



Technical note

Intraabdominal Roux-en-Y reconstruction with a novel stapling technique after laparoscopic distal gastrectomy

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Abstract

Laparoscopic gastrectomy is widely used as minimally invasive surgery for gastric carcinoma. Billroth I or Roux-en-Y reconstruction is commonly performed after laparoscopic distal gastrectomy (LDG). Roux-en-Y reconstruction after LDG is one of the best methods for reconstruction of the alimentary tract when Billroth I reconstruction is difficult. There are few reports of intracorporeal Roux-en-Y reconstruction after LDG because of the technical difficulties of such a procedure. In particular, in the case of a very small gastric remnant, gastrojejunostomy using endoscopic linear staplers becomes more complicated. We developed a new technique for intracorporeal Roux-en-Y reconstruction: a modified stapling technique to allow the gastrojejunostomy to be made on the stomach transecting line that is applicable even when the residual stomach is very small. Roux-en-Y reconstruction with our modified technique was performed in six patients. There was no intraoperative complication or conversion to minilaparotomy or conventional celiotomy in any patient. Oral intake was easy and adequate after surgery. The present Roux-en-Y reconstruction procedure is feasible. Herein we describe an intraabdominal Roux-en-Y reconstruction with a modified stapling technique after LDG.

Key words Laparoscopic surgery · Distal gastrectomy · Roux-en-Y reconstruction · Gastric carcinoma

Introduction

Laparoscopic or laparoscopy-assisted gastrectomy is a widely accepted surgical treatment for gastric cancer

in Japan [1–3]. We and others have reported the advantages of the laparoscopic procedure compared to the conventional open method [4–6]. Distal gastrectomy is usually followed by Billroth I or Roux-en-Y anastomosis to restore continuity of the alimentary tract. When Billroth I reconstruction is difficult because of the physical status of the patient or because a large portion of the stomach has been resected, Roux-en-Y anastomosis is an alternative. Because intraabdominal anastomotic procedures are very complex, Billroth I or Roux-en-Y reconstruction is commonly performed extracorporeally through a minilaparotomy incision; thus, it is termed laparoscopy-assisted gastrectomy [7]. There have been only a few reports of intracorporeal Billroth I or Roux-en-Y reconstruction after laparoscopic distal gastrectomy (LDG). Kanaya and colleagues [8] developed a method for Billroth I anastomosis after LDG that uses only endoscopic linear staplers. Takaori et al. [9] reported intracorporeal Roux-en-Y anastomosis with linear staplers, where the gastrojejunostomy was performed by “functional end-to-end anastomosis” between the residual stomach and the jejunum. In another type of intracorporeal side-to-side gastrojejunostomy, the outlet of the jejunum is arranged in a cranial-caudal straight direction [7]. In the case of a very small gastric remnant, the posterior wall of the greater curvature side near the transected stapler line becomes particularly susceptible to ischemia because the blood supply from the short gastric artery is interrupted by stapling for the gastrojejunostomy, as commonly performed using endoscopic linear staplers. To avoid this potentially dangerous condition, we have developed a new technique for intraabdominal Roux-en-Y reconstruction to allow the gastrojejunostomy to be made on the stomach transecting line.

Herein we describe a unique but secure intraabdominal stapling technique that can be used even in patients with a very small residual stomach after LDG.

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Patients and methods

Patients

At our institutions, laparoscopic gastrectomy has been applicable for all patients with preoperatively diagnosed T1 and T2 N0 or N1 gastric carcinoma. Between January 1996 and August 2006, 206 patients with preoperatively diagnosed gastric carcinoma underwent extracorporeal Billroth I or Roux-en-Y reconstruction through an approximately 5-cm minilaparotomy after LDG at either of our two institutions. Since August 2006, our technique has advanced to allow intracorporeal Roux-en-Y reconstruction with endoscopic linear staplers, and this modified technique has been used in 98 patients with gastric carcinoma. Roux-en-Y reconstruction with our modified technique was performed in 6 patients with a very small gastric remnant. As the anastomosis of a conventional Roux-en-Y reconstruction using endoscopic linear staplers is made on the posterior wall or greater curvature side of the remnant stomach, the following two conditions are essential to avoid creating ischemic parts in the gastric remnant after reconstruction: a valid blood supply from the short gastric arteries after reconstruction, and a sufficiently wide angle between the transection line and the anastomosis. We performed our new Roux-en-Y reconstruction in six patients with a very small gastric remnant, according to the operative findings, as these critical conditions could not be achieved. Details of our approach to the intracorporeal Roux-en-Y reconstruction after LDG are described below. Reconstruction was undertaken when the gastric carcinoma was located in the antrum and/or the body of the stomach. The procedure was accompanied by D1 or D2 lymph node dissection, as described in the *General rules for the gastric study in surgery and pathology in Japan* [10].

Surgical technique

Each patient was placed in the supine reverse Trendelenburg position with legs apart, under general anesthesia. Five working ports, including a subumbilical port inserted by the open method, were placed (Fig. 1). A laparoscope was inserted at the subumbilical port. Carbon dioxide pneumoperitoneum was achieved at a pressure of 8–10 mmHg. Under laparoscopic vision, two ports for the operator's use were inserted in the right abdomen, and two ports for the assistant's use were inserted in the left abdomen. Lesions marked by clips during preoperative gastroscopy were identified by X-ray during surgery. Mobilization of the stomach and lymph node dissection were performed as previously described [5]. The duodenum was divided with the use of an endoscopic linear stapler (Echelon 60–2.5 or 3.5;

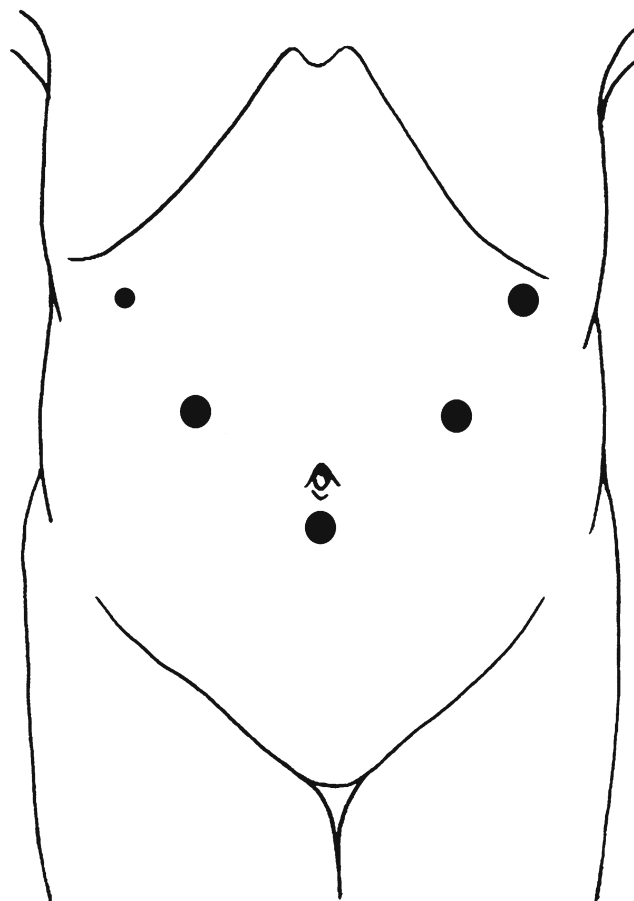


Fig. 1. Locations of five ports. Placement of subumbilical 12-mm trocar for a laparoscope. Two or three 12-mm trocars are added to insert an endoscopic linear stapler. A subumbilical or left subcostal port site is extended to 3–4 cm to retrieve the excised specimen

Ethicon Endo-Surgery, Cincinnati, OH, USA) immediately after dissection of the infra- and suprapyloric nodes.

Roux-en-Y reconstruction with the modified stapling technique

Usually, the stomach was not transected at the end of its mobilization and lymph node dissection, although our modified Roux-en-Y reconstruction could be performed after the stomach was transected. On the distal side of the proposed transection line, an endoscopic atraumatic intestinal clamp was applied to avoid leakage of the gastric contents. A small incision was made on the greater curvature of the planned transection line. The jejunal limb and a small incision were prepared. The jejunum 20–30 cm distal to Treitz' ligament was prepared as a Roux limb. The mesentery was divided along the jejunum for approximately 5 cm, and the resulting ischemic part of the jejunum was discarded by

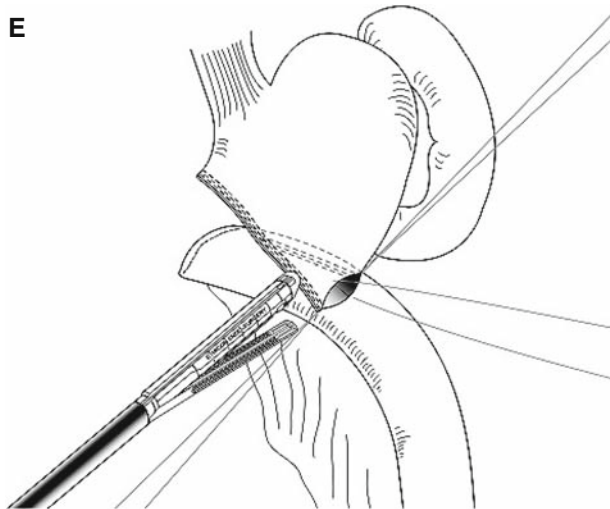
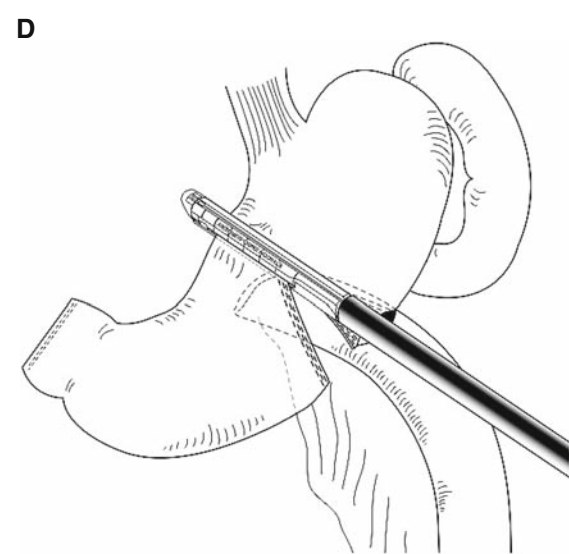
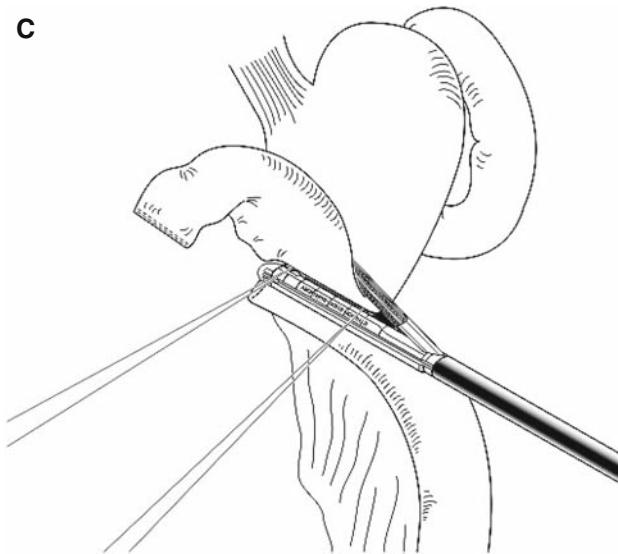
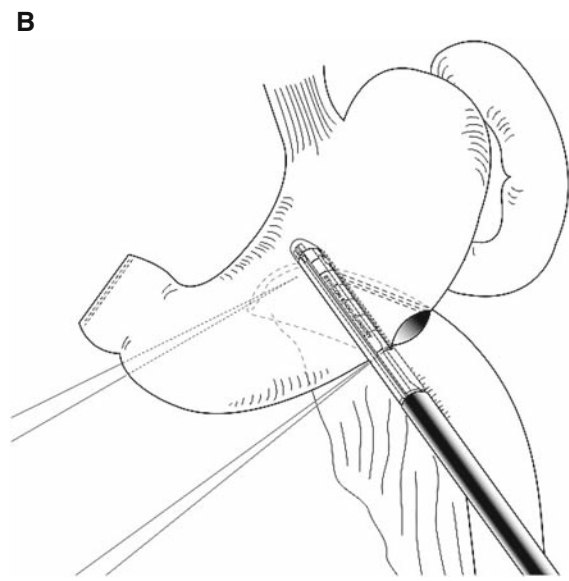
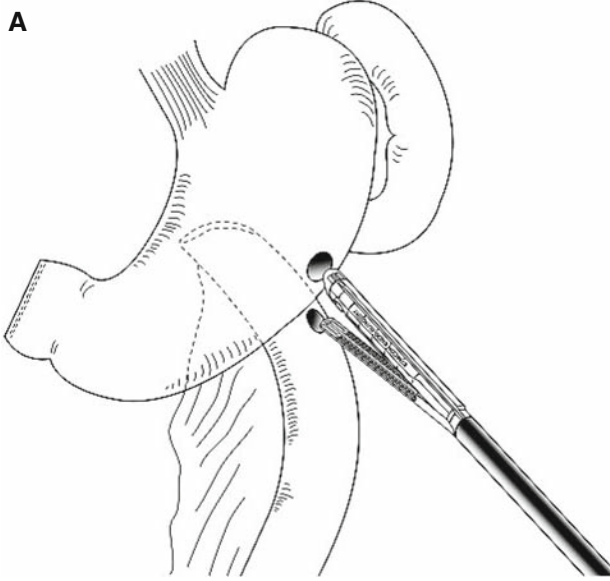
transection with an endoscopic linear stapler (Echelon 60-2.5) to allow the jejunal limb to be moved to the residual stomach without any tension. The jejunal limb was brought up via the antecolic route. A small incision was made on the anti-mesenteric side of the Roux jejunal limb, 6 cm from the stump, for a side-to-side anastomosis. The small incision on the jejunum was made longitudinally to prevent reduction of the size of the outlet of the anastomosis after closure of the common incision for insertion of the stapler. A 60-mm endoscopic linear stapler (Echelon 60-3.5) was introduced into the abdominal cavity through the left subcostal port. The anvil fork side of the linear stapler was inserted into a small incision of the jejunum, and then the cartilage fork side was inserted into a small incision of the gastric remnant. After step-by-step insertion of the stapler forks, the posterior wall of the stomach along the planned transection line and the anti-mesenteric side of the jejunum were put together, and an anastomosis was made with the linear stapler (Fig. 2A). A V-shaped anastomosis was thus created on the posterior wall of the stomach. To make the gastrojejunostomy on the transection line of the gastric remnant, the next stapling involved the anterior wall of the stomach along the planned transection line and the anal (distal side) line of the V-shaped anastomosis made by the first stapling (Fig. 2B). In this step, two or three anchor sutures allowed the initial staple line on the anal side to be excised easily and adequately to remove the potentially ischemic part of the gastric wall and prevent reduction of the size of the resulting gastrojejunostomy (Fig. 2C). Following the second stapling, transection along the planned line toward the lesser curvature was completed with one or two additional staples (Fig. 2D). Finally, the initial common incision was closed vertically along the jejunum by hand-sewing with PDS II 4-0 (Ethicon) or with an endoscopic linear stapler (Fig. 2E) and the intraabdominal gastrojejunostomy was thus completed (Fig. 3). Side-to-side or end-to-side jejunojunctionostomy was performed 30 cm from the gastrojejunostomy in the conventional manner, with a linear stapler, intracorporeally, or by hand-sewing through a port site extended to 3–4 cm for the purpose of removing excised specimens.

Results

Between August 2006 and December 2008, 203 patients with gastric carcinoma underwent distal gastrectomy at our institution. During this period, LDG was indicated for 149 patients. In these patients, we used Billroth I reconstruction in 57 patients after LDG, and Roux-en-Y reconstruction in 92 patients. Roux-en-Y reconstruction with our modified technique that eliminates the distal-side anastomotic stapler line was performed in 6 patients; 4 men and 2 women, with an average age of 64 years (range, 48–77 years). Mean body mass index (\pm SD) was 20.3 ± 2.6 kg/m². According to the *Japanese classification of gastric carcinoma* [10], 3 patients were stage I, 2 were stage II, and 1 was stage III. There was no intraoperative complication or conversion to mini-laparotomy or conventional celiotomy in any of these 6 patients. Mean time (\pm SD) from the beginning of the operation to the completion of the Roux-en-Y gastrojejunostomy was 56 ± 8 min for the modified technique. No patient had a cancer-positive surgical margin, verified by pathologic examination. The mean proximal margin size (\pm SD) in the 6 patients was 1.5 ± 0.5 cm, excluding the discarded stapling line of about 0.5 cm. In 1 patient, the stomach was transected before making the Roux-en-Y gastrojejunostomy because the surgical margin should have been determined. The modified Roux-en-Y reconstruction was carried out without any problem in this patient, although additional staplers were required. There was no significant difference in postoperative courses between the patients with the modified Roux-en-Y procedure and the courses of the other patients. In the 6 patients with the modified Roux-en-Y procedure, the nasogastric tube was removed at the end of surgery; oral intake was resumed on postoperative day 2, and the mean postoperative hospital stay was 8 days. There was no anastomotic leak or delayed gastric emptying, conditions which might lengthen the hospital stay. No patient suffered heartburn. A barium swallow study performed in 4 patients who underwent the modified Roux-en-Y reconstruction showed normal transit (Fig. 4). During the follow-up period (mean, 17 months), none of the patients developed complications related to the anastomosis.

Fig. 2. **A** The first stapling is between the posterior wall of the stomach along the planned transection line and the anti-mesenteric side of the jejunum. A V-shaped anastomosis is created on the posterior wall of the stomach. **B** View from the anterior aspect of the second stapling. This must be performed between the anterior wall of the stomach along the planned transection line and the jejunum involving the distal-side staple line of the gastrojejunostomy. **C** View from the poste-

rior wall of the stomach of the second stapling line. In this step, two or three anchor sutures allow the initial staple line to be excised easily and accurately. **D** Additional stapling is applied in continuity to the second stapler line to complete transection of the stomach. Finally, the initial common entry incision is closed transversely by hand-sewing with PDS II 4-0 (Ethicon) or **E** by the application of an endoscopic linear stapler



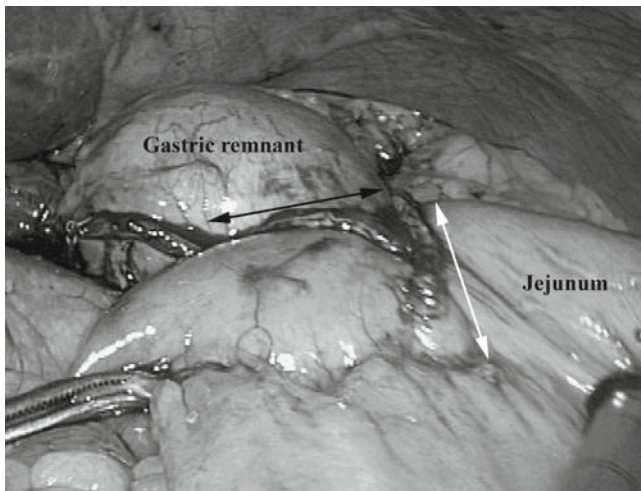


Fig. 3. Completion of gastrojejunostomy with the novel Roux-en-Y reconstruction technique that eliminates the distal-side gastrojejunostomy staple lines. A sufficient-sized anastomosis (*black arrow*) and outlet to the jejunum (*white arrow*) are achieved

Discussion

Recent advances in surgical techniques and modalities have allowed adequate dissection of regional lymph nodes and safe reconstruction during laparoscopic and laparoscopy-assisted gastrectomy for the treatment of gastric carcinoma [4–6]. However, there are still some problems with anastomotic procedures after laparoscopic or laparoscopy-assisted distal gastrectomy that must be addressed [7]. Billroth I reconstruction is most commonly performed after laparoscopic gastrectomy to facilitate anastomosis. When Billroth I reconstruction is difficult, Billroth II reconstruction or Roux-en-Y reconstruction must be used. With respect to the potential risk of carcinogenesis in the gastric remnant, and reflux esophagitis or gastritis due to bile influx into the gastric remnant, Roux-en-Y reconstruction is thought to be superior to Billroth II [11–13]. However, choosing the best reconstruction method among several feasible types of anastomosis remains problematic.

The decision to use Roux-en-Y reconstruction instead of Billroth I reconstruction after laparoscopic or laparoscopy-assisted distal gastrectomy is made during surgery, depending on the following situations in which Billroth I reconstruction cannot be performed: the resected range of the distal stomach is too wide because of the location of the lesion (for example, a lesion located in the middle or upper body of the stomach) and/or there are problems with the patient's physical status. Thus, the laparoscopic Roux-en-Y reconstruction procedure was developed. Roux-en-Y reconstruction can be performed through a minilaparotomy, but

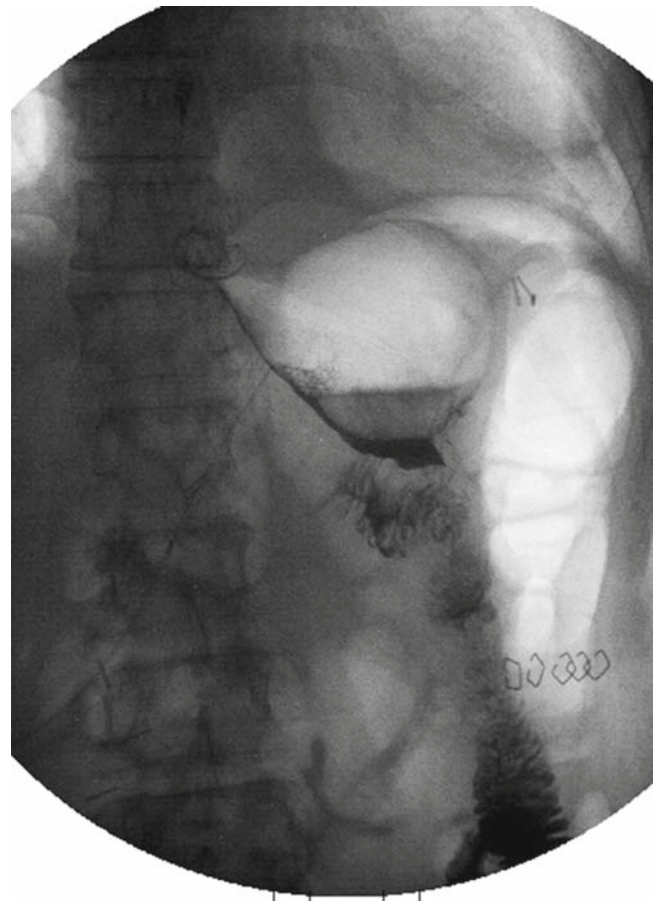


Fig. 4. Postoperative barium swallow study showing normal transit in a patient who underwent Roux-en-Y reconstruction performed by the modified technique

this is sometimes difficult when the gastric remnant is too small to be handled through the minilaparotomy. Placement of the Roux limb through the minilaparotomy often results in torsion. To avoid intestinal torsion or other difficulties in the reconstruction through the minilaparotomy, we must carry out Roux-en-Y reconstruction either by extending the minilaparotomy or by performing the procedures intracorporeally. Although there is no evidence that the intracorporeal reconstruction is superior to the extracorporeal reconstruction with respect to advantages for the patients, we have performed intraabdominal Roux-en-Y reconstructions for use after LDG. In the special condition that the gastric remnant is very small, the present modified technique is used. This procedure is novel in that the distal-side stapling line is eliminated so that the anastomosis can be made along the transection line of the gastric remnant.

Our modified technique of Roux-en-Y reconstruction is feasible and safe. Oral intake is easy and adequate after surgery because a sufficient sized anastomosis is

obtained. We make the anastomosis with a 60-mm linear stapler and close the common incision transversely in relation to the jejunal limb so that the size of the V-shaped anastomosis is maximized. Even though the distal-side stapling line of the gastrojejunostomy is eliminated, the size of the anastomosis is sufficient. Another important point is the need for smooth transit to the jejunal limb through the anastomosis. When a functional end-to-end anastomosis is used for gastrojejunostomy [8], the prong of the V-shaped anastomosis is directed toward the outlet of the jejunal limb, and the outlet of the jejunal limb is sometimes raised cranially, bending the anastomosis. These factors may result in disturbed gastric emptying. We arrange the outlet to the jejunal limb caudally. With our present method of gastrojejunostomy, the gastric outlet is large, and the transit is smooth if the common incision is closed carefully, to avoid jeopardizing the size of the outlet. In this context, we recommend hand-sewn closure of the common incision for insertion of the stapler arms. We often use intracorporeal hand-sewing instead of staplers to close the common entry hole. We also use anchor knot suturing to make the stapling easy and secure. Intracorporeal hand-sewing techniques require some skill, but would allow variations in laparoscopic surgeries that could yield better outcomes. Furthermore, the number of linear staplers per surgery could be reduced.

For our new Roux-en-Y reconstruction method, which eliminates one of the gastrojejunostomy stapling lines, the location and the extent of the lesions must be accurately confirmed before and during surgery, because the stomach is not transected before completion of the gastrojejunostomy. We confirm the location of the lesions marked by preoperatively placed clips. Consequently, in the present series, there was no single patient with a cancer-positive surgical margin, as proven by pathologic examination. If determination of the surgical margin is necessary during surgery, the stomach may be transected before reconstruction. Transection of the stomach has little influence on the carrying out of our modified Roux-en-Y reconstruction apart from the increased number of endoscopic linear staplers required. Actually, we performed transection before reconstruction in one of our six patients.

We have developed a method for intraabdominal Roux-en-Y reconstruction after LDG. Our Roux-en-Y reconstruction is feasible and safe, and it can be used especially in patients with a very small residual stomach after LDG.

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