Book-Binding Technique for Billroth I Anastomosis During Totally Laparoscopic Distal Gastrectomy

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Surgical technique

A schematic illustration of the operation is shown in Figure 1. Distal gastrectomy and lymph node dissection were performed according to the guidelines of the Japanese Gastric Cancer Association[1] Under general anesthesia, the patient was in the supine position. Using the cut-down method, a 12-mm trocar was inserted in the umbilical region and a pneumoperitoneum was created. A laparoscope was then inserted through the trocar, and the liver was pulled up using a silicone disc.[2] After removing the distal stomach, reconstruction was performed using the book-binding technique (BBT) or a delta-shaped (DS) anastomosis, depending on the operator's preference. Details of the distal gastrectomy and DS anastomosis procedures have been reported previously.[3-6] Only the BBT is explained briefly in this article (see also Video 1, online only). Small entry holes were made in the greater curvature side of the stomach and in the duodenal stump (Fig. 1). An entry hole on the side of the stomach was made in the anterior wall, and an entry hole on the duodenal stump was also made in the anterior wall. A 45-mm endoscopic linear stapler was inserted through the left lower port, and a jaw was inserted into each of the entry holes (Fig. 1C). Then, the duodenum and remnant stomach were attached on the posterior wall (Fig. 1B). Using ultrasonic scissors, all transection lines on the duodenum, the anterior side of the anastomosis line between the duodenum and the stomach, and approximately one-third of the transection lines on the stomach were dissected, and holes were made in the anterior wall (Fig. 1C). These holes in the anterior wall, including the entry hole of the linear stapler, were anastomosed together using 2 applications of the linear stapler to form the tip of a triangle. Book-binding technique anastomoses were intracorporeally completed (Fig. 2A to C).

DISCUSSION

Totally laparoscopic distal gastrectomy was established as a method for the intracorporeal resection and anastomosis using the laparoscopic technique[7-10]; it has several advantages over laparoscopy-assisted distal gastrectomy, including a smaller wound, less invasiveness, and better feasibility for secure ablation.[7] However, intracorporeal reconstruction is sometimes difficult. Therefore, the method of reconstruction varies among institutions.[11-14] Some institutions use a circular stapler; others use a linear stapler for Billroth I reconstruction or Roux-en-Y reconstruction. We usually performed DS anastomosis for intracorporeal Billroth I anastomosis. The DS anastomosis method was first reported by Kanaya and colleagues[15] in 2002 and has since been used at many institutions in Japan. Previously, we retrospectively analyzed 114 serial patients who underwent DS anastomosis at least 1 year earlier, and we showed the feasibility of using this method.[4] Our study demonstrated the infrequent complications associated with this method. However, in some cases, we could not use DS anastomosis for technical reasons. For DS anastomosis, at least 45 mm of remnant duodenum were needed because the fork of the 45-mm linear stapler had to be inserted longitudinally.[4,16] In a severely obese patient or a patient with a history of cholecystectomy, the duodenum may not be long enough. To address this issue, we established a new method.

The book-binding technique involves an intracorporeal triangulating anastomosis based on the Billroth I method. The triangulating anastomosis is a method of end-to-end anastomosis that uses a linear stapler in open surgery for colectomy, gastrectomy, and esophagectomy.[17-20] Feasible results have been reported; the lumen of anastomosis was wide and postoperative anastomotic complications were rare. To complete this technique intracorporeally, we modified the triangulating anastomosis procedure to establish the BBT. The first side between the posterior

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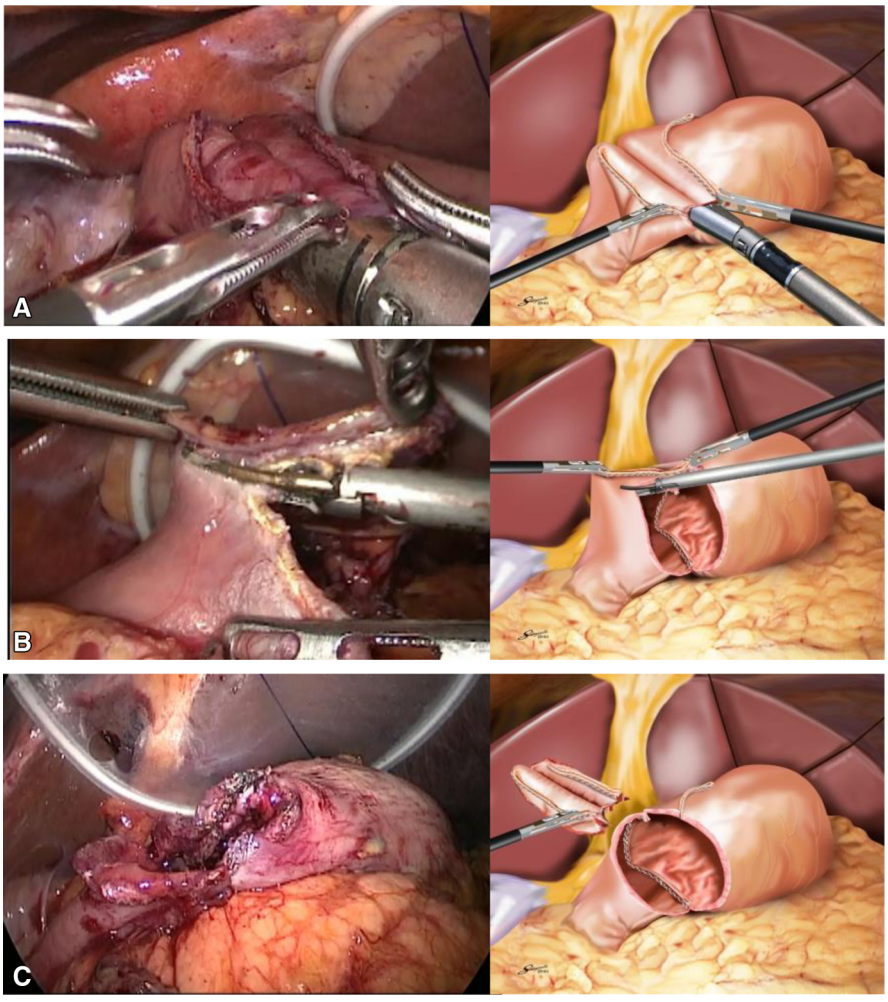

Figure 1. First step of the book-binding technique (BBT). (A) The stapler is inserted straight into the duodenum and remnant stomach. (B) All transection lines on the duodenum, anterior side of the anastomosis line between the duodenum and stomach, and approximately one-third of the transection line on the stomach are dissected. (C) The anterior walls of the duodenum and stomach are opened in this procedure.

wall of the duodenum and the remnant stomach was made without fully opening the duodenum and stomach stump (Fig. 1A). A linear stapler was used for the small incision made at the anterior wall of the duodenum and stomach. Next, removal of the duodenum end and distal side of the stomach end was necessary (Fig. 1B, C). The duodenum and stomach were opened once in this procedure, but closed when the second (Fig. 2A) and third sides were created (Fig. 2B).

Between January 2011 and December 2013, 103 patients underwent totally laparoscopic distal gastrectomy for gastric cancer at the Department of Surgical Science, Kyushu University. Of these patients, 50 underwent BBT or DS anastomosis for Billroth I anastomosis. Other patients underwent Roux-en-Y anastomosis because the tumor was located in the upper stomach or the cancer had invaded the duodenum. The 2 methods were selected by the operator at a BBT:DS ratio of 2:1. However, DS anastomosis was not used if the patient had a history of cholecystectomy because this was not a prospective comparative study. Preoperative assessments were made using endoscopy, endoscopic ultrasonography, abdominal ultrasonography, and CT to characterize the tumors. Patients were retrospectively classified according to the reconstructive procedure into the BBT (n = 33) and DS anastomosis groups (n = 17). The clinical and pathologic backgrounds of the patients are summarized in Table 1. There were no significant differences in age,

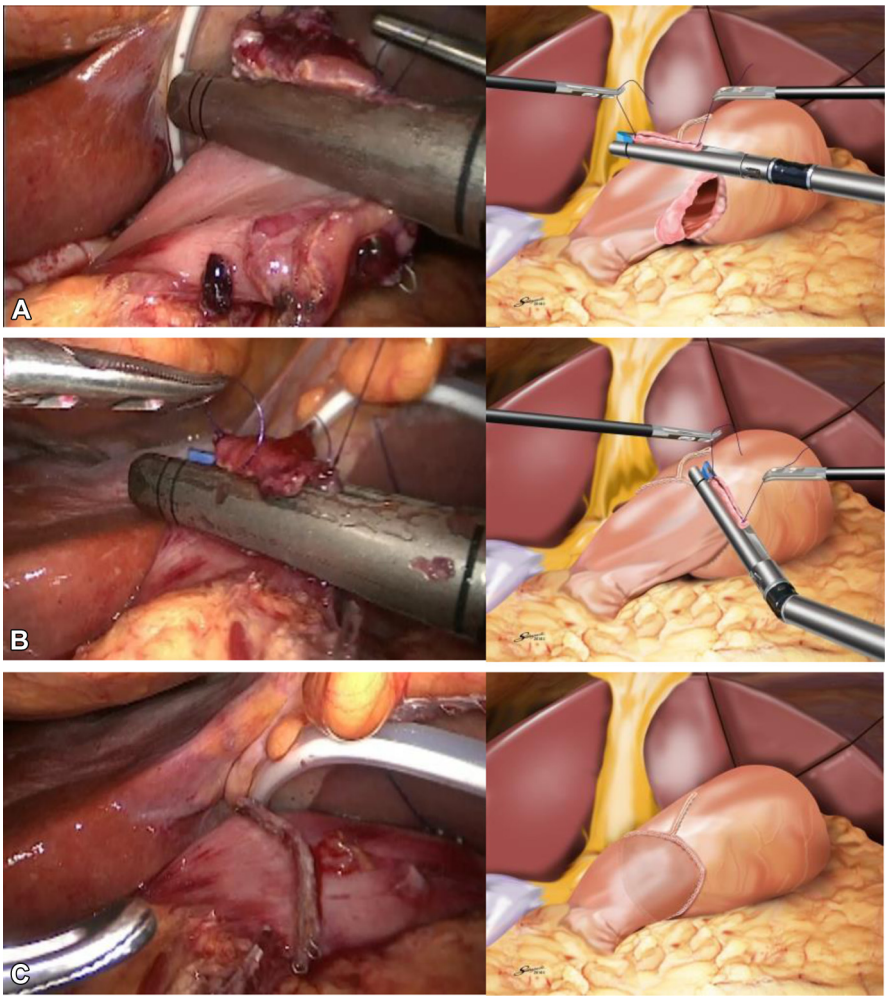

Figure 2. (A) Second and (B) third staples of the triangulating anastomosis. The duodenum and remnant stomach are anastomosed together using 2 applications of the linear stapler to form the tip of a triangle. (C) The book-binding technique is intracorporeally completed.

sex, body mass index, or stage and location of the tumor between the 2 groups. Four patients in the BBT group and 2 in the DS group had a BMI > 25 kg/m^2. Two patients had a history of cholecystectomy in the BBT group; none in the DS group had a history of cholecystectomy. The extent of lymph node dissection was different between the 2 groups. A D2 gastrectomy was chosen for 43% (17 cases) of patients in the BBT group, and 12% (2 patients) in the DS group. The bias was attributable to the nonrandom selection performed by the operators. Details of operative status are given in Table 2. The mean ($\pm$ SD) operating time did not significantly differ between the 2 procedures (289.4 $\pm$ 46.5 minutes for the BBT group, 307.5 $\pm$ 79.2 minutes for the DS group). However, the mean time ($\pm$ SD) required for anastomosis was different between the 2 procedures (41.6 $\pm$ 12.9 minutes for BBT anastomosis, 26.1 $\pm$ 10.4 minutes for DS anastomosis; $p = 0.0003$). Estimated blood loss, time to first flatus, and duration of postoperative hospital stay did not differ significantly between the 2 groups. Minor leakage was observed in 1 patient who underwent DS anastomosis in the follow-up period, but no postoperative complications were observed in the BBT group. All patients began eating food 3 or 4 days after the operation. In our analysis, we determined that the BBT is not inferior to DS anastomosis in terms of perioperative factors and postoperative complications. Delta-shaped anastomosis requires an assistant to cover the stapler with the duodenum after mobilization of the duodenum. However, the BBT requires only insertion of the stapler into the duodenum without any special preparation. We believe that the BBT is simpler than DS anastomosis. The

Table 1. Patient Characteristics

Characteristic	BBT* (n = 33)	DS Anastomosis (n = 17)	p Value
Mean age, y ± SD	61.1 ± 2.1	67.6 ± 2.4	NS
Sex, n			
Male	19	11	NS
Female	14	6	
BMI, kg/m^2, mean ± SD	21.7 ± 2.7	22.1 ± 4.1	NS
T, n (%)			
T1	25 (76)	15 (88)	NS
T2–3	8 (24)	2 (12)	
N, n (%)			
N0	25 (76)	16 (94)	NS
N1–2	8 (24)	1 (6)	
Location of cancer, n (%)			
Middle	20 (61)	12 (71)	NS
Lower	13 (39)	5 (29)	
Histology, n (%)			
Intestinal	15 (45)	12 (71)	NS
Diffuse	18 (55)	5 (29)	
Extent of lymph node resection, n (%)			
D1+	19 (57)	15 (88)	0.027
D2	14 (43)	2 (12)	
Resected lymph nodes, n ± SD	33 ± 15	40 ± 18	NS

*Two patients in the BBT group had a history of cholecystectomy; none in the DS group had a history of cholecystectomy.
BBT, book-binding technique; BMI, body mass index; DS, delta-shaped.

operative times for BBT anastomosis for each case are shown in Figure 3. The time was defined as the duration from the time the operator began to cut the stump of the stomach to the end of anastomosis. The time required for the BBT gradually decreased as the method became more standardized. By the last case, the time had shortened to nearly half of that in the early cases, when the method was first introduced. Similarly, the time for anastomosis can be shortened after sufficient experience.

Table 2. Perioperative Factors of Book-Binding Technique and Delta-Shaped Anastomosis

Variables	BBT (n = 33)	DS Anastomosis (n = 17)	p Value
Operation time, min, mean ± SD	289.4 ± 46.5	307.5 ± 79.2	NS
Time required for the anastomosis, min, mean ± SD	41.6 ± 12.9	26.1 ± 10.4	0.0003
Bleeding, g, mean ± SD	133.8 ± 23.6	96.6 ± 23.4	NS
Open conversion	0	0	NS
Time to first diet, d, mean ± SD	4.4 ± 0.9	4.5 ± 2.4	NS
Anastomotic leakage*	0	1	NS
Anastomotic bleeding*	0	0	NS

*More than Grade I of the Clavien–Dindo classification.
BBT, book-binding technique; DS, delta-shaped.

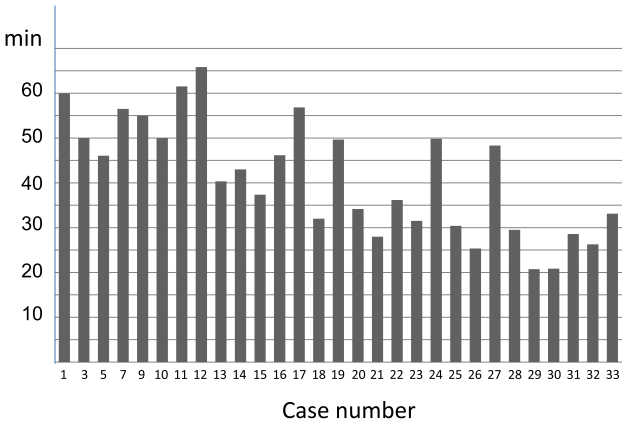

Figure 3. The time required for the book-binding technique. Required time for anastomosis is calculated via video recordings. In 3 cases, the recordings could not be used to assess the time.

Here, we introduced the BBT to overcome the problems associated with DS. The BBT does not require extra detachment and mobilization of the duodenum and can anastomose the remnant stomach and duodenum. This method can be used in patients even after they have undergone cholecystectomy and in obese patients. Therefore, we believe that the BBT may become a standard method for intracorporeal anastomosis in the future.

Author Contributions

Study conception and design: Oki, Ikeda
Acquisition of data: Saeki, Imamura, Nakashima, Ohgaki
Analysis and interpretation of data: Tsuda, Ando
Drafting of manuscript: Oki
Critical revision: Morita, Maehara

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