

Intracorporeal circular stapling esophagojejunostomy using the transorally inserted anvil (OrVil™) after laparoscopic total gastrectomy

Oh Jeong · Young Kyu Park

Received: 18 January 2009 / Accepted: 14 March 2009 / Published online: 3 April 2009
© Springer Science+Business Media, LLC 2009

Abstract

Background Laparoscopic total gastrectomy (LTG) has not become as popular as laparoscopic distal gastrectomy (LDG) because of the more difficult reconstruction technique. Despite various modifications of reconstruction methods after LTG, an optimal procedure has yet to be established. The authors report the newly developed reconstruction technique after LTG: intracorporeal circular stapling esophagojejunostomy using the transorally inserted anvil (OrVil™; Covidien, Mansfield, MA, USA).

Methods After full mobilization of the abdominal esophagus, the esophagus is transected with an endoscopic linear stapler. The anvil is then transorally inserted into the esophagus by using the OrVil™ system. After jejunojunctionostomy is performed through a 4-cm midline minilaparotomy, preparing a 50-cm Roux-en-Y jejunal limb, a circular stapler is inserted into the jejunum and introduced into the abdominal cavity. Pneumoperitoneum is established by sealing off the laparotomy wound retractor with a surgical glove attached to the circular stapler. Double-stapling esophagojejunostomy with a circular stapler is performed intracorporeally, and the jejunal stump is closed with an endoscopic linear stapler.

Results Of the 16 patients who underwent this operation, there was no intraoperative complication or conversion to open surgery, and no patient required an extension of the initial incision for anastomosis. Mean operation time and blood loss were 194 min and 272 ml, respectively. One

patient developed an intra-abdominal abscess postoperatively. Postoperative fluorography revealed no anastomosis leakage or stenosis in any of the patients. Patients resumed an oral liquid diet on postoperative day 3–5, and the mean postoperative hospital stay was 11 days.

Conclusions We have successfully performed LTG with Roux-en-Y reconstruction using our technique in 16 patients without any anastomosis complications. We believe that our procedure is a secure and reliable reconstruction method after LTG, which is especially useful in obese patients, in whom conventional extracorporeal anastomosis often is difficult.

Keywords Laparoscopic surgery · Total gastrectomy · Esophagojejunostomy · Reconstruction · Gastric cancer

With the advance of instruments and surgical technique, laparoscopic surgery has become widely used in recent years for the treatment of early gastric cancer [1]. The techniques and advantages of laparoscopic distal gastrectomy (LDG) in early gastric cancer have been well studied since its introduction in 1994 [2]. LDG in early gastric cancer has lots of advantages, including reduced surgical invasiveness, less postoperative pain, better cosmesis, earlier postoperative recovery, and excellent long-term survival [3–5]. However, laparoscopic total gastrectomy (LTG) has not become as popular as LDG because of the low incidence of gastric cancer necessitating total gastrectomy and the more difficult surgical technique of LTG, particularly when reconstruction is necessary. Extracorporeal esophagojejunostomy through minilaparotomy, which is similar to conventional open surgery, has been commonly performed after LTG [6–8]. However, it often is difficult to complete anastomosis through minilaparotomy

O. Jeong · Y. K. Park (✉)
Department of Gastroenterologic Surgery, Chonnam National University Hwasun Hospital, 160, Ilsim-ri, Hwasun-eup, Hwasun-gun, Jeollanam-do 519-809, Korea
e-mail: parkyk@jnu.ac.kr

O. Jeong
e-mail: surgeonjeong@yahoo.co.kr

due to the narrow operating window for anvil insertion and application of instruments. Some studies have described various modified techniques of esophagojejunostomy after LTG to overcome these technical problems; however, an optimal procedure has yet to be established [9–12].

In this study, we present intracorporeal circular stapling esophagojejunostomy using the newly developed transorally inserted anvil (OrVil™; Covidien, Mansfield, MA, USA). In this method, the anvil is transorally inserted into the esophagus intracorporeally, and esophagojejunal anastomosis is performed using a circular stapler under the direct laparoscopic view. We believe that this procedure is especially useful in obese patients, in whom conventional extracorporeal anastomosis often is difficult. It also is of utility for patients who need sufficient proximal esophageal margins due to suspected tumor invasion of the esophago-gastric junction.

Patients and methods

From May 2008 to Aug 2008, 16 consecutive patients underwent LTG with Roux-en-Y reconstruction at our institution using this reconstruction technique. Preoperative staging was based on upper gastrointestinal endoscopy, endoscopic ultrasonography, and abdominal computed tomography (CT) scan. Gastric carcinomas, which invade deeper than proper muscle layer or had lymph node metastasis upon preoperative examination, were excluded from laparoscopic gastrectomy. All patients were diagnosed with early gastric cancer located in the upper half of the stomach, and the depth of tumor invasion was limited to the submucosa without lymph node involvement. Data regarding patients' clinicopathological features, operative procedures, surgical outcomes, hospital courses, and postoperative complications were obtained from the prospectively constructed laparoscopic surgery database.

Materials

We used the newly developed transorally inserted anvil (OrVil™) and a circular stapler (EEA25; Covidien) for esophagojejunal reconstruction after LTG. The OrVil™ system is a ready-to-use anvil delivery device, which is designed to transorally insert the anvil into the abdominal esophagus, similar to inserting the orogastric tube through the mouth (Fig. 1). In the OrVil system, the orogastric tube is connected to the center rod of the anvil, so that the anvil is transorally delivered into the esophagus, guided by the orogastric tube. The orogastric tube is easily removed from the anvil by cutting the connecting thread. The tilted anvil head of the OrVil™ system facilitates the passage of the anvil through the mouth and upper esophagus, and

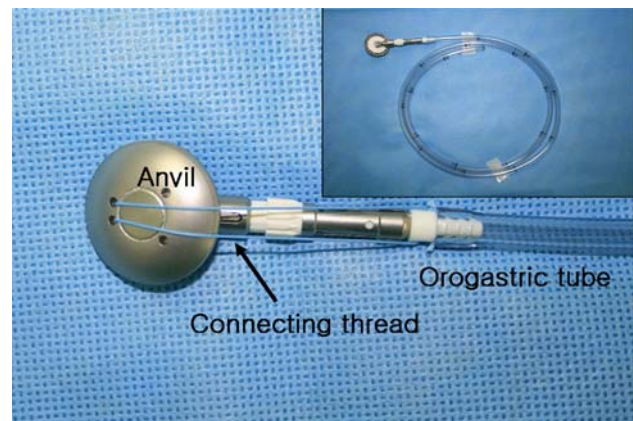


Fig. 1 The ready-to-use transorally inserted anvil (OrVil™). The orogastric tube is connected to the center rod of the anvil, so that the anvil is transorally inserted into the esophagus guided by the orogastric tube. The tilted anvil head facilitates the passage of the anvil through the mouth and the esophagus, and untilts automatically when combined with the circular stapler

automatically untilts for parallel closure when combined with a stapler. Intracorporeal double-stapling esophagojejunostomy is performed using a circular stapler (EEA25; Covidien), which can be combined with the OrVil™ system.

Surgical technique

The patient was placed in a modified lithotomy position. The operator stood on the right side of the patient, with the first assistant on the left side and the videolaparoscope operator standing between the patient's legs. After a CO₂ pneumoperitoneum of 12–14 cm H₂O was established through the umbilical port, four operating ports were placed in the upper abdomen (Fig. 2A). A 30-degree rigid videolaparoscope was then introduced via the umbilical port. To secure the laparoscopic operating field, the falciform ligament was transfixed to the abdominal wall, and the liver was retracted with an endo-grasper holding the lesser omentum or the abdominal esophagus through the 5-mm epigastrium port (Fig. 2B). Total gastrectomy with regional lymph node dissection (D1 and stations No. 7, 8a, 9, and 11p) was performed laparoscopically.

After full mobilization of the abdominal esophagus, the esophagus was transected 2 cm above the esophago-gastric junction with an endoscopic linear stapler. The OrVil™ tube was then transorally introduced into the esophagus. As the operator identified the OrVil™ tube reaching the esophageal stump, a small hole was created on the esophageal stump (Fig. 3A). The tube was then extracted through the hole until the anvil reached the esophageal stump (Fig. 3B), at which time the tube was disconnected from the anvil by cutting the connecting thread and

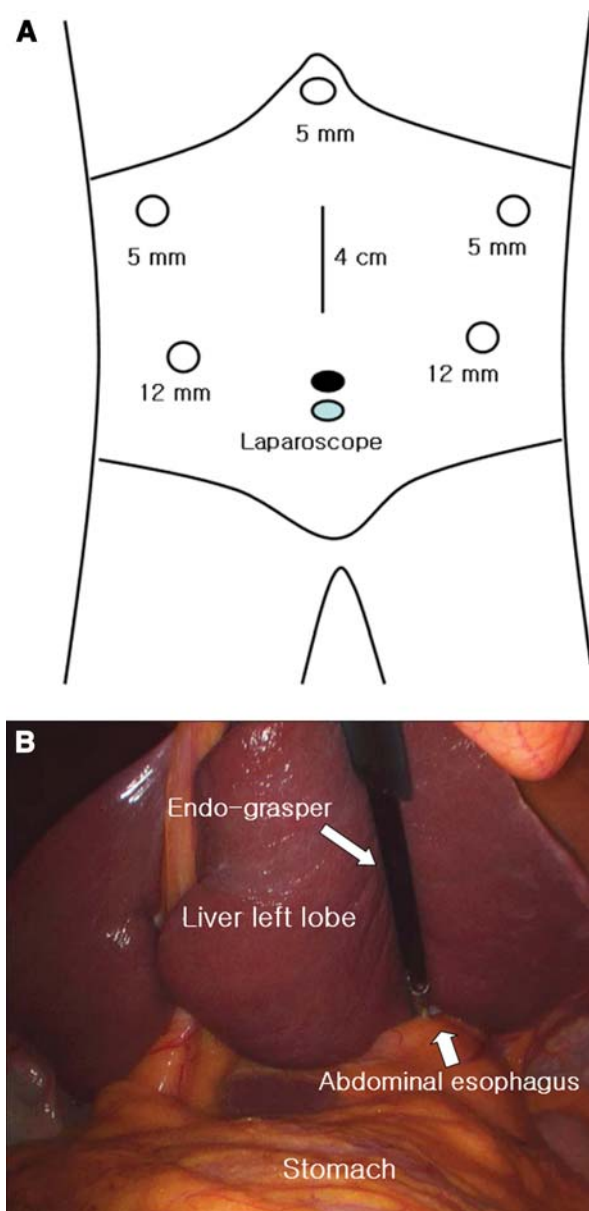


Fig. 2 **A** Placement of surgical ports and minilaparotomy. **B** Liver retraction method. The falciform ligament is transfixed to the abdominal wall, and the liver is retracted with an endoscopic grasper holding the abdominal esophagus or lesser omentum

removed from the abdominal cavity (Fig. 3C, D). Abdominal irrigation around the esophageal stump was performed to prevent postoperative abdominal infection.

After marking the jejunal loop for the subsequent Roux-en-Y reconstruction, a 4-cm longitudinal minilaparotomy incision was made between the epigastrium and umbilicus, approximately the closest area to the ligament of Treitz. The minilaparotomy wound was retracted and protected using a laparotomy wound retractor (Alexis Wound Retractor; Applied Medical, CA, USA), and the stomach was delivered out through the minilaparotomy. The marked jejunal loop

was brought out through the laparotomy and transected, and then side-to-side jejunojunctionostomy was performed to create a 50-cm Roux-en-Y limb.

For intracorporeal use, a surgical glove was attached on the circular stapler. Then, the circular stapler can be used in the abdominal cavity and maintain pneumoperitoneum during the intracorporeal procedure (Fig. 4). A circular stapler was inserted into the jejunal limb and the jejunum was tied to the instrument with a rubber band to prevent slippage of the jejunum from the circular stapler during the intracorporeal procedure (Fig. 5A). The circular stapler was then introduced into the abdominal cavity, and pneumoperitoneum was established by sealing off minilaparotomy with a surgical glove attached to a circular stapler (Fig. 5B). A videolaparoscope was introduced via the left lower abdominal port to obtain a good operating view for intracorporeal anastomosis. The anvil and circular stapler were connected and anastomosis was performed under direct laparoscopic view (Fig. 5C). Finally, the jejunal stump was closed with a 45-mm endoscopic linear stapler (Fig. 5D). The anastomosis and abdominal cavity were checked and a silicon drainage tube was placed around the esophagojejunal anastomosis.

Results

A total of 16 patients underwent LATG with Roux-en-Y reconstruction using this method (10 men; 6 women; mean age, 59 (range, 48–72) years). The mean body mass index was 23 (range, 19–27) kg/m². Four patients had medical comorbidities, such as hypertension or diabetes mellitus. None of the patients had a past history of abdominal surgery. All tumors were diagnosed as mucosal or submucosal gastric carcinoma without lymph node metastasis by pre-operative examinations.

All patients successfully underwent this operation without intraoperative complications or conversion to open surgery. The mean operating time was 194 (range, 160–270) min, and estimated blood loss was 170 (range, 120–410) ml. The mean operating time for the reconstruction, including esophagojejunostomy and jejunojunctionostomy, was 54 (range, 38–75) min. No patient required extension of the initial incision for a difficult anastomosis. On pathological examination, 11 patients had tumors confined within the mucosal or submucosal layer; however, one patient had a tumor that extended to the proper muscle layer. A total of two patients had lymph node metastasis. All resected specimens had tumor-free resection margins, and the mean number of harvested lymph nodes was 33 (range, 18–49).

One patient developed an intra-abdominal abscess postoperatively, which was the first case of this method.

Fig. 3 Intracorporeal anvil insertion using the OrVil™ system. **A** As the OrVil™ tube reaches the esophageal stump, a small hole is created on the esophageal stump. **B** The tube is pulled out through the hole, until the anvil reaches the esophageal stump. **C** The tube is disconnected from the anvil by cutting the connecting thread and then removed from the abdominal cavity. **D** Laparoscopic view after completion of the transoral anvil insertion

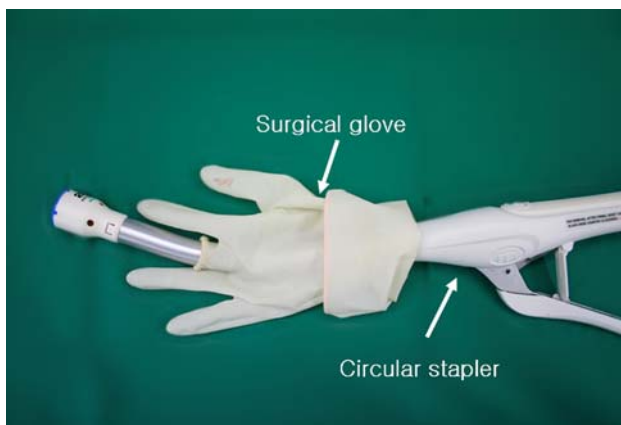
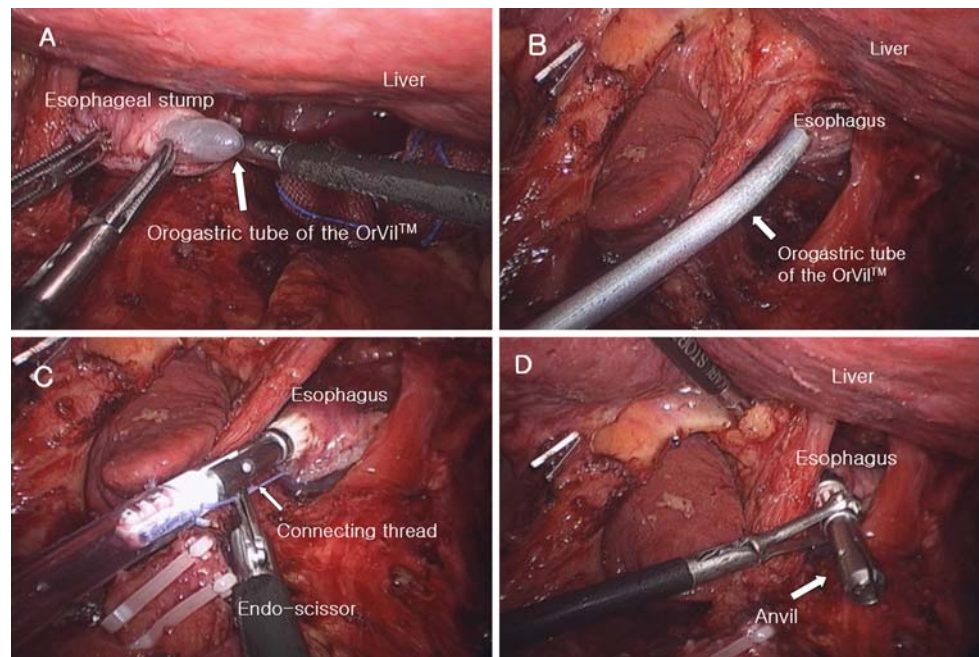


Fig. 4 Preparing a circular stapler for the subsequent intracorporeal use. Insert a circular stapler into a surgical glove as illustrated. Pneumoperitoneum is established by sealing off the laparotomy wound retractor with an attached surgical glove during the intracorporeal anastomosis

The patient required an additional operation for adequate abdominal irrigation and drainage and was discharged 27 days after the initial operation. There were no other postoperative surgical complications (e.g., wound infection or pancreatitis). Postoperative fluorography was performed on postoperative day 5–7 in all patients, and demonstrated no leakage or stenosis of esophagojejunal anastomosis (Fig. 6). The mean hospital stay was 11 (range, 8–14) days postoperative, with the exception of the one patient with postoperative complications. Patients resumed an oral liquid diet on postoperative day 3–5. During the mean follow-up of 6.4 (range 3–9) months, two patients reported dysphagia when swallowing solid food; however,

radiologic examination revealed no evidence of anastomotic stenosis in those patients.

Discussion

Because of mass screening and widespread use of endoscopic examination, gastric cancer often is detected early in Korea and Japan. The number of patients with early gastric cancer amounted to nearly half the total cases requiring surgical or endoscopic treatment recently in Korea [13]. The advantages of laparoscopic distal gastrectomy in early gastric cancer has been well studied; however, laparoscopic total gastrectomy has not become as popular as LDG due to a low incidence of upper gastric cancer necessitating total gastrectomy and the technical difficulty of LTG, especially for the reconstruction procedure. A simple, secure technique of reconstruction is necessary to facilitate the use of LTG for the treatment of upper gastric cancer. In this article, we described the intracorporeal esophagojejunostomy using a circular stapler and the transorally inserted anvil: OrVil™. In this method, the transoral placement of the anvil using the OrVil™ system simplified the anvil insertion procedure and reduced operative time. Intracorporeal stapling technique is not technically demanding due to the use of a circular stapler. We have successfully performed this procedure in 16 patients without any intraoperative complications or conversion to open surgery. Although study size was small in number and the follow-up duration was relatively short, there were no perioperative complications (e.g., leakage or stenosis) associated with the anastomosis.

Fig. 5 Intracorporeal circular stapling technique. **A** Circular stapler is inserted into the jejunum, and the jejunum is tied with a rubber band to prevent slippage of the jejunum from the circular stapler. **B** Circular stapler is introduced into the abdomen, sealing off the laparotomy wound with an attached surgical glove. **C** After pneumoperitoneum is established, double-stapling esophagojejunostomy is performed under the direct laparoscopic view. For a superior operating view, the laparoscope is introduced via the left lower abdominal port. **D** Laparoscopic view after completion of the anastomosis. The jejunal stump is closed with an endoscopic linear stapler

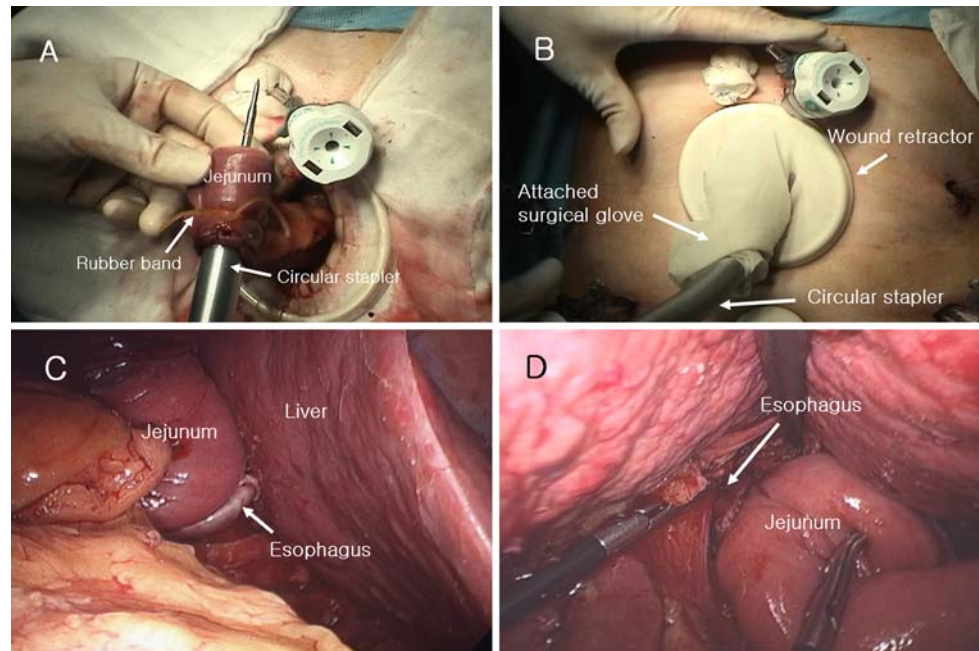


Fig. 6 Postoperative fluorography demonstrates normal passage of the oral contrast without leakage or stenosis of the anastomosis

Esophagojejunostomy after LTG is generally performed using one of two reconstruction methods: the extracorporeal and intracorporeal methods. The commonly used method is extracorporeal esophagojejunostomy, which is similar to conventional open surgery. We previously reported the technique and feasibility of this method [14], which is fairly simple and familiar to most surgeons. However, it often is difficult to complete esophagojejunal anastomosis through minilaparotomy because of the

narrow operating window for anvil insertion and application of instruments, especially in obese patients. To overcome these potential problems, various modified techniques have been reported. Okabe et al. [10] developed a modified esophagojejunostomy through minilaparotomy, in which side-to-side esophagojejunostomy is performed using an endoscopic linear stapler. Asao et al. [15] introduced a newly developed pursestring suture device (Takasago Medical, Tokyo, Japan), which is small enough to apply to the esophagus through the small abdominal incision. Takiguchi et al. [16] developed a simple laparoscopic pursestring suture technique using a semiautomatic suturing device (Endostich; Covidien). Intracorporeal esophagojejunostomy is usually performed with endoscopic linear staplers, and various technical modifications have been reported [11, 12, 17]. These novel procedures are all excellent, but more complex surgical technique is required. Meanwhile, few studies have performed intracorporeal esophagojejunostomy using a circular stapler for Roux-en-Y reconstruction after LTG [9, 18]. In this study, by adopting the technique of transoral anvil insertion, we developed a simple technique of intracorporeal circular stapling esophagojejunostomy.

Because there is no circular stapler specifically designed for endoscopic surgery, surgeons have preferred the extracorporeal use of a circular stapler for esophagojejunostomy after LTG. Two main obstacles seem to prevent the use of a circular stapler for intracorporeal anastomosis after LTG. First, the simple technique of intracorporeal anvil insertion is required. Unlike other anvil insertion techniques [9, 16], anvil insertion using the OrVil™ system is very simple and time-saving. In addition, because the

OrVil™ is designed to transorally insert the anvil into the esophagus, there is no need to perform pursestring suturing. Thus, the risk of esophageal injury during anvil insertion could be minimized. The next problem is how to use a circular stapler in the abdominal cavity while maintaining pneumoperitoneum. Some surgeons use a specialized wound-sealing device (Lap Disc; Ethicon Endo-Surgery, Cincinnati, OH, USA) for this purpose, but it often is difficult to manipulate the jejunum through the narrow operating window of this device [19]. Instead, we simply reformed a circular stapler for intracorporeal use by attaching a surgical glove (Fig. 4). With this simple manipulation, pneumoperitoneum can be established with ease during the intracorporeal procedure, and extracorporeal handling of the jejunum also is convenient with the wide operating window of the conventional wound retractor (Alexis Wound Retractor).

When using the OrVil™ system, careful attention should be made to prevent abdominal infection, because the contaminated OrVil™ tube enters the abdominal cavity during the procedure. Unfortunately, in our experience there was one postoperative abdominal infection, which was the first case of this method. After that case, we performed some preventive measures to avoid this potential problem: frequent oral gargling with hexamidine solution (Chlorohexidine Gluconate Solution 0.005 ml/ml) before surgery, direct removal of the tube through the surgical port from the anvil, which avoided contact with the abdominal cavity, and abdominal irrigation just after anvil insertion. By performing these preventive measures, we avoided the occurrence of postoperative abdominal infection in the other patients. We believe these measures would be effective in minimizing the risk of postoperative abdominal infection when using the OrVil™ system.

The videolaparoscope position is very important during the intracorporeal anastomosis procedure in this method. The umbilical port is not useful for guidance of the videolaparoscope during the intracorporeal anastomosis because a circular stapler is introduced into the abdomen through the midline laparotomy. This hampers the operating view for esophagojejunostomy when the videolaparoscope is introduced via the umbilical port. Therefore, we changed the position of the videolaparoscope from the umbilical port to the left lower abdominal port during the intracorporeal procedure; this change provides a direct laparoscopic view for esophagojejunostomy and the anastomosis procedure can be safely monitored intracorporeally (Fig. 5C).

Conclusions

This novel technique of intracorporeal circular stapling esophagojejunostomy using transorally inserted anvil

(OrVil™) is technically feasible and safe. We have successfully performed LTG with Roux-en-Y reconstruction using this procedure with a relatively short operation time and excellent surgical outcomes. Although there is concern about abdominal infection, it can be minimized by performing preventive measures. We believe that this procedure is especially useful in obese patients, in whom conventional extracorporeal anastomosis often is difficult. It also is of utility in patients who need sufficient proximal esophageal margins due to suspected tumor invasion of the esophagogastric junction.

References

- Nomura S, Kaminishi M (2007) Surgical treatment of early gastric cancer. *Dig Surg* 24:96–100
- Kitano S, Iso Y, Moriyama M, Sugimachi K (1994) Laparoscopy-assisted Billroth I gastrectomy. *Surg Laparosc Endosc* 4:146–148
- Kojima K, Yamada H, Inokuchi M, Hayashi M, Sekita Y, Kawano T, Sugihara K (2006) Current status and evaluation of laparoscopic surgery for gastric cancer. *Nippon Geka Gakkai Zasshi* 107:77–80
- Shehzad K, Mohiuddin K, Nizami S, Sharma H, Khan IM, Memon B, Memon MA (2007) Current status of minimal access surgery for gastric cancer. *Surg Oncol* 16:85–98
- Kitano S, Shiraishi N, Uyama I, Sugihara K, Tanigawa N (2007) A multicenter study on oncologic outcome of laparoscopic gastrectomy for early cancer in Japan. *Ann Surg* 245:68–72
- Kim SG, Lee YJ, Ha WS, Jung EJ, Ju YT, Jeong CY, Hong SC, Choi SK, Park ST, Bae K (2008) LATG with extracorporeal esophagojejunostomy: is this minimal invasive surgery for gastric cancer? *J Laparoendosc Adv Surg Tech A* 18:572–578
- Usui S, Yoshida T, Ito K, Hiranuma S, Kudo SE, Iwai T (2005) Laparoscopy-assisted total gastrectomy for early gastric cancer: comparison with conventional open total gastrectomy. *Surg Laparosc Endosc Percutan Tech* 15:309–314
- Mochiki E, Toyomasu Y, Ogata K, Andoh H, Ohno T, Aihara R, Asao T, Kuwano H (2008) Laparoscopically assisted total gastrectomy with lymph node dissection for upper and middle gastric cancer. *Surg Endosc* 22:1997–2002
- Tanimura S, Higashino M, Fukunaga Y, Kishida S, Ogata A, Fujiwara Y, Osugi H (2007) Laparoscopic gastrectomy with regional lymph node dissection for upper gastric cancer. *Br J Surg* 94:204–207
- Okabe H, Satoh S, Inoue H, Kondo M, Kawamura J, Nomura A, Nagayama S, Hasegawa S, Itami A, Watanabe G, Sakai Y (2007) Esophagojejunostomy through minilaparotomy after laparoscopic total gastrectomy. *Gastric Cancer* 10:176–180
- Okabe H, Obama K, Tanaka E, Nomura A, Kawamura J, Nagayama S, Itami A, Watanabe G, Kanaya S, Sakai Y (2008) Intracorporeal esophagojejunal anastomosis after laparoscopic total gastrectomy for patients with gastric cancer. *Surg Endosc*. doi:10.1007/s00464-008-9987-8
- Ziqiang W, ZhiMin C, Jun C, Xiao L, Huaxing L, PeiWu Y (2008) A modified method of laparoscopic side-to-side esophagojejunal anastomosis: report of 14 cases. *Surg Endosc* 22:2091–2094
- Lee HJ, Yang HK, Ahn YO (2002) Gastric cancer in Korea. *Gastric Cancer* 5:177–182
- Jeong O, Kim BS, Yook JH, Oh ST, Lim JT, Kim KJ, Choi JE, Park GC (2008) Laparoscopic assisted total gastrectomy with

- extracorporeal anastomosis and using circular stapler for middle or upper early gastric cancer: review of single surgeon's experience of 48 consecutive cases. *J Korean Gastric Cancer Assoc* 1: 27–34
15. Asao T, Hosouchi Y, Nakabayashi T, Haga N, Mochiki E, Kuwano H (2001) Laparoscopically assisted total or distal gastrectomy with lymph node dissection for early gastric cancer. *Br J Surg* 88:128–132
 16. Takiguchi S, Sekimoto M, Fujiwara Y, Miyata H, Yasuda T, Doki Y, Yano M, Monden M (2005) A simple technique for performing laparoscopic purse-string suturing during circular stapling anastomosis. *Surg Today* 35:896–899
 17. Matsui H, Uyama I, Sugioka A, Fujita J, Komori Y, Ochiai M, Hasumi A (2002) Linear stapling forms improved anastomoses during esophagojejunostomy after a total gastrectomy. *Am J Surg* 184:58–60
 18. Dulucq JL, Wintringer P, Perissat J, Mahajna A (2005) Completely laparoscopic total and partial gastrectomy for benign and malignant diseases: a single institute's prospective analysis. *J Am Coll Surg* 200:191–197
 19. Omori T, Nakajima K, Endo S, Takahashi T, Hasegawa J, Nishida T (2006) Laparoscopically assisted total gastrectomy with jejunal pouch interposition. *Surg Endosc* 20:1497–1500