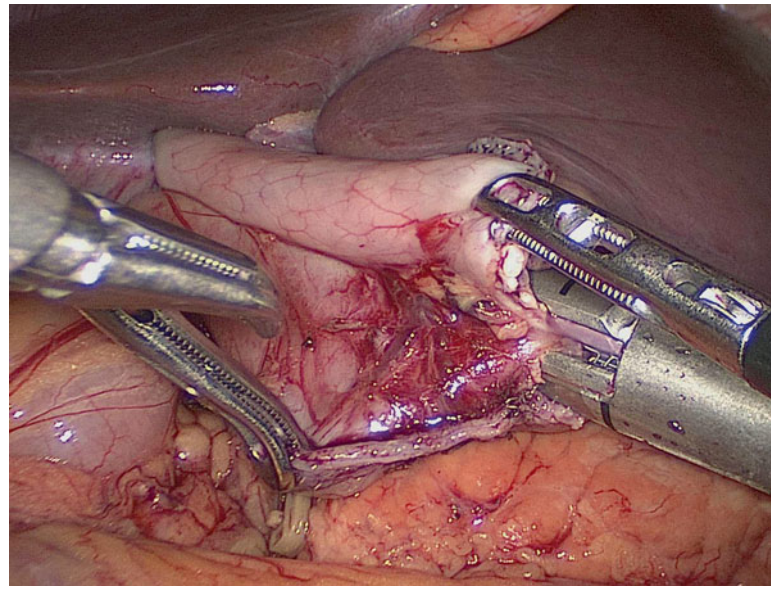

Fig. 8.13 The posterior side of the duodenum is anastomosed to the remnant stomach using the linear stapler

and to the cutting edges of the stomach and duodenum to obtain a better involution and pull (Fig. 8.15). Finally, the common stab incision is closed with the stapler (Fig. 8.16), resulting in the conventional DSG (Fig. 8.17). The trocar incision below the umbilicus is enlarged to 3 cm to remove the specimen.

However, this conventional method contains a duodenal blind side and two intersections of the cutting edge of the remnant stomach with the duodenum and common closed edge. In theory, there will be three weak points (Fig. 8.18), which may increase the risk of anastomosis-related complications. Therefore, we have modified the conventional DSG procedure to improve its safety [28, 29]. The duodenal cutting edge is completely resected, and the intersection of the duodenal cutting edge and the common closed edge is resected

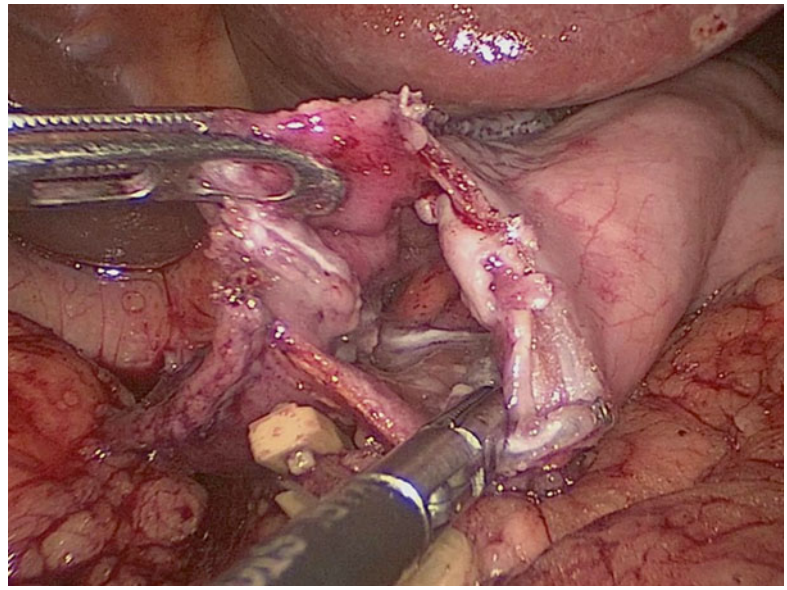

Fig. 8.14 Check the common stab incision

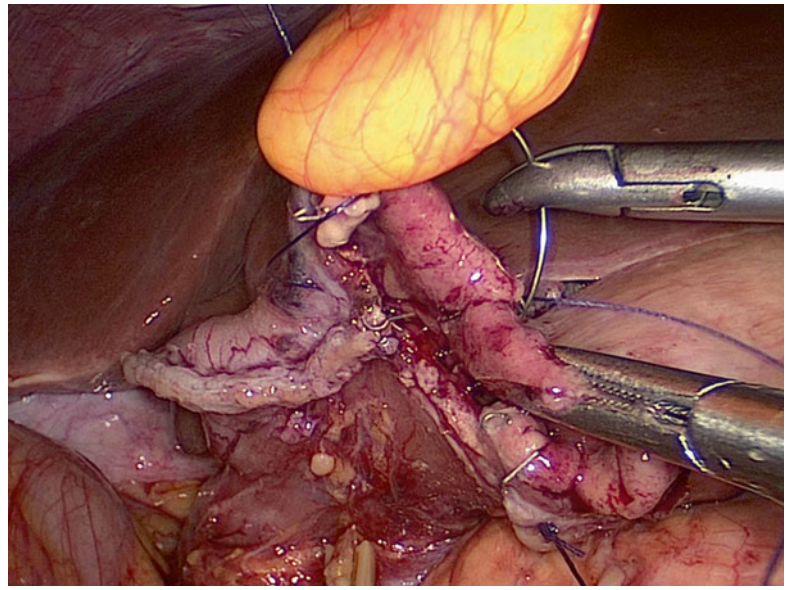

Fig. 8.15 Three sutures are added to each end and middle of the common stab incision to obtain a better involution and pull

at the same time. As a result, there is only one intersection of the gastric cutting edge and the common closed edge, leaving only one weak point instead of three in the conventional DSG. The anastomosis appears as an inverted T-shape (Fig. 8.19). Operationally, after the involution of the common stab incision, the end of the duodenal cutting edge is pulled up into the linear stapler by the assistant's right forceps (Fig. 8.20). The surgeon fires the stapler to close the common stab incision vertically to the gastric cutting edge, with the duodenal cutting edge completely resected at the same time. It can only require the instruments of the surgeon and assistant to grasp directly the tissue to accomplish involution of the common stab incision instead of the laparoscopic suturing in conventional DSG. Thus, it simplifies the operation procedures (Fig. 8.21).

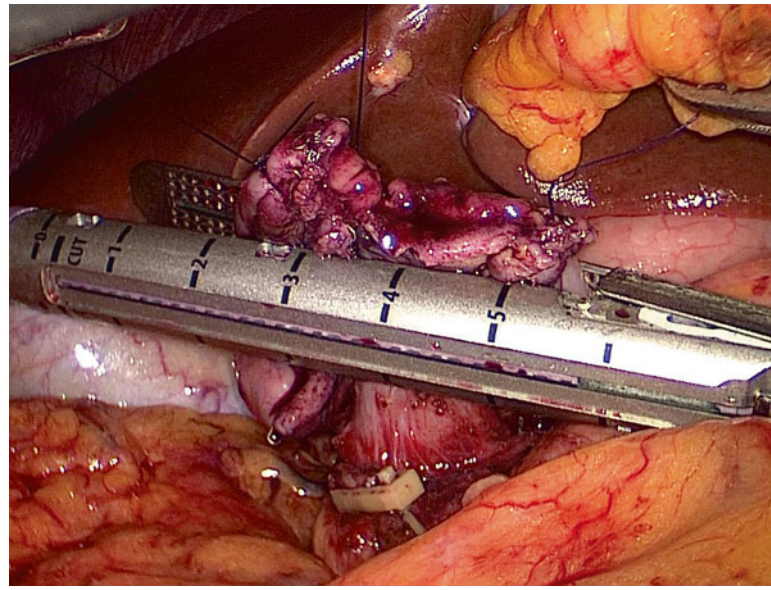

Fig. 8.16 The common stab incision is closed with the stapler

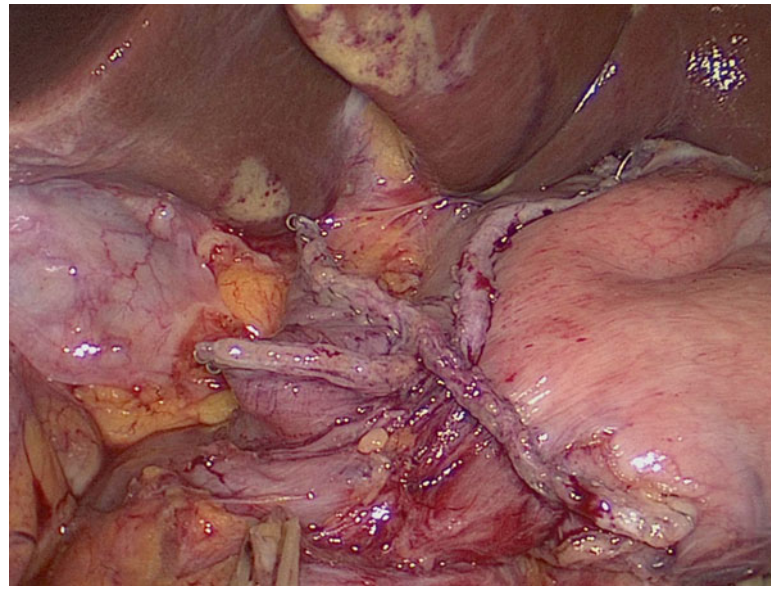

Fig. 8.17 The appearance of the anastomosis in the conventional DSG

Out center found that the modified DSG is a simpler process with significantly shorter anastomosis time by comparing the clinical data of the 22 patients undergoing a conventional DSG and 41 patients undergoing a modified DSG [23]. In addition, we summarized the clinical data of 122 patients undergoing modified DSG along with TLDG. Our results show that no patient of the 46 cases of early gastric cancer experienced any anastomosis-related complications such as anastomotic leakage and anastomotic hemorrhage. Of all the patients, only two elderly patients with late-stage gastric cancer experienced a minor anastomotic leakage after surgery and were managed conservatively. The average time of anastomosis was 12.2 ± 4.2 min. And the mean blood

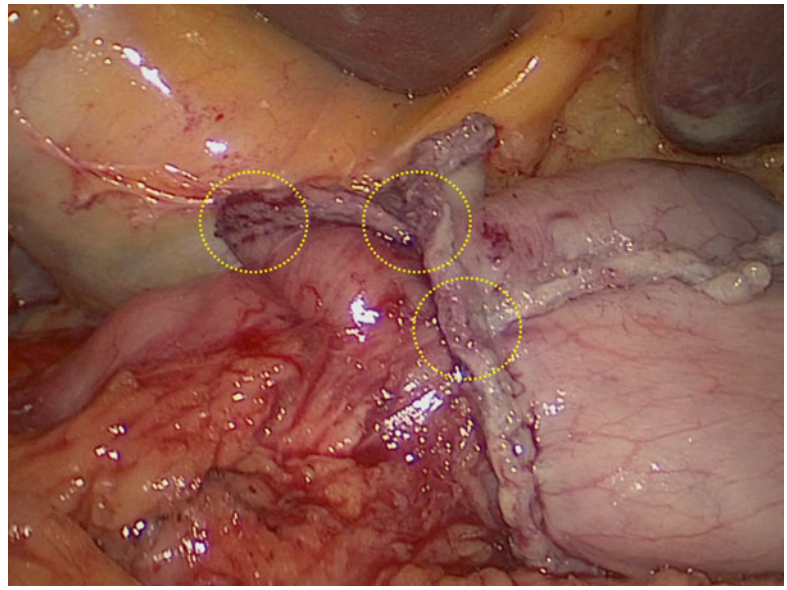

Fig. 8.18 The conventional DSG contains three weak points

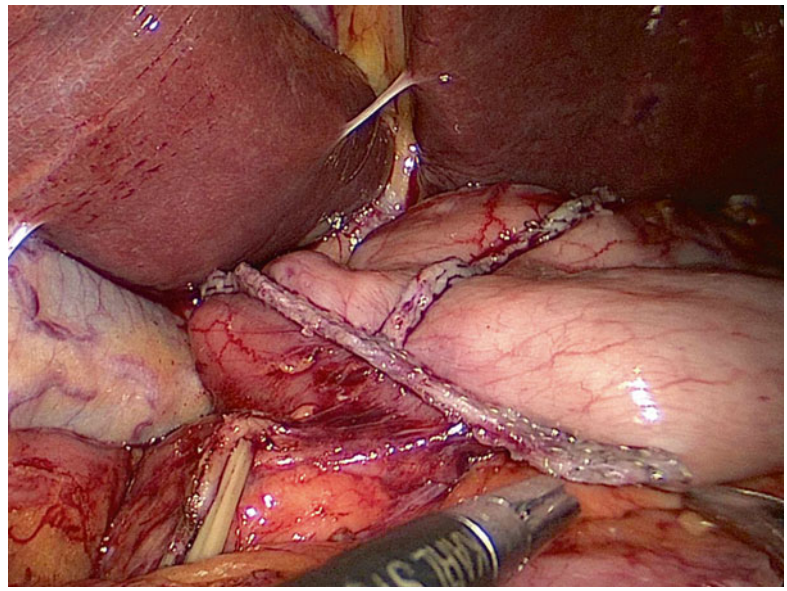

Fig. 8.19 The modified DSG appears as an inverted T-shape

loss and postoperative morbidity were comparable with other reports. Therefore, our results indicated that the modified DSG was technically safe and feasible in patients with gastric cancer undergoing TLDG. The procedure decreased the anastomotic weak points and avoided the poor blood supply to the duodenal stump. It may be promising and easier to perform with acceptable surgical outcomes [29].

8.3.5 Billroth-II Anastomosis After TLDG

8.3.5.1 Anastomosis Method

It is the functional side-to-side gastrojejunostomy using the linear stapler under totally laparoscopy. If the tumor invades the pylorus or duodenum, Billroth-II anastomosis can be safely performed to achieve R0 resection. Since

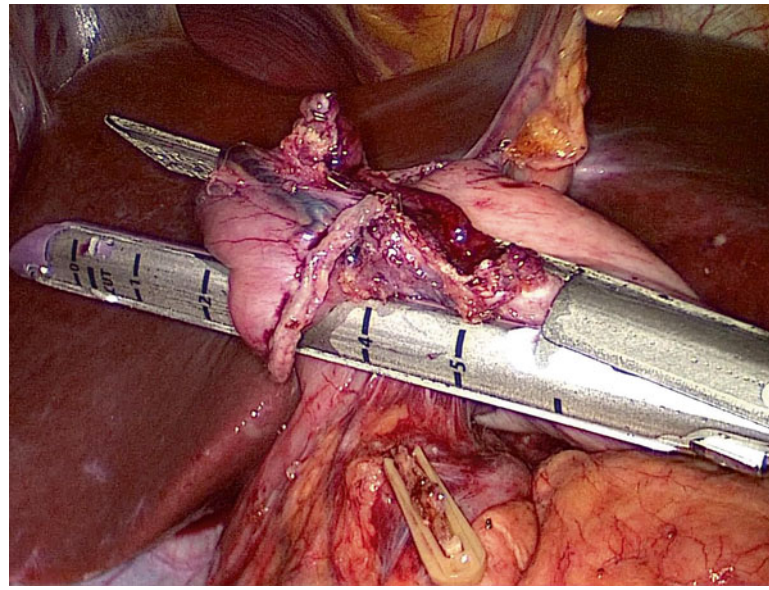

Fig. 8.20 The duodenal blind side is pulled up into the linear stapler, and the common stab incision is closed

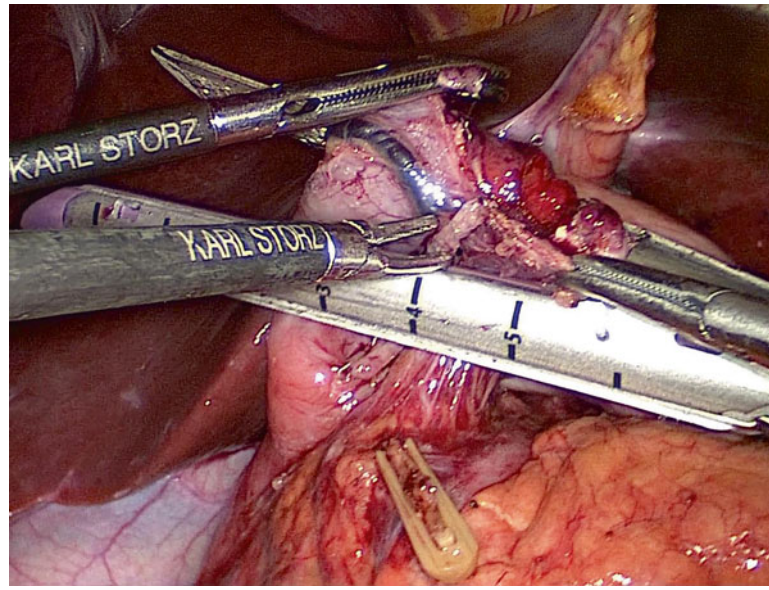

Fig. 8.21 The instruments of the surgeon and assistant directly grasp the tissue and accomplish the involution of the common stab incision

Ballesta-Lopez from Spain first reported Billroth-II anastomosis in TLDG in 1996, various methods of Billroth-II anastomosis have been created. Among all, the one using the linear stapler is proved to be the simplest in technical.

8.3.5.2 Technical Tips

Reconstruction of the digestive tract is performed using the linear stapler after completion of laparoscopic lymph node dissection. The duodenum is transected in the predetermined positions using an endoscopic linear stapler after it is fully dissociated, and the stomach is resected from the greater curvature side to the lesser curvature side with two staplers. The specimen is then placed into a plastic specimen bag. Small incisions are made both on the greater curvature of the remnant stomach and the anti-mesenteric

Fig. 8.22 A small incision is made on the antimesenteric side of the jejunum located 12–15 cm distal to the ligament of Treitz

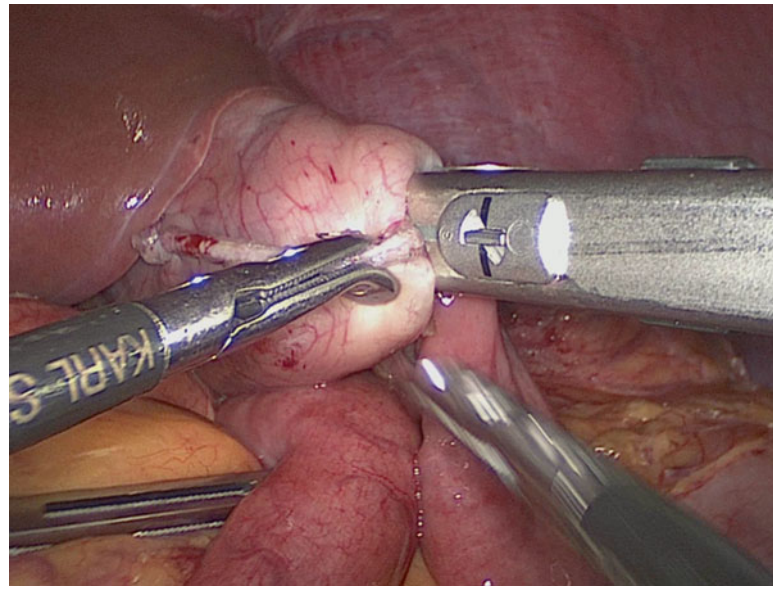

Fig. 8.23 The stapler is fired to perform a side-to-side gastrojejunostomy

side of the jejunum located 12–15 cm distal to the ligament of Treitz (Fig. 8.22). After opening the 60-mm endoscopic linear stapler, one limb is first inserted into the small incision in the jejunum toward the direction of the jejunal proximal end, and the stapler is temporarily closed. The jejunum is pulled up antecolically, and the stapler is opened again to insert the other limb into the small incision on the greater curvature of the remnant stomach. The stapler is then fired to perform a side-to-side gastrojejunostomy with a common stab incision created (Fig. 8.23). The afferent loop of the proximal jejunum should not be too long during the antecolic anastomosis. Otherwise, it may cause internal herniation or bowel ischemic necrosis due to bowel tortuosity or torsion. After confirming the quality of the anastomosis via the common stab incision

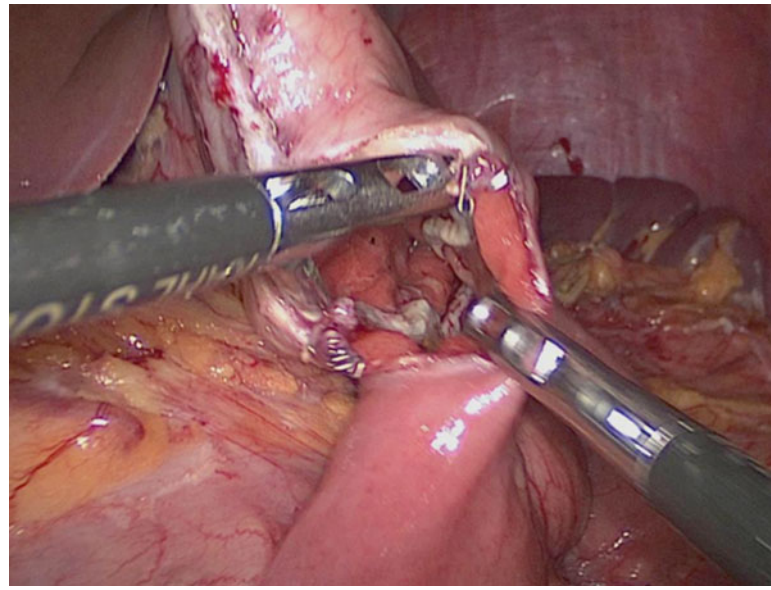

Fig. 8.24 Check the anastomosis via the common stab incision

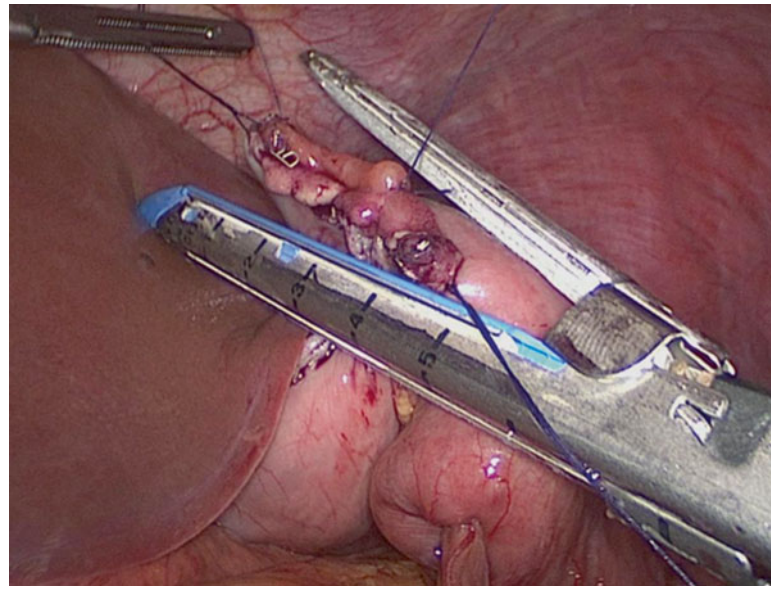

Fig. 8.25 The common stab incision is closed with the linear stapler

(Fig. 8.24), both ends of the common stab incision are pulled to be aligned, using atraumatic graspers. Three sutures are made at each end of the common stab incision to obtain better involution and pull. The common stab incision is then closed with the 60-mm linear stapler (Fig. 8.25), completing the reconstruction (Fig. 8.26). The trocar incision below the umbilicus is enlarged to 3 cm to remove the specimen.

8.3.6 Functional Side-to-Side Esophagojejunostomy After TLTG

8.3.6.1 Anastomosis Method

Functional side-to-side esophagojejunostomy is an anastomosis method that is carried out under totally laparoscopic view using the linear stapler. The abdominal esophagus and duodenum are

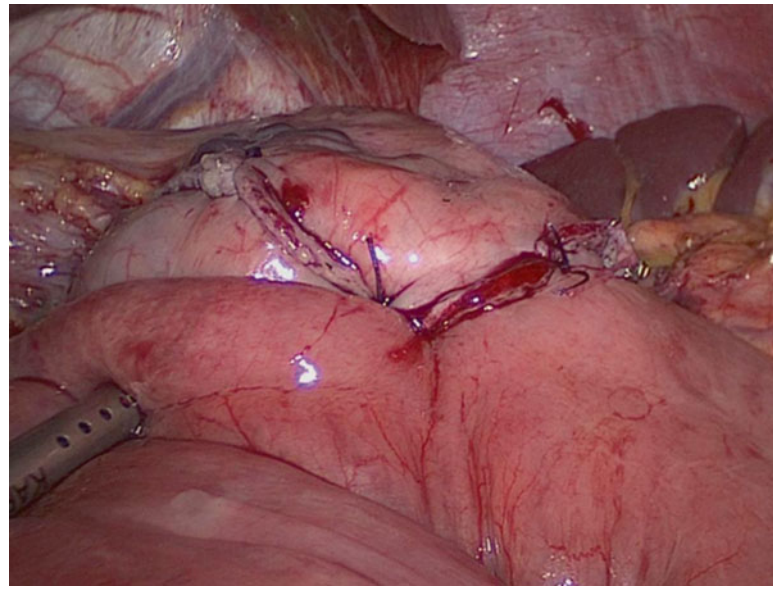

Fig. 8.26 The appearance of the anastomosis after the reconstruction

transected to complete functional side-to-side esophagojejunostomy and side-to-side jejunojejunostomy. This anastomosis method was first reported by Uyama et al. in Japan [6]. Anvil placement and purse-string suture are two difficult steps during the anastomosis using a circular stapler, especially when the diameter of the esophagus or the jejunum is small. Hence, they are omitted during functional side-to-side esophagojejunostomy in TLTG, and the anastomosis size is not restricted to the diameter of the esophagus, reducing the incidence of postoperative anastomotic stricture. Therefore, functional side-to-side esophagojejunostomy in TLTG is an ideal Roux-en-Y anastomosis procedure.

8.3.6.2 Technical Tips

After completing laparoscopic lymph node dissection, the stomach is pulled down to expose the vagus nerve and then severed. The esophagus is mobilized and bared to >5 cm distal to the upper border of the tumor to ensure a negative cutting edge. The duodenum is transected in the predetermined positions using an endoscopic linear stapler after it is fully mobilized, and the esophagus is transected above the cardia (Fig. 8.27). The mesenteric border of the jejunum located 20 cm distal to Treitz's ligament is denuded up to about 1 cm, and this segment of the jejunum is then transected using a linear stapler (Fig. 8.28). Small holes are made using the ultrasonic scalpel on the left side of the esophageal cutting edge and the antimesenteric border of the distal jejunum about 7 cm distal to its cutting edge (Figs. 8.29 and 8.30). Care should be taken to avoid injuring the esophageal or bowel wall on the opposite side. Subsequently, two limbs of the 60-mm linear stapler are respectively inserted into the small holes. The jejunum is more mobile; therefore, one limb of the stapler is first inserted into the hole in the jejunum (Fig. 8.31) and the other into the esophageal lumen. At this moment, the limb should not be inserted into the false lumen between the esophageal submucosa and muscular layer. The stapler is fired to create a common stab incision (Fig. 8.32). After confirming the quality of the anastomosis via the common stab incision (Fig. 8.33), the incision is closed with a laparoscopic suture, completing the esophagojejunostomy (Figs. 8.34 and 8.35). Using the ultrasonic scalpel, small holes are made in the proximal jejunum and the antimesenteric border of the distal jejunum about 40 cm distal to the esophagojejunostomy. Each limb of the 45-mm stapler is placed into the lumens, and the stapler is fired to create a side-to-side jejunojejunostomy (Fig. 8.36). After checking for no bleeding points and intestinal mucosa injury, the common stab incision is closed using a laparoscopic suture (Fig. 8.37), completing the anastomosis (Fig. 8.38).

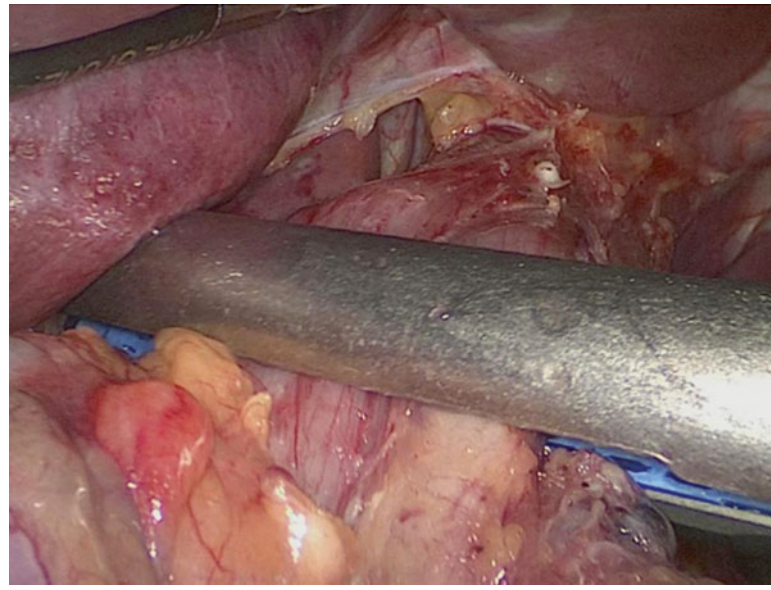

Fig. 8.27 The esophagus is transected above the cardia using a linear stapler

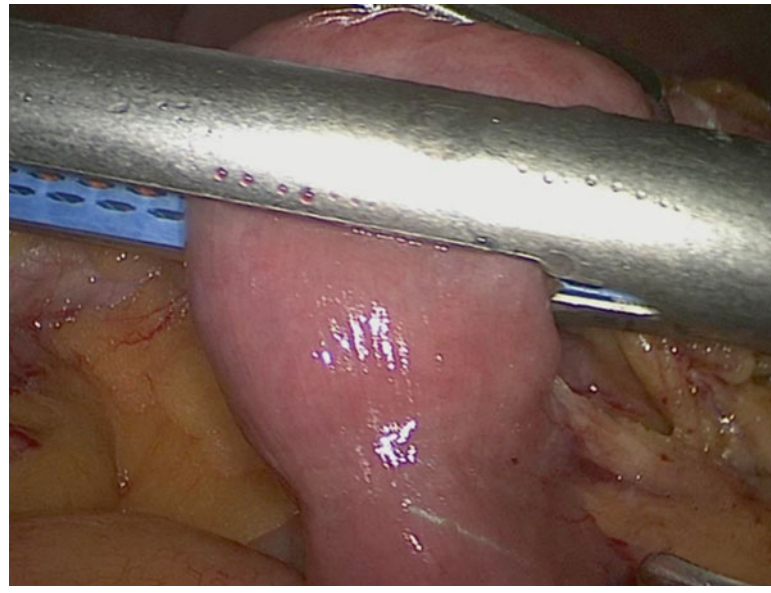

Fig. 8.28 The jejunum is transected using a linear stapler

8.3.7 Orvil™: Assisted Anastomosis After TLTG

8.3.7.1 Anastomosis Method

OrVil™ is an integrative transorally inserted device. The orogastric tube is connected to the center rod of the anvil head by the connecting thread. The anvil head is transorally inserted to work directly without purse-string sutures for the esophageal stump. The leaning anvil head at the top of the OrVil™ device is designed to facilitate its passing through the oral cavity and proximal esophagus. When the anvil head is connected to the stapler body, it automatically restores it to a horizontal position. Application of the OrVil™ device offers a clearer visual field, more convenient anastomosis, and a higher cutting edge. It successfully simplifies the difficulties of anvil

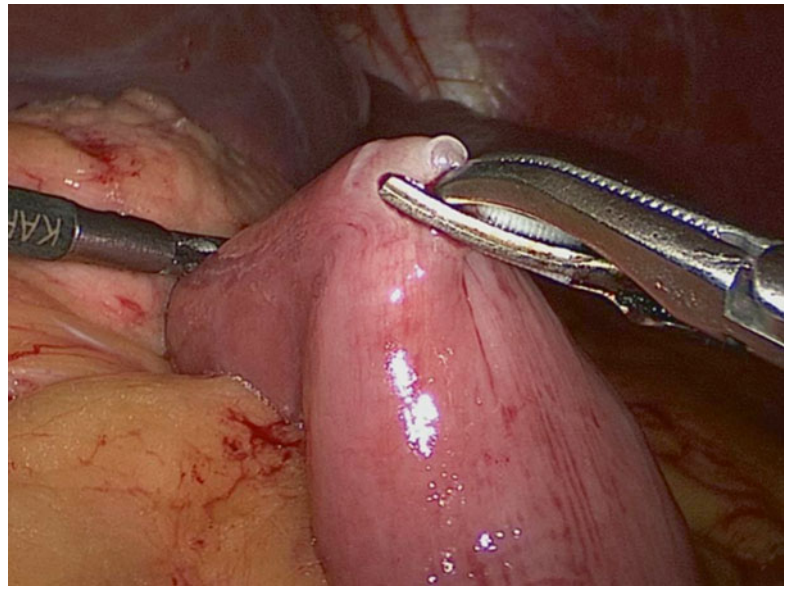

Fig. 8.29 A small hole is made on the distal jejunum

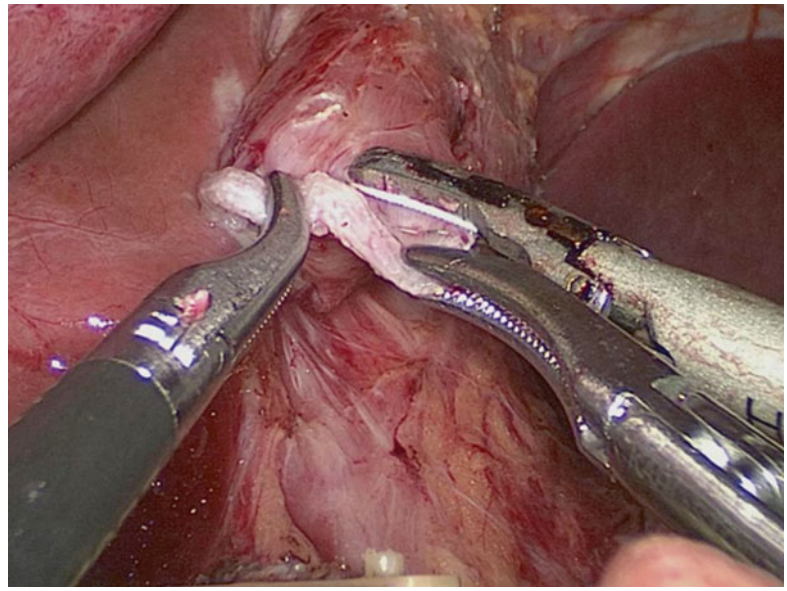

Fig. 8.30 A small hole is made on the left side of the esophageal cutting edge

placement, making the anastomosis faster and easier. An anastomosis at a higher site can also be performed. Therefore, the OrVil™ device provides ideal anvil placement during intracorporeal reconstruction of the digestive tract.

8.3.7.2 Technical Tips

After completing laparoscopic lymph node dissection and mobilization of the stomach, the stomach is pulled down to free the posterior aspect of the esophagus and the right side of the gastric cardia. The anterior and posterior branches of the vagus nerve are severed, and the esophagus is mobilized up to about 6 cm. The duodenum is transected using an endoscopic linear stapler, and the esophagus is transected >3 cm away from the upper border of the tumor (Fig. 8.39). The OrVil™ catheter stapling anvil is slowly passed

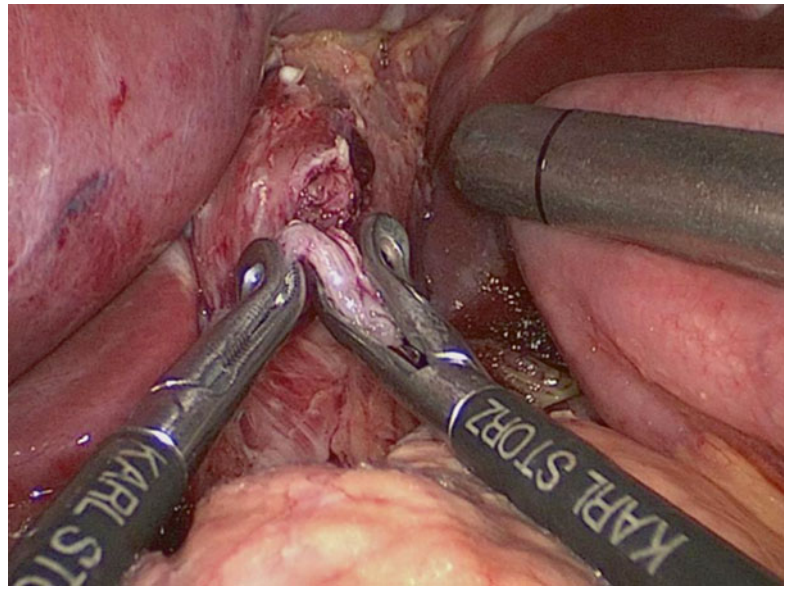

Fig. 8.31 One limb of the stapler is first inserted into the hole on the jejunum

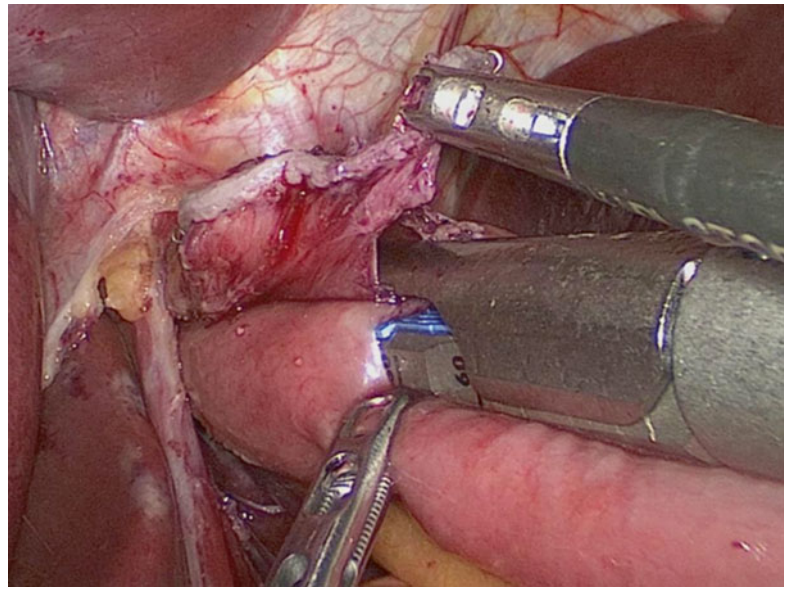

Fig. 8.32 The stapler is fired to perform the side-to-side esophagojejunostomy

transorally by the experienced anesthetist through the larynx to the stapled esophageal stump. Sufficient lubrication of the catheter and the anvil is necessary before placement, and the back of the patient's neck should be lifted. It must be confirmed that the spherical surface of the anvil faces the patient's palate when inserting the catheter. After the anvil enters the esophagus, the gasbag of the endotracheal tube is evacuated to facilitate the passage of the anvil into the esophagus with the help of a laryngoscope. A small hole that only allows the passage of the tube is created by an ultrasonic knife in the stapled esophageal stump (Fig. 8.40). Then the tube is pulled out into the abdominal cavity through the hole until the white plastic rubber ring is fully revealed (Fig. 8.41). The entire process should be gentle and slow rather than rough and hard. In case of resistance,

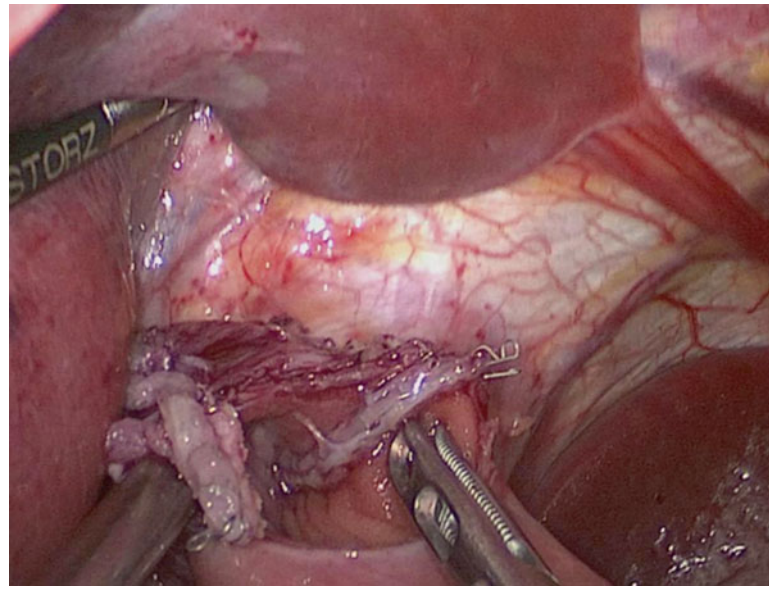

Fig. 8.33 Check the anastomosis via the common stab incision

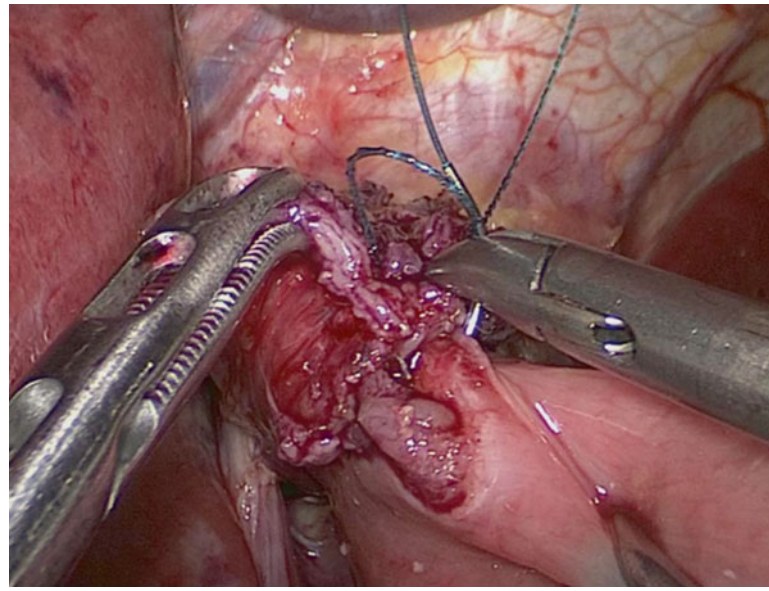

Fig. 8.34 The incision is closed using the laparoscopic suture

a little traction forces are adequate to prevent damage to the esophageal lining. The connecting thread between the orogastric tube and the anvil is cut (Fig. 8.42), and the anvil head attaches to the esophageal stump. The grasper then clamps the white part of the tube to remove it from the major hand port (Fig. 8.43). A 4–5-cm longitudinal incision is made at the midline on the epigastrium, and a wound protector is placed. The stomach is removed through the incision for pathological examination. The mesenteric border of the jejunum located 20 cm distal to Treitz's ligament is denuded up to about 1 cm, and this segment of the jejunum is then transected. The proximal jejunal stump is sutured. A 25-mm OrVil™ circular stapler is inserted into the distal jejunum and is introduced into the abdominal cavity through the minilaparotomy (Fig. 8.44).

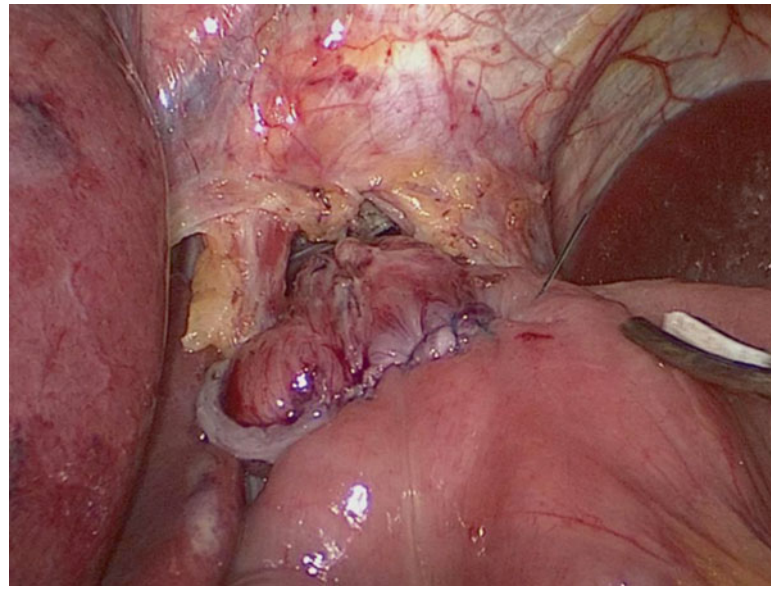

Fig. 8.35 The esophagojejunostomy is completed

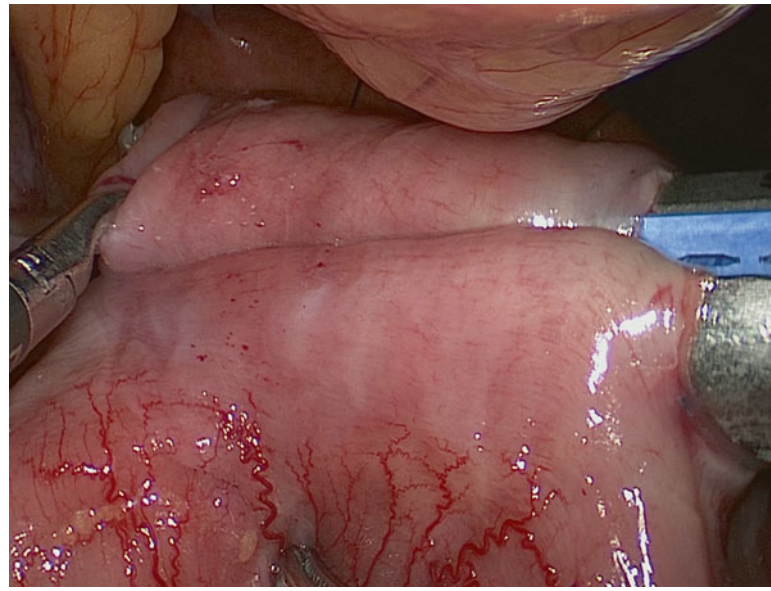

Fig. 8.36 The stapler is fired to create a side-to-side jejunojejunostomy

The pneumoperitoneum is reestablished. The anvil is connected to the circular stapler under total laparoscopy (Fig. 8.45), to create an end-to-side esophageal jejunostomy (Fig. 8.46). The distal jejunal stump is intracorporeally closed using a linear stapler.

Using the ultrasonic scalpel, small holes are made on the proximal jejunal stump and the antimesenteric border of the distal jejunal stump about 40 cm distal to the esophageal jejunostomy. Each limb of the 45-mm stapler is introduced into the jejunal lumens to perform a side-to-side jejunojejunostomy, and a common stab incision is created. After checking for no bleeding points and intestinal mucosa injury, the common stab incision is closed using a laparoscopic suture to complete the side-to-side jejunojejunostomy. We summarize clinical data of 28

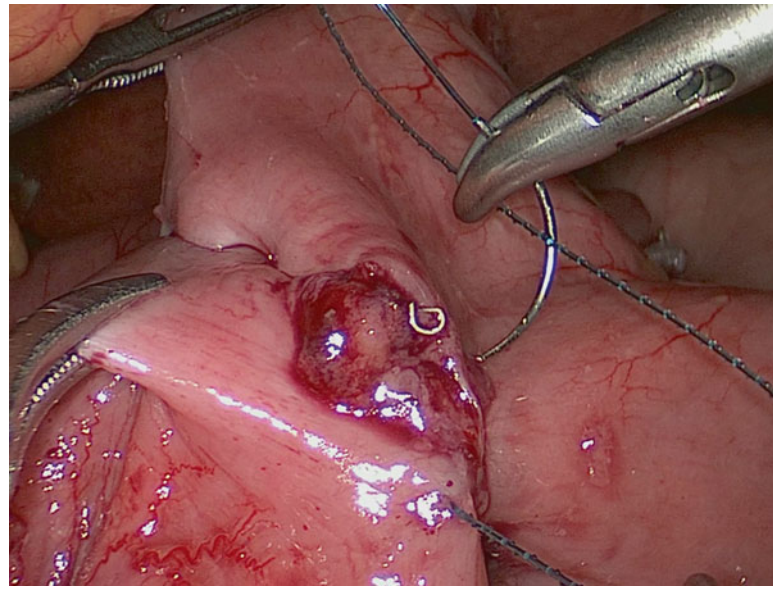

Fig. 8.37 The common stab incision is closed using a laparoscopic suture

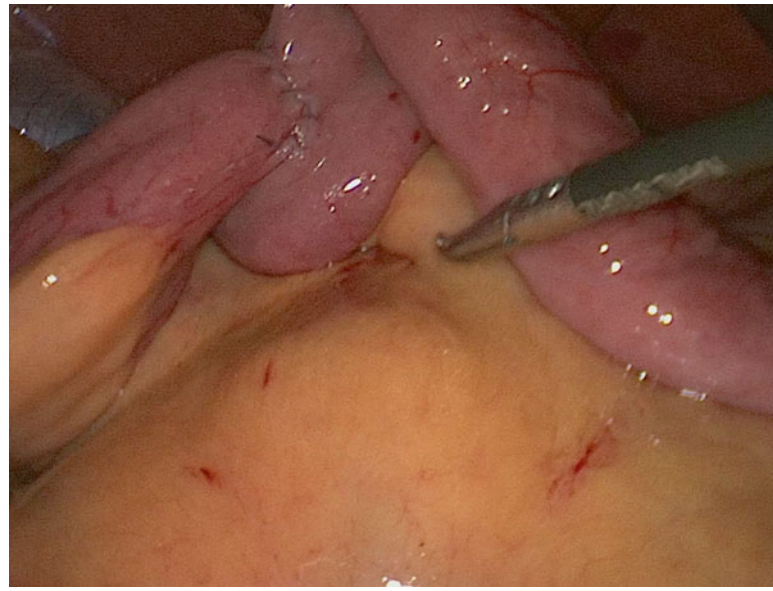

Fig. 8.38 The side-to-side jejunojejunostomy is completed

patients with gastric fundus and cardia cancer who underwent laparoscopic total gastrectomy with a Roux-en-Y-esophagojejunostomy anastomosed with OrVil™ and show that surgeries are successfully performed in all patients without conversions to open. Mean operative time and blood loss were 143 min and 70 ml, respectively. Mean number of LNs is 36.4 per patient. During the follow-up with a median of 28.6 months (24–36 months), no complications, such as recurrence, anastomosis stenosis, and reflux esophagitis, are observed. Thus, we consider that the use of the OrVil™ is technically feasible and relatively safe. It can reduce the difficulty of reconstruction without increasing the risk of postoperative complications and recurrence.

In conclusion, reconstruction of the digestive tract after laparoscopic gastrectomy faces great

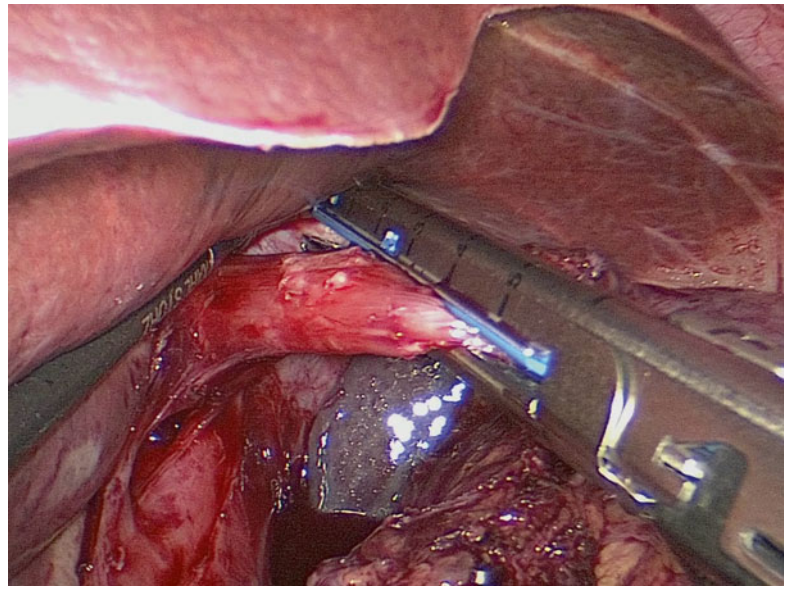

Fig. 8.39 The esophagus is transected using a linear stapler

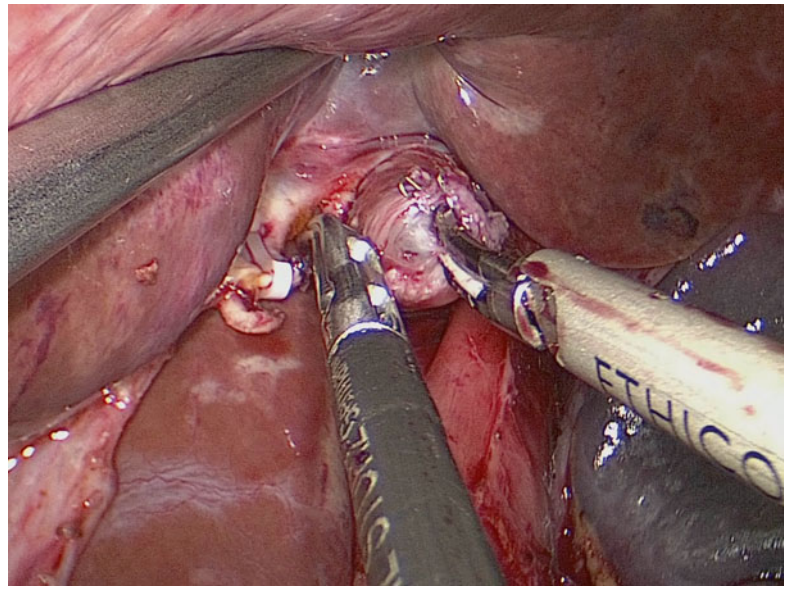

Fig. 8.40 A small hole is created in the stapled esophageal stump

challenges because of the high demand for minimal invasion and quality of life. Choosing a proper reconstruction method to minimize postoperative complications is the basic requirement in laparoscopic gastrectomy for gastric cancer. However, given the specificity and technical difficulty of digestive tract reconstruction after laparoscopic gastrectomy, it is unnecessary to pursue blindly the success and perfection of laparoscopic techniques or impose totally laparoscopic reconstruction of the digestive tract. After acquiring basic experience of open surgery, surgeons should master the surgical indications for laparoscopic gastrectomy and choose a rational reconstruction method according to tumor site, TNM stage, and extent of gastrectomy, along with characteristics of laparoscopic techniques. The superiority of laparoscopic surgery, including its minimally invasive nature, can ensure good quality of life after surgery for gastric cancer.

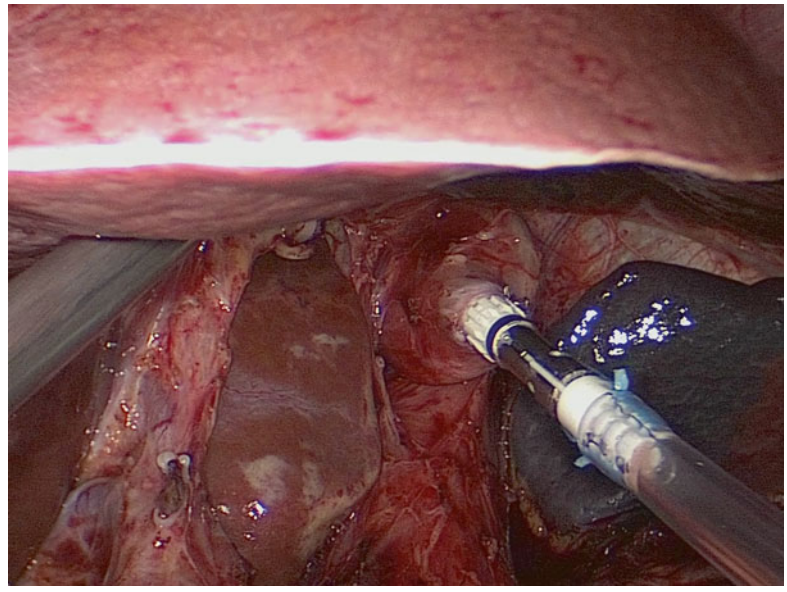

Fig. 8.41 The white plastic rubber ring is fully revealed

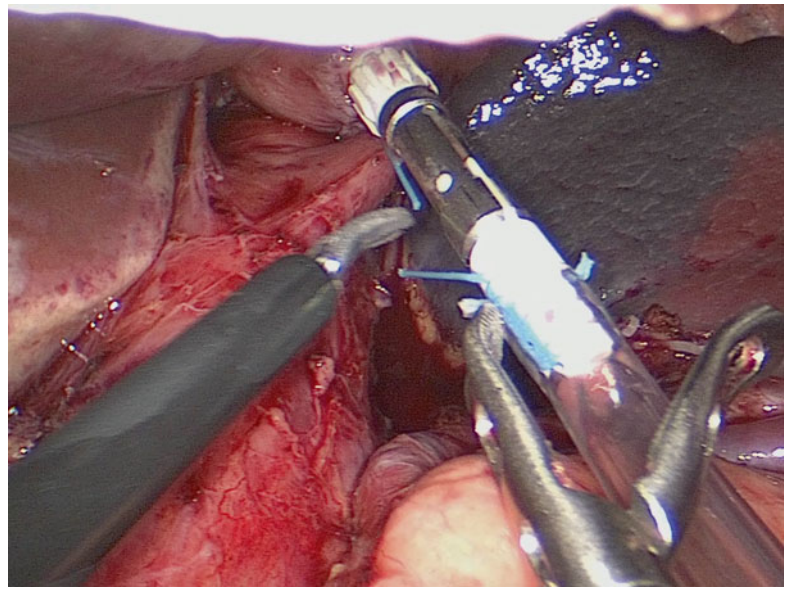

Fig. 8.42 The connecting thread between the orogastric tube and the anvil is cut

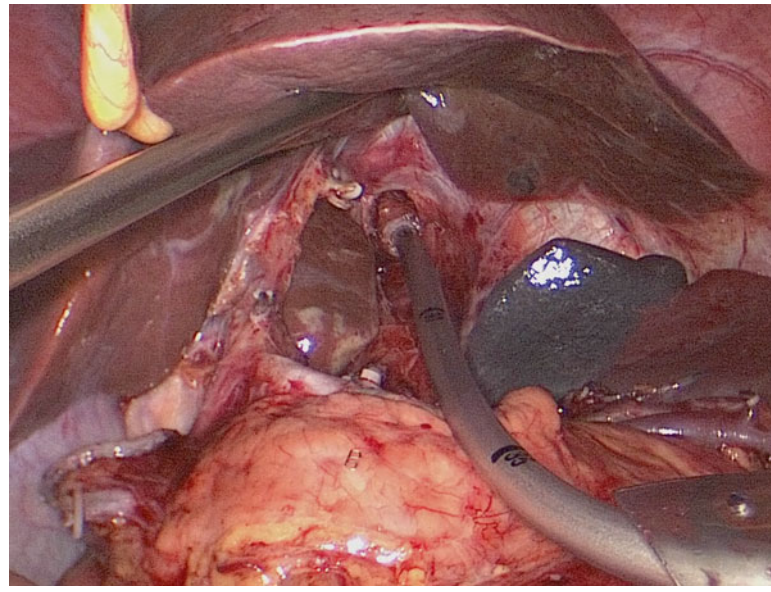

Fig. 8.43 The tube is removed from the major hand port

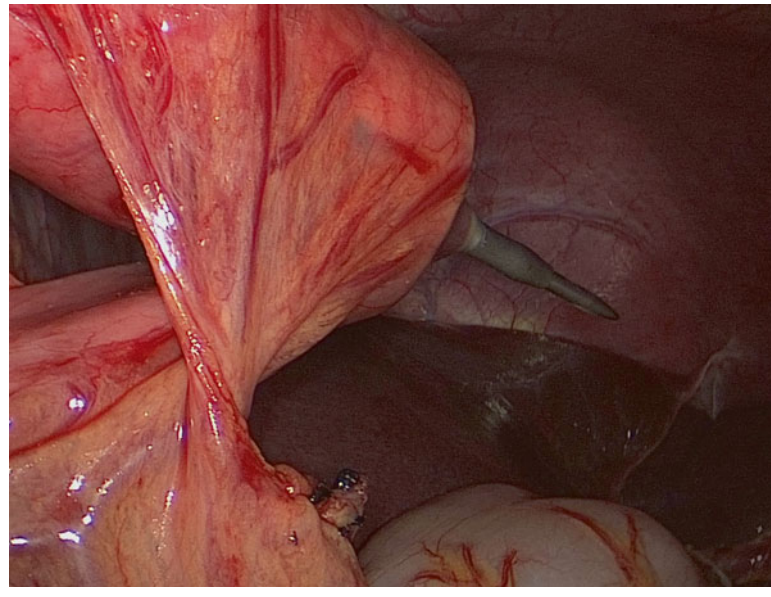

Fig. 8.44 A 25-mm OrVil™ circular stapler is introduced into the abdominal cavity through the minilaparotomy

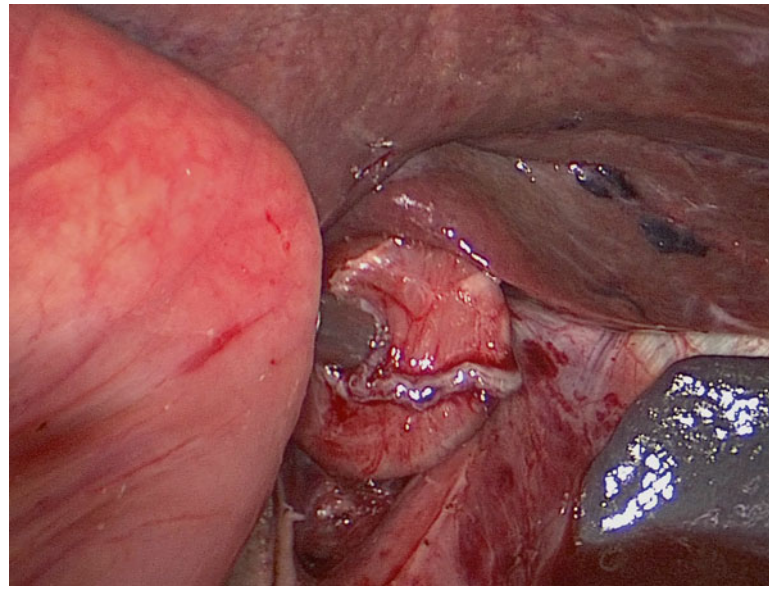

Fig. 8.45 The anvil is connected to the circular stapler under total laparoscopy

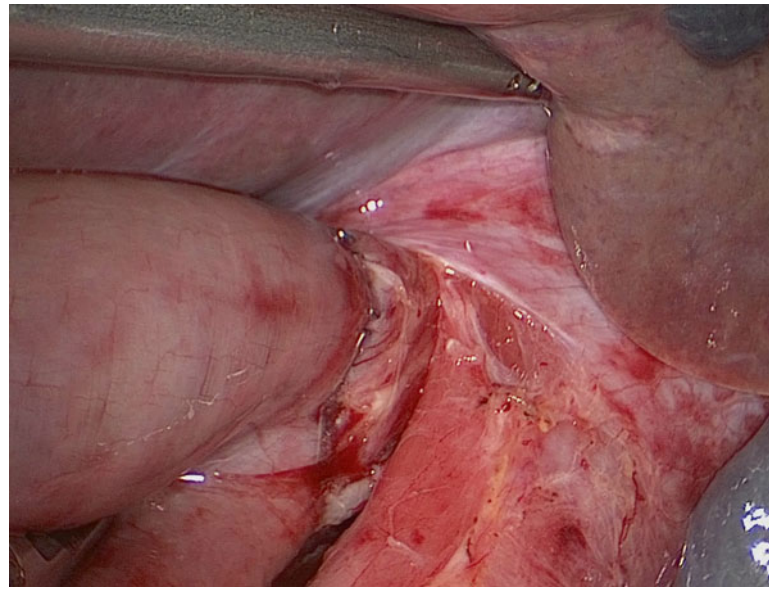

Fig. 8.46 The end-to-side esophageal jejunostomy is created

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