

Laparoscopy-assisted proximal gastrectomy with gastric tube reconstruction for early gastric cancer

Ryuusuke Aihara · Erito Mochiki · Teturo Ohno · Mituhiro Yanai · Yoshitaka Toyomasu · Kyoichi Ogata · Hiroyuki Ando · Takayuki Asao · Hiroyuki Kuwano

Received: 2 July 2009 / Accepted: 21 November 2009 / Published online: 8 April 2010
© Springer Science+Business Media, LLC 2010

Abstract

Background In this report, laparoscopy-assisted proximal gastrectomy (LAPG) and gastric tube reconstruction using a mini-loop retractor (MLR) is described for the treatment of early gastric cancer.

Methods Early upper gastric carcinoma with no metastasis had been diagnosed in the subjects of this study. Five surgical ports were inserted into the abdomen. The stomach was lifted to the abdominal wall side with a MLR. Three of five gastric arteries were divided using ultrasonically activated coagulating shears and ligated with ligation forceps. A fixed gastric part with MLR was properly changed according to the lymph node dissection. Reconstruction with a gastric tube (20 cm long, 3 cm wide) using a circular stapler was performed through a small incision, through which the specimen was removed.

Results Fourteen patients underwent LAPG. The mean operating time and blood loss were 202 min and 236 ml, respectively. The operations were performed without serious complications. None was changed to a laparotomy, and there were no deaths.

Conclusions This technique of LAPG and gastric tube reconstruction using MLR for the treatment of proximal early gastric cancer was simple and safe.

Keywords Gastric cancer · Proximal gastrectomy · Laparoscopy · Gastric tube

Due to advances in the screening mechanisms and diagnostic techniques for the stomach, the detection rate of early-stage gastric carcinoma located in the upper one-third of the stomach has increased [1]. For the treatment of upper gastric carcinoma, less invasive surgical procedures, including endoscopic submucosal resection (ESD) and laparoscopic surgery, have been reported [2–5]. The procedure of ESD is performed whenever possible for the treatment of upper small gastric cancer with mucosal invasion. On the other hand, in cases of gastric carcinoma with submucosal invasion or carcinoma of more than 2 cm, gastrectomy with lymph node dissection is recommended by the Japanese Gastric Cancer Association guidelines: D1+ α for mucosal cancer and D1+ β for submucosal cancer with no lymph node metastasis [6]. The extent of resection and the reconstruction method of upper-one-third gastric carcinomas are controversial. Total gastrectomy had been recommended in the past because of its radicality and safety [7]. Recently, no significant difference has been reported in total gastrectomy and proximal gastrectomy in terms of survival. Furthermore, proximal gastrectomy has been recommended because of the physiological function of the remnant stomach compared to that after total gastrectomy [8–11].

In a recent report on laparoscopic surgery for tumors in the upper one-third of the stomach, the techniques of laparoscopy-assisted total gastrectomy (LATG) or proximal gastrectomy (LAPG) have been reported [3–5, 12]. However, they were not standard methods because of the difficulty of the surgical technique. Since June 2007, we have performed LAPG and gastric tube reconstruction in 14 patients with gastric tumors in the upper one-third of the stomach. There were no major complications or patient deaths. In this report, we reveal a safe technique for LAPG with gastric tube reconstruction using a mini-loop retractor

R. Aihara (✉) · E. Mochiki · T. Ohno · M. Yanai · Y. Toyomasu · K. Ogata · H. Ando · T. Asao · H. Kuwano
Department of General Surgical Science (Surgery I), Graduate School of Medicine, 3-39-22, Showamachi, Maebashi, Gunma 371-8511, Japan
e-mail: ryu-aihara@maebashi.saiseikai.or.jp

E. Mochiki
e-mail: emochiki@yahoo.co.jp

(MLR) and a miniature purse-string suture instrument (mini-PSI).

Patients and methods

Patients

Between June 2007 and September 2008, 14 patients underwent laparoscopy-assisted proximal gastrectomy (LAPG) with gastric tube reconstruction at the Department of General Surgical Science (Surgery I) of Gunma University Hospital. The indication for LAPG was determined according to the Guidelines of Gastric Cancer of the Japan Gastric Cancer Society [6]. The tumor was located in the upper one-third of the stomach, and the depth of tumor invasion was diagnosed as less than submucosal invasion. The evaluation of the preoperative stage of gastric cancer was based on examination, including gastrointestinal endoscopy and endoscopic ultrasonography (EUS). All patients underwent computed tomography (CT), and no distant metastasis, such as that in the liver and lymph nodes, was reported. In this method, the dissection of lymph nodes was limited to Nos. 1, 2, 3, 4sa, 4sb, and 7. Proximal resection margins were evaluated intraoperatively as frozen section to confirm freedom from disease.

Surgical technique

The laparoscopic operation was performed with the patient in the open-leg position. A 12-mm port was inserted through the inferior of the umbilicus by the open method,

and the peritoneal cavity was inflated with 10 mmHg carbon dioxide (CO₂). The video laparoscope operator stood between the patient's legs and inserted a flexible gastrointestinal fiberscope through the umbilical port. The surgeon stood to the right side of the patient and, under a laparoscopic guideline, inserted two surgical ports in the right upper abdomen. The first assistant stood to the left side of the patient and inserted two surgical ports from the left upper abdomen (Fig. 1A).

The left side of the greater omentum was opened toward the lower pole of the spleen with ultrasonically activating coagulation shears. The arcade of the right gastroepiploic artery was preserved (LCS, Ethicon, Cincinnati, OH, USA) and LigaSureTM Atlas (Tyco Healthcare). The left gastroepiploic artery and vein were clipped and divided, and No. 4sb lymph nodes were removed. From the left side of the falciform ligament, a MLR (Tyco Healthcare) was inserted into the abdomen (Fig. 1B) [13]. The MLR went through from the lesser omentum to the bursa omentalis, and the stomach body was lifted and fixed to the abdominal wall side (Fig. 2A, B). The apex of the MLR was exteriorized through the access and held on the abdominal wall with forceps. The location of the stomach fixed with the MLR was changed according to the gastrectomy to preserve good tension. The left gastric artery (No. 7) and vein were identified and clipped from the posterior of the stomach (Fig. 2C). After the posterior gastric artery was resected, the short gastric artery (No. 4sa) and vein were divided. The short gastric arteries can be divided safely and easily from the posterior view of the stomach, which is not the case with the anterior approach (Fig. 2D). After releasing the MLR,

Fig. 1 Placement of surgical ports and mini-loop retractor. **A** Placement of surgical ports. Initially, five ports were introduced into the right upper quadrant (5 mm), right middle quadrant (12 mm), umbilical (12 mm), left middle quadrant (5 mm), and left upper quadrant (12 mm). A mini-loop retractor was inserted from the left side of the falciform ligament. **B** The mini-loop retractor consisted of a stainless-steel catheter (2 mm in diameter, 15 cm long), an inner needle, and a wire loop

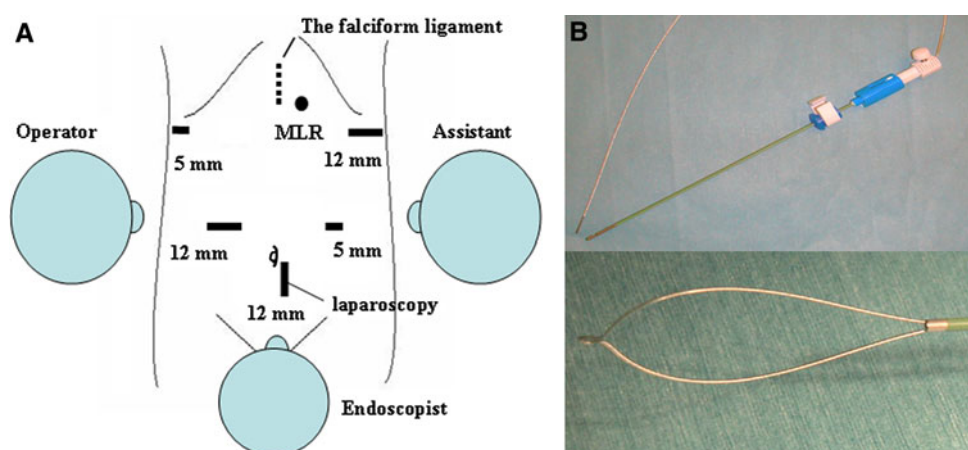
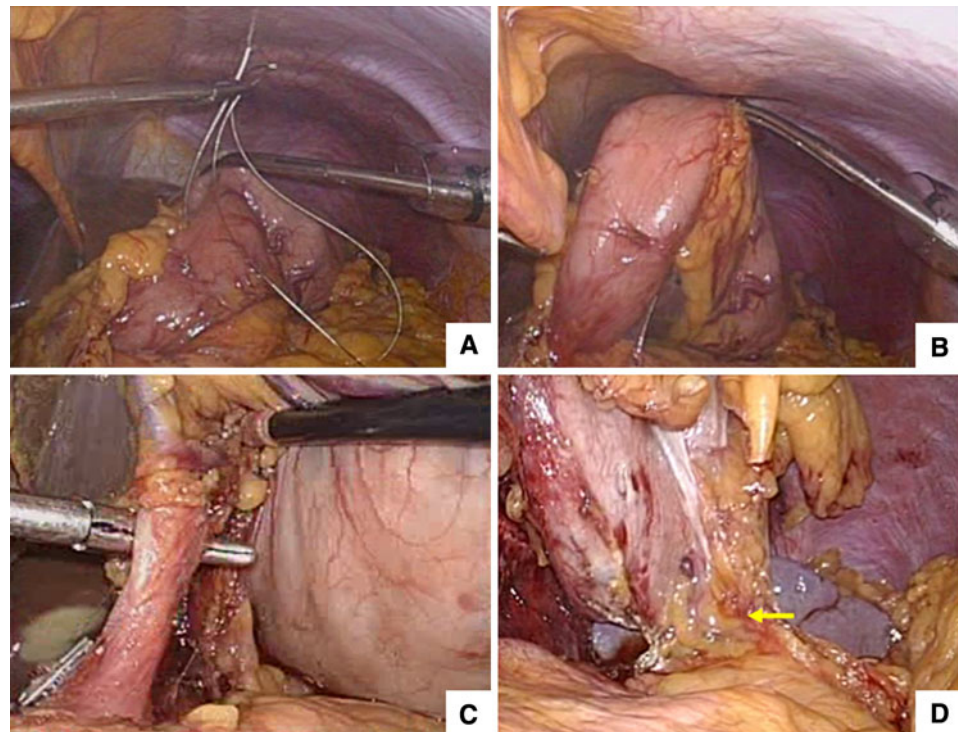


Fig. 2 Intraoperative view of the mini-loop retractor (MLR) insertion and lymph node dissection. **A, B** The MLR is inserted from the upper left of the abdomen, and the stomach is lifted and fixed to the abdominal wall with the MLR. **C** Intraoperative view after dissection of the lymph nodes around the left gastric artery. **D** The short gastric artery was safely and easily ligated from the posterior side of the stomach



the dissection of the lesser curvature (Nos. 1 and 3) and greater curvature (No. 2) was progressed to the EG junction. The vagal nerve was divided enough to introduce the stomach to the out of the stomach. The right gastric artery and right gastroepiploic artery were not resected.

A median incision (about 5 cm long) was made at the epigastrium and the peritoneal cavity was entered. The laparotomy wound was protected and retracted using a wound-sealing device (Lap Protector, Hakko Medical Co., Nagano, Japan). The vessel tape was introduced through the posterior of the esophagus, and the esophagocardiac junction was elevated to the abdominal wall side. The esophagus was transected using a mini-PSI [14], and the anvil head of a circular stapler (CDH, 25 mm, Ethicon) was inserted into the esophageal stump.

The reconstruction was performed using the gastric tube. The stomach was introduced to the out of the abdomen through the median incision. After the vessels of the greater and lesser curvatures were ligated, the gastric body was divided with a linear stapler device to make the gastric tube (20 cm long, 3 cm wide) (Fig. 3A). After the dissected line was closed with 3-0 Vicryl (Fig. 3B), the gastric tube and the esophagus were anastomosed by a circular stapler introduced through the stump of the gastric tube (Fig. 3C). The access opening on the gastric tube stump was closed with the laparoscopic linear stapler device (Fig. 3D). The diaphragm–esophagus gastric tube was

sutured to prevent leakage and reflex esophagitis. The pyloplasty was adequately performed using the finger fracture method. After the drain was inserted into the anastomosis through the right upper port, the wound was closed in three layers.

Results

Fourteen patients (11 male and 3 female) underwent LAPG. The mean age was 62.2 years (range = 48–71 years). The mean operating time and blood loss were 202 min (range = 146–271 min) and 236 ml (range = 21–455 ml), respectively. The postoperative depth of invasion for the LAPG included 11 cases of T1, 1 case of proper muscle, 1 case of subserosal invasion, and 1 case of gastrointestinal stromal tumor. All procedures were curative. The resected margin was always free from invasion. No laparoscopic surgery had to be changed to a laparotomy. There was no hemorrhaging, pancreatic fistula, or abdominal abscess. Reflux symptoms were observed in 2 of 14 patients. Four patients (35%) experienced postoperative complications, including four patients with anastomotic stenosis and one patient with anastomotic leakage. Each case of stenosis required one or two endoscopic dilations. The mean postoperative hospital stay was 16 days (range = 11–35). 5-POD fluoroscopy using an oral contrast medium revealed

Fig. 3 Method of gastric tube reconstruction. **A, B** The upper two-thirds of the stomach was resected using a linear stapler device. **C** A center rod was pierced through the posterior wall of the gastric tube. **D** The anastomosis was made between the esophagus and the gastric tube

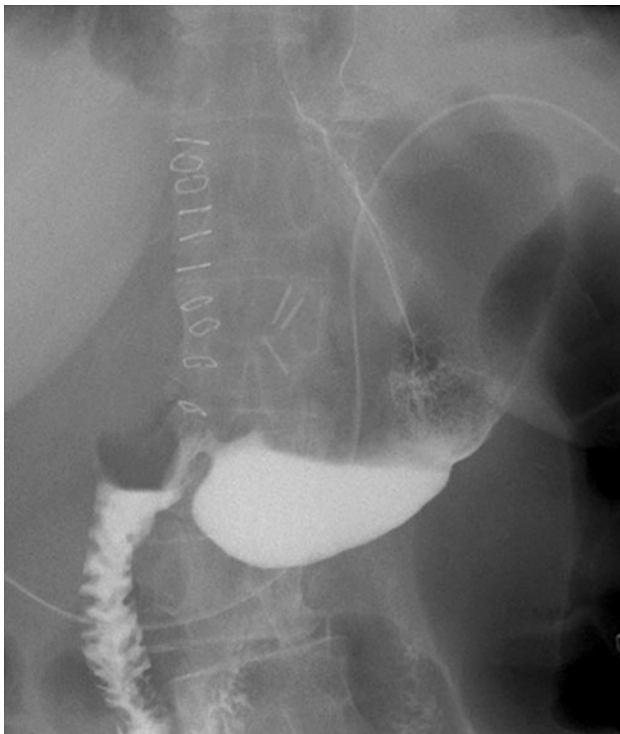
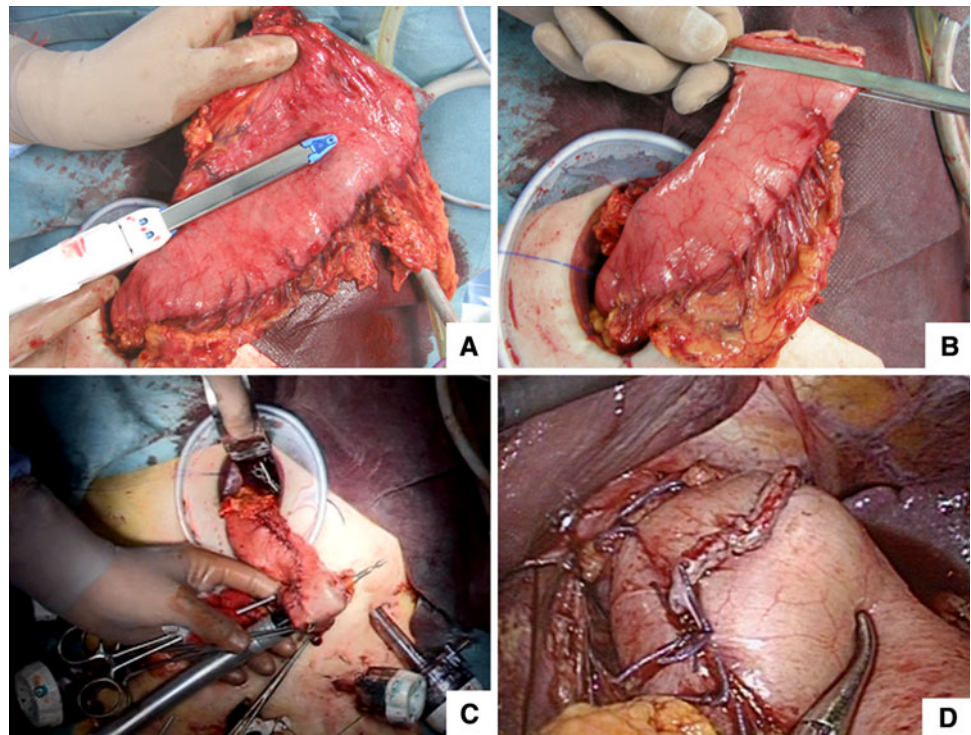


Fig. 4 5-POD fluoroscopy revealed neither leaks nor stenosis of the anastomosis

no leaks or stenosis of the anastomosis (Fig. 4). All patients have been free from recurrence for a follow-up period of 19 months.

Discussion

Recently, there have been advances in the screening mechanism and, thus, the detection rate of upper-one-third early-stage gastric carcinomas [1]. It is now possible to treat these tumors with minimal surgery using techniques such as endoscopic submucosal resection (ESD) or laparoscopic surgery [2–5]. However, these techniques are not standard methods, especially for treating gastric cancer in the upper one-third of the stomach, because these methods are technically difficult. Furthermore, gastric carcinomas of the upper one-third of the stomach have been treated with total gastrectomy in open surgery, and proximal gastrectomy has been considered appropriate treatment for early-stage upper gastric cancer [8–11]. In this article we revealed a safe laparoscopic technique to resect the proximal stomach using a mini-loop retractor followed by gastric tube reconstruction.

The benefits of proximal gastrectomy for early-stage gastric carcinoma of the upper one-third of the stomach have been reported. The procedure has been compared with total gastrectomy with respect to safety and digestive function. Various reconstruction methods have been tried; however, none has been determined as the best [8–11]. Gastroesophageal reconstruction has frequently been performed since the direct anastomosis is very simple. However, severe reflux esophagitis has been reported as a complication of gastroesophageal reconstruction [8, 15]. On the other hand, jejunum interposition has been reported

to be a less complicated method than gastroesophageal reconstruction [11, 16]. However, jejunum interposition is complex and time-consuming because it requires at least three anastomoses. Since the laparoscopic technique of proximal gastrectomy for gastric carcinoma in the upper one-third of the stomach is very complex, a simple and less complicated method has been recommended.

The use of a gastric tube made from the greater curvature of the stomach provides a simple and safe anastomosis for proximal gastrectomy because it is a single anastomosis. The technique of gastric tube reconstruction by open surgery was first reported by Adachi et al. [9] to prevent esophageal reflux. They demonstrated that gastric tube reconstruction is superior to jejunum interposition because it is simple, safe, and less complex. In 2002, Shiraishi et al. [10] reported on the clinical outcome of gastric tube reconstruction. This procedure has a shorter operating time, faster recovery, lower hospital expenses, and superior performance compared with jejunum reconstruction or total gastrectomy. Thus, proximal gastrectomy followed by gastric tube reconstruction has several advantages over other methods.

In 1999, Kitano et al. [12] reported two cases of laparoscopy-assisted proximal gastrectomy (LAPG) followed by gastric tube reconstruction. He revealed that the technique is safe and minimally invasive for early-stage upper gastric carcinoma. The present technique is simple and safe with the use of MLR and mini-PSI. Since 1999, laparoscopic gastrectomies have been performed at Gunma University Hospital with an MLR and mini-PSI. Laparoscopy-assisted distal gastrectomy (LADG) and laparoscopy-assisted total gastrectomy (LATG) using MLR have been reported to be safe and easy [3–5, 13, 14]. The advantages of the technique reported here are as follows: (1) MLR enables the surgeon to have a clear view of the laparoscopic procedure and, thus, to easily resect a lymphoid and ligate a major vessel. (2) Mini-PSI allows the surgeon to easily fix the anvil head to the abdominal esophagus through the small abdominal incision. (3) Diaphragm–esophagus gastric tube suturing prevents the anastomotic lesion from moving above the diaphragm as well as leakage and reflux esophagitis. Thus, using these developed instruments, LAPG followed by gastric tube reconstruction can be performed safely and easily.

There have been reports about the complications of proximal gastrectomy. Reflex esophagitis and anastomotic stenosis have been reported as problems common to proximal gastrectomy. With regard to the gastroesophageal reflex after gastric tube reconstruction, Adachi et al. [9] reported that only one patient (7%) complained of heartburn. In our series, reflex esophagitis with symptoms was observed in only 2 (14%) of 14 patients. All reflex symptoms were relieved by medication. This result was almost

compatible with that of a previous report of gastric tube reconstruction. On the other hand, in our series, the incidence of anastomotic stenosis (35%) was markedly higher than in previous reports. Balloon dilatation was found to effectively manage gastroesophageal anastomotic stenosis [9]. The cause of anastomotic stricture is not clear. The different calibers of esophagus and gastric tube might cause the anastomotic stenosis. In addition, in our study, all patients with gastroesophageal reflux had anastomotic stenosis. This result suggested that the gastroesophageal reflux is associated with anastomotic stenosis. All cases of stenosis required one or two endoscopic dilations and did not show any recurrence [17, 18]. However, further clinical observation and prospective controlled studies are needed to elucidate the development of anastomotic stenosis.

In conclusion, laparoscopy-assisted proximal gastrectomy with gastric tube reconstruction using MLR was a simple and safe technique for the treatment of proximal early gastric cancer. When patients are carefully selected, LAPG can be curative and minimally invasive for the treatment of upper-third early-stage gastric cancer.

Disclosures Dr. Takayuki Asao received royalty on a patent from Covidien (Tyco Healthcare) Japan. Drs. Ryuusuke Aihara, Erito Mochiki, Teturo Ohno, Mitsuhiro Yanai, Yoshitaka Toyomasu, Kyoichi Ogata, Hiroyuki Ando, and Hiroyuki Kuwano have no conflicts of interest or financial ties to disclose.

References

1. Salvon-Harman JC, Cady B, Nikulasson S, Khettry U, Stone MD, Lavin P (1994) Shifting proportions of gastric adenocarcinomas. *Arch Surg* 129:381–389
2. Ono H, Kondo H, Gotoda T, Shirao K, Yamaguchi H, Saito D, Hosokawa K, Shimoda T, Yoshida S (2001) Endoscopic mucosal resection for treatment of early gastric cancer. *Gut* 48:229–255
3. Mochiki E, Kamimura H, Haga N, Kuwano H (2002) The technique of laparoscopically assisted total gastrectomy with jejunal interposition for early gastric cancer. *Surg Endosc* 16:540–544
4. Mochiki E, Kamiyama Y, Aihara R, Nakabayashi T, Kamimura H, Asao T, Kuwano H (2004) Postoperative functional evaluation of jejunal interposition with or without a pouch after a total gastrectomy for gastric cancer. *Am J Surg* 187(6):728–735
5. 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(9):1997–2002
6. Nakajima T (2002) Gastric cancer treatment guideline in Japan. *Gastric Cancer* 5(1):1–5
7. Papachristou DN, Fortner JG (1996) Adenocarcinoma of the gastric cardia: the choice of gastrectomy. *Ann Surg* 192:58–64
8. Harrison LE, Karpeh MS, Brennan MF (1998) Total gastrectomy is not necessary for proximal gastric cancer. *Surgery* 123:127–130
9. Adachi Y, Inoue T, Hagino Y, Shiraishi N, Shimoda K, Kitano S (1999) Surgical results of proximal gastrectomy for early-stage gastric cancer: jejunal interposition and gastric tube reconstruction. *Gastric Cancer* 2:40–50
10. Shiraishi N, Adachi Y, Kitano S, Kakisako K, Inomata M, Yasuda K (2002) Clinical outcome of proximal versus total

- gastrectomy for proximal gastric cancer. *World J Surg* 26:1150–1154
11. Katai H, Sano T, Fukagawa T, Shinohara H, Sasako M (2003) Prospective study of proximal gastrectomy for early gastric cancer in the upper third of the stomach. *Br J Surg* 90:850–853
 12. Kitano S, Adachi Y, Shiraiishi N, Suematsu T, Bando T (1999) Laparoscopic-assisted proximal gastrectomy for early gastric carcinomas. *Jpn J Surg* 29:389–391
 13. Asao T, Yanagita Y, Nakamura J, Hosouchi Y, Takenoshita S, Nagamachi Y (1999) Usefulness of visceral mini-retractor accessible without trocar port during laparoscopic surgery. *Surg Endosc* 13:91
 14. 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
 15. Hsu CP, Chen CY, Hsieh YH, Hsia JY, Shai SE, Kao CH (1997) Esophageal reflux after total or proximal gastrectomy in patient with adenocarcinoma of the gastric cardia. *Am J Gastroenterol* 92:1347–1350
 16. Takeshita K, Saito N, Saeki I, Honda T, Tani M, Kando F, Endo M (1997) Proximal gastrectomy and jejunal pouch interposition for the treatment of early cancer in the upper third of the stomach: surgical techniques and evaluation of postoperative function. *Surgery* 121:278–286
 17. Pierie JP, de Graaf PW, Poen H, van der Tweel I, Obertop H (1993) Incidence and management of benign anastomotic stricture after cervical oesophagogastronomy. *Br J Surg* 80:471–474
 18. Shemesh E, Czemiak A (1990) Comparison between Savary-Gilliard and balloon dilatation of benign esophageal strictures. *World J Surg* 14:518–521