



Morphologic Analysis of Gastroesophageal Reflux Diseases in Patients after Distal Gastrectomy

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Abstract. The precise mechanisms that cause gastroesophageal reflux after distal gastrectomy remain unclear. We analyzed the endoscopic findings of the cardia and the position of the remnant stomach, which are related to gastroesophageal reflux. We retrospectively examined the records of 45 patients with Billroth I (B-I) and 39 patients with Roux-en-Y (R-Y) procedure for gastric cancer. Esophagitis was evaluated by the Los Angeles (LA) classification. The endoscopic findings of hiatus hernia were classified according to the criteria of the Keio Cancer Detection Center form (K-form). The valvular appearance of the cardia was classified according to V-grades. The height of the remnant stomach was measured on computed tomography scans. The postoperative findings of esophagitis in the B-I group were significantly worse than the preoperative findings, but no significant change was observed in the R-Y group. The postoperative V-grades and K-form findings in the B-I group were worse than their preoperative findings. In the R-Y group, however, there was no significant change in the V-grades or K-form findings. In addition, the height of the remnant stomach was significantly higher in the B-I group than in the R-Y group. This study suggested that an aggravated cardia is associated with the B-I procedure and that the position of the remnant stomach may therefore play an important role in the occurrence of postoperative reflux esophagitis. In contrast, the R-Y operation was shown to preserve the cardia and the position of the remnant stomach better. As a result, R-Y might help prevent not only duodenogastric reflux but also gastroesophageal reflux.

activity has been reported to be related to the alkaline exposure (detected by pH monitoring), and trypsin is known to play an important role in the development of reflux esophagitis after gastrectomy [7-9]. It is important to maintain the postoperative QOL during treatment for reflux esophagitis after distal gastrectomy.

Reflux esophagitis after distal gastrectomy should be treated conservatively with a protease inhibitor or cisapride [10]. However, the protease inhibitor has been reported to be ineffective in 35.7% of patients after 6 weeks of administration [11]. It is therefore important for patients undergoing distal gastrectomy to be treated by a surgical modality that prevents reflux esophagitis. The Roux-en-Y reconstruction (R-Y) prevents duodenogastric reflux [12-14]. However, gastroesophageal reflux in R-Y patients has not yet been examined in detail, and the factors related to gastroesophageal reflux remain unclear. The gastroesophageal valve is an important factor affecting the prevention of gastroesophageal reflux. A previous report showed that the endoscopic findings of the gastroesophageal valve viewed by a retroflexed scope were related to the yield pressure [15]. A hiatus hernia has been shown to be related to low esophageal pressure and has been reported to play a key role in the development of reflux disease [16-18]. We evaluated the endoscopic findings of hiatus hernia based on the Keio Cancer Detection Center form (K-form) [19]. Conventionally, hiatus hernia is usually diagnosed on the basis of radiographic findings. More than 70% of endoscopic hiatus hernia cases evaluated by the K-form have been found to correspond to a hiatus hernia diagnosed by radiographic examination. In addition, the height of the remnant stomach in the supine position might affect gastroesophageal reflux of intestinal juice. When the remnant stomach is high in the supine position, gastroesophageal reflux can easily occur. In the present study, we measured the distance between the remnant stomach and the esophagus on computed tomography (CT) scans.

We analyzed the endoscopic findings of the cardia and CT findings of the remnant stomach to determine whether a disturbance of antireflux mechanisms is induced by the B-I reconstruction but not by the R-Y procedure.

Symptoms of gastroesophageal reflux disease have been previously reported to occur in about 30% of patients undergoing distal gastrectomy with Billroth I reconstruction (B-I) [1,2]. Untreated reflux esophagitis has been reported to have a greater effect on the quality of life (QOL) than other diseases, such as angina pectoris, untreated hypertension, and duodenal ulcer [3]. There are two important factors that cause reflux esophagitis after distal gastrectomy with B-I. The first factor is duodenogastric reflux that includes bile and pancreatic juice. The second factor is gastroesophageal reflux that includes gastric acid and intestinal juice. Previous studies have shown that alkaline exposure detected by pH monitoring might play an important role in the pathogenesis of reflux esophagitis after distal gastrectomy [4-6]. Trypsin

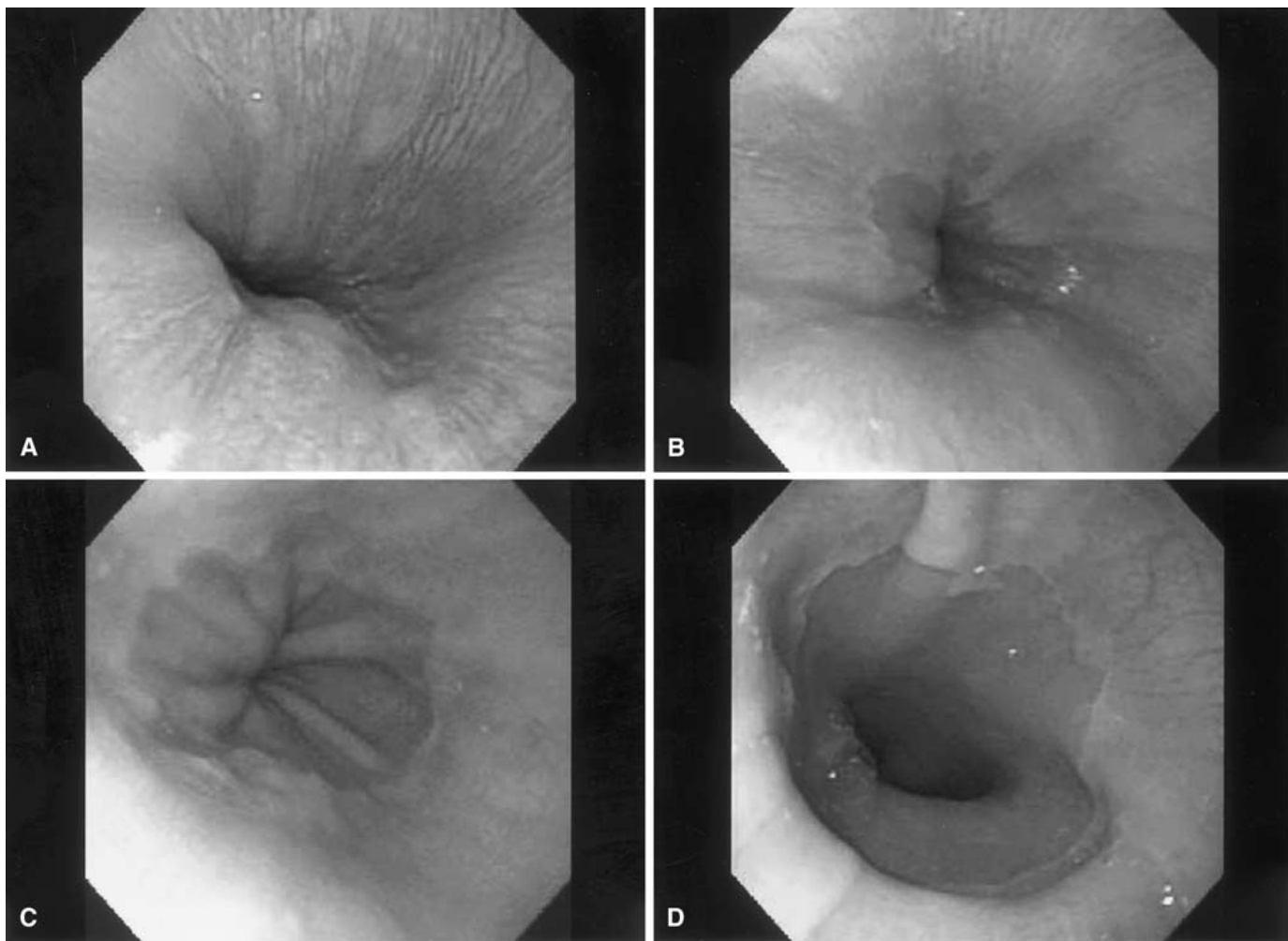


Fig. 1. Endoscopic findings of hiatal hernia were classified according to K-form criteria. **A.** With grade 0, the mucosal junction is below the hiatus. **B.** With grade C, the mucosa is seen partially above the hiatus, **C.** With grade B, the gastric mucosa is seen circularly less than 3 cm above hiatus, **D.** Grade A is a definite hiatal hernia. A sac-shaped portion covered with the gastric mucosa is seen more than 3 cm above the hiatus.

Patients and Methods

We retrospectively examined the pre- and postoperative findings of upper gastroesophageal endoscopy and the CT findings of the patients who had undergone distal gastrectomy for gastric cancer at Keio University Hospital, Tokyo. After distal gastrectomy the patient undergoes follow-up examinations, including endoscopy and abdominal CT, on the same day. The patients have not eaten a meal since the night before the examination. In almost all cases, there was no or little residual food in the remnant stomach. Of the 62 patients who underwent distal gastrectomy for gastric cancer between January and December 2000, a total of 45 underwent B-I. All of them were enrolled in this study. Of the 711 patients who underwent distal gastrectomy for gastric cancer between December 1994 and May 2002, a total of 39 underwent R-Y. All of them were enrolled in this study.

Esophagitis was evaluated by such endoscopic findings as mucosal breakage, which was graded according to the Los Angeles (LA) classification [20]. Grade A is one or more mucosal breaks confined to the mucosal folds, each no longer than 5 mm. Grade B is at least one mucosal break more than 5 mm long confined to the

mucosal folds but not continuous between the tops of two mucosal folds. Grade C is at least one mucosal break continuous between the tops of two or more mucosal folds but that is not circumferential. Grade D is a circumferential mucosal break.

The endoscopic findings of hiatal hernia were classified according to the K-form criteria [19]. In grade 0, the mucosal junction is below the hiatus. Grade A is a definite hiatal hernia, and a sac-shaped portion covered with the gastric mucosa is seen more than 3 cm above the hiatus. Grades B and C are minor hernias. With grade B, the gastric mucosa is seen circularly less than 3 cm above the hiatus. With grade C, the mucosa is seen partially above the hiatus (Fig. 1).

The valvular appearance of the cardia visualized from below using the retroflexed endoscope was evaluated by V-grades as reported by Ismail et al. [15]. The V-grades are classified as follows: V0 is no hiatal hernia and a normal valve appearance. V1 is a small hiatal hernia, and the cardia is closed around the gastroscope. V2 is an open cardia with minimum distension and no hiatal hernia. V3 is an open cardia and a hiatal hernia (Fig. 2).

The relative height of the remnant stomach in each patient was evaluated on postoperative CT scans as follows. The height of the

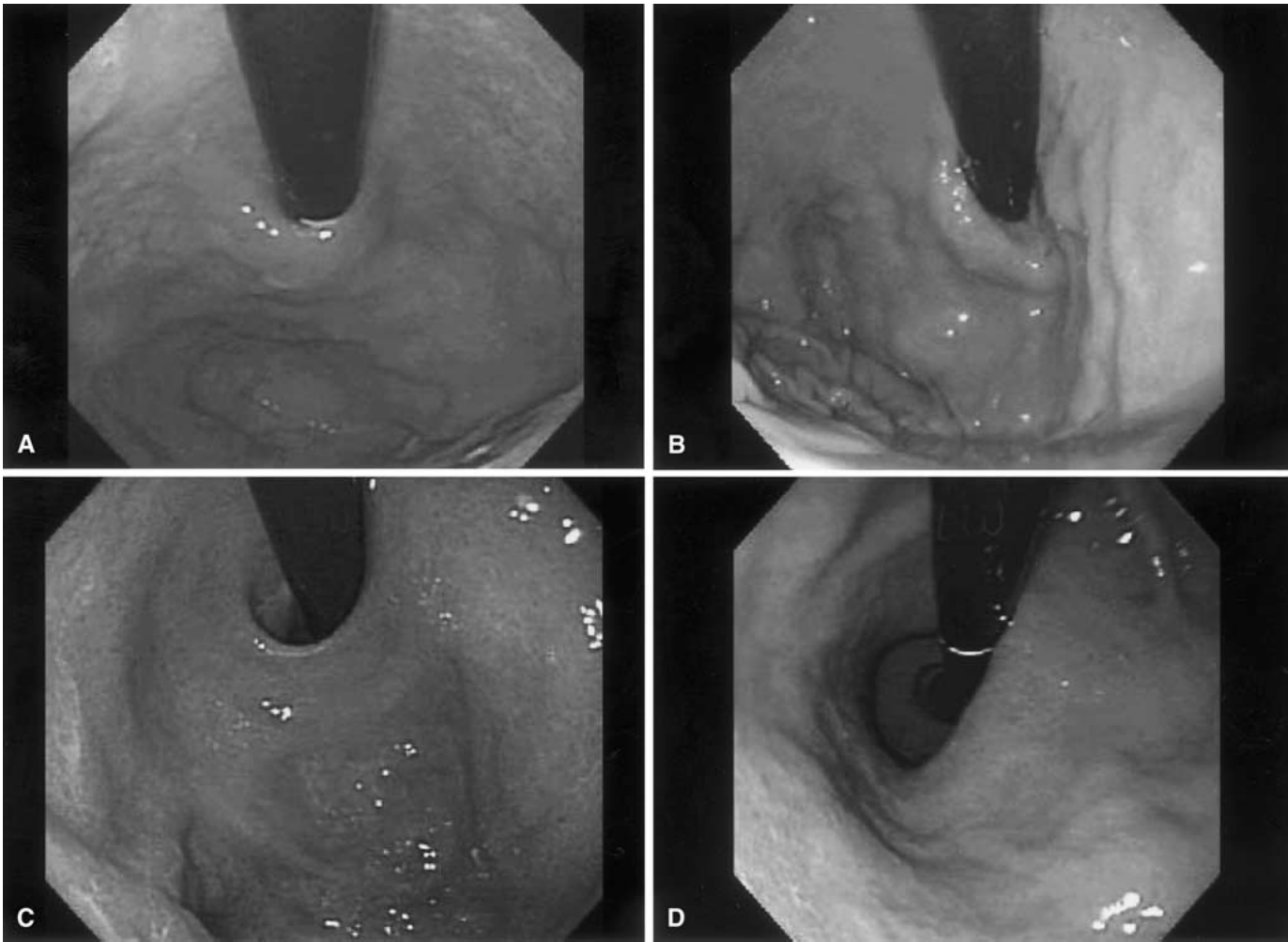


Fig. 2. Valvular appearance of the cardia was evaluated by V-grades. **A.** V0 is no hiatus hernia and normal valve appearance. **B.** V1 is a small hiatus hernia, and the cardia is closed around the gastroscope. **C.** V2 is an open cardia with minimum distension and no hiatus hernia. **D.** V3 is an open cardia and a hiatus hernia.

esophagus was measured as the distance between the esophagus and the dorsum (Fig. 3A). The height of the remnant stomach was measured as the distance between the top of the remnant stomach and the dorsum (Fig. 3B). The relative height of the remnant stomach was calculated by subtracting the height of the esophagus and the remnant stomach.

The findings in each group were statistically analyzed by the chi-squared test or the Mann-Whitney test. Differences were considered significant at $p < 0.05$.

Results

Patient characteristics

The patient characteristics in each group are shown in Table 1. There were 45 patients in the B-I group; 32 of them were male; and the median age at operation time was 62.0 ± 12.3 years (range 40-87 years). There were 39 patients in the R-Y group; 30 of them were male; and the median age at the time of operation was 60.8 ± 12.4 years (range 22-83 years). The location of the

tumors was classified according to the general rules for a gastric cancer study [21]. In the B-I group, the primary tumors were mainly located in the middle third of the stomach (M) in 26 patients (58%) and mainly in the lower third (L) in 19 patients (42%). In the R-Y group, the primary tumors were mainly located in the middle third (M) in 25 patients (64%) and mainly in the lower third (L) in 14 patients (36%). There were no statistically significant differences in sex, age, tumor location, disease stage, or lymph node dissection.

We performed D2 lymph node dissection in patients with advanced-stage disease based on the surgical findings. Kocherization of the duodenum was performed in all patients who underwent distal gastrectomy, regardless of the reconstruction method, to explore the paraaortic lymph nodes.

LA Classification

The findings of reflux esophagitis evaluated according to the LA classification are shown in Fig. 4. In the B-I group, 8 of 44 (18%) were diagnosed as having reflux esophagitis by preoperative

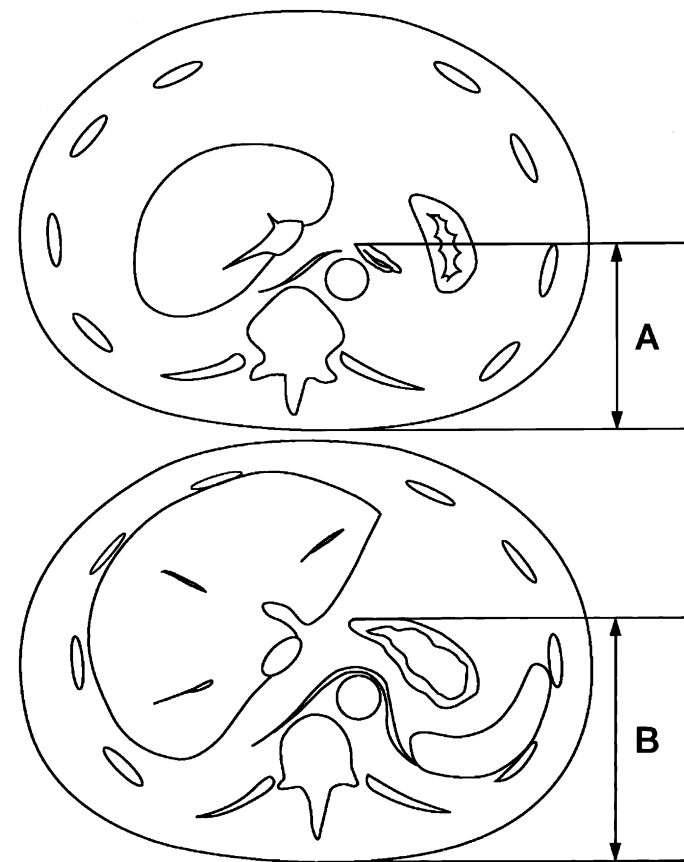


Fig. 3. **A.** Height of the esophagus was measured by postoperative computed tomography scans. The distance between the esophagus and the dorsum was evaluated as the height of the esophagus. **B.** The distance between the top of the remnant stomach, and the dorsum was evaluated as the height of the remnant stomach. The relative height of the remnant stomach was calculated by subtracting the height of the esophagus and the height of the remnant stomach.

Table 1. Patient characteristics

Characteristic	B-I	R-Y
No.	45	39
Sex		
Male	32	30
Females	13	9
Age	62.0 ± 12.3	60.8 ± 12.4
Stage		
Early	33	26
Advanced	12	13
Location of the tumor ^a		
M	24	23
ML	2	2
LM	4	2
L	15	12
Lymph node dissection		
D1	33	26
D2	12	13

The differences between groups were not significant for all categories.

^aM: middle third of the stomach; L: lower third of the stomach; ML, LM: proportional in the middle and lower third.

endoscopy. Of the 8 with reflux esophagitis, 7 (16%) were grade A, and 1 (2%) was grade B. After the operation, the number of patients with reflux esophagitis increased to 20 of 42 (48%). Of

the 20 with reflux esophagitis, 12 (29%) were grade A. Three patients were classified as grade B or C (7%), and two (5%) were classified as grade D. In the R-Y group, 5 of 37 (14%) were diagnosed as having reflux esophagitis before surgery. Of the five with reflux esophagitis, four (11%) were grade A, and one (3%) was grade B. After surgery, 5 of 35 (14%) were diagnosed with reflux esophagitis, and 3 (9%) were grade A. One patient each was grade B and grade C (3%), respectively. There was no significant difference between the pre- and postoperative prevalence of reflux esophagitis in the R-Y group.

K-Form

The findings of hiatus hernia evaluated by K-form are shown in Figure 5. In the B-I group, 27 of 44 (61%) were grade 0; 17 of 44 (39%) had a hiatus hernia before the operation. Of the 17 with a hiatus hernia, 7 (16%) were grade C, and 10 (23%) were grade B. No patient had a definite hiatus hernia. After surgery, the number of patients with a hiatus hernia increased to 36 of 42 (86%). Of these 36 hernias, 12 were grade C (29%), and 17 were grade B (40%). In addition, 7 (17%) patients had a definite hernia evaluated as grade A. As a result, in comparison with the preoperative findings of hiatus hernia, the postoperative findings were worse ($p < 0.01$) in the B-I group. In the R-Y group, preoperative endoscopy revealed that 9 of 37 (24%) hernias were grade C, and 12 of 37 (32%) were grade B. After surgery, 35 underwent postoperative endoscopy: 8 (23%) hernias were grade C, and 14 (40%) were grade B. One (3%) patient had a definite hiatus hernia. However, there were no significant differences between the pre- and postoperative findings of hiatus hernia in the R-Y group.

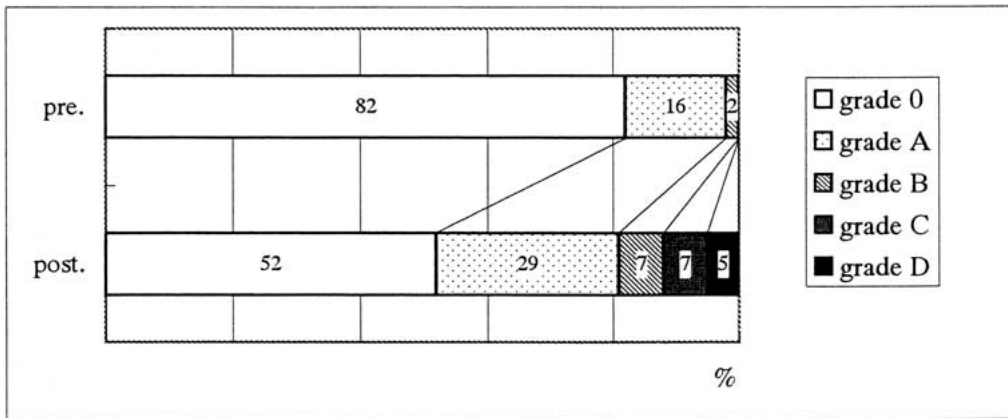
V-grades

The results for the V-grades are shown in Figure 6. In the B-I group, 25 of 38 (66%) had abnormal findings for the gastroesophageal valve before the operation: V1, 17 (45%); V2, 8 (21%). The other 13 (34%) had a normal valve (V0). After surgery, 40 of 42 (95%) had abnormal findings for the gastroesophageal valve: V1, 25 (60%), V2, 4 (10%); V3, 11 (26%). The postoperative appearance of the valve was worse compared to the preoperative findings ($p < 0.01$). In the R-Y group, 31 of 35 (89%) had abnormal gastroesophageal valve findings before the operation: V1, 21 (60%); V2, 9 (26%); V3, 1 (3%). The other 4 (11%) were V0. Postoperative endoscopy revealed that 30 of 34 (88%) had an abnormal valve: V1, 20 (59%); V2, 7 (21%); V3, 3 (9%). The other 4 (12%) were V0. There were no significant differences between the pre- and postoperative findings regarding the valve.

Distance between Remnant Stomach and Esophagus

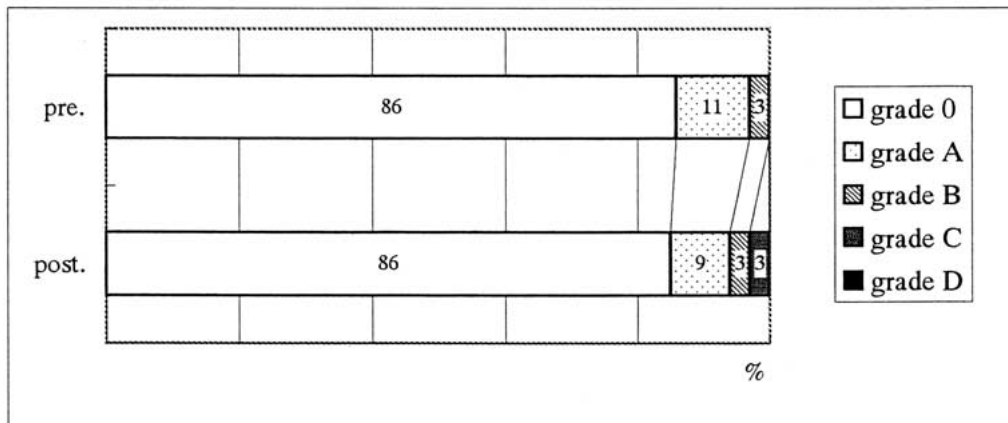
The average distance between the esophagus and the top of the remnant stomach in the B-I group (postoperative CT was performed in 25 patients) was 8.20 ± 1.55 cm. In the R-Y group (postoperative CT was performed in 22 patients), the average distance between the esophagus and the top of the remnant stomach was 5.23 ± 2.38 cm. The difference between the B-I group and the R-Y group regarding the distance between the esophagus and the remnant stomach based on the Mann-Whitney test was statistically significant ($p < 0.05$).

p<0.01



(a) Billroth-I

N. S.



(b) Roux-en-Y

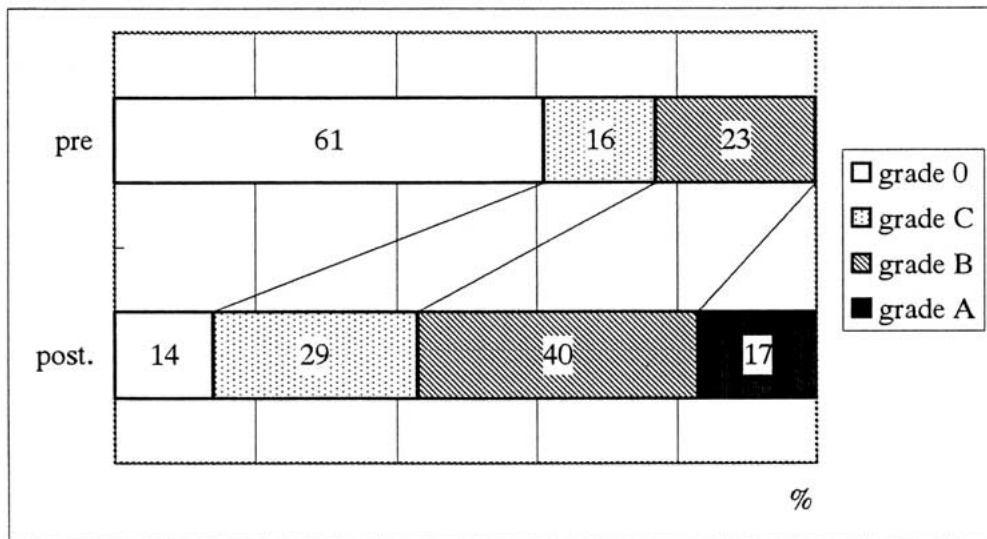
Fig. 4. a. Postoperative incidence of reflux esophagitis was compared with the preoperative incidence using the chi-squared test. The postoperative incidence was higher than the preoperative incidence in the B-I group, b. In the R-Y group, there was no significant difference between the pre- and postoperative incidence of reflux esophagitis.

Discussion

Gastroesophageal reflux disease affects the QOL of patients undergoing distal gastrectomy. In those patients, the prevention and treatment of gastroesophageal reflux disease are important for maintaining a good postoperative QOL. Symptoms of gastroesophageal reflux have been reported to occur in about 30% of the patients undergoing distal gastrectomy with B-I [1, 2]. The pathogenesis of the reflux esophagitis comprised two factors: duodenogastric and gastroesophageal reflux. With this pathogenesis, B-I often results in duodenogastric reflux, whereas R-Y tends to prevent duodenogastric reflux [12–14]. We encountered a patient with severe reflux esophagitis after distal gastrectomy with B-I anastomosis and converted the anastomosis to R-Y. Simultaneous pH monitoring of the lower esophagus and remnant stomach showed a similar mean pH value in the esophagus and

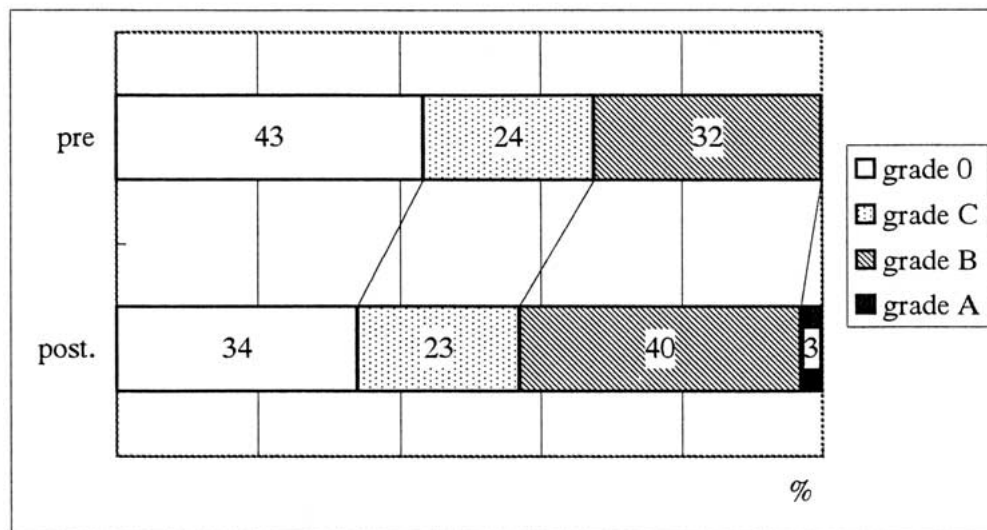
remnant stomach before the R-Y conversion. However, the mean pH value of the esophagus decreased and a discrepancy in the pH value between the esophagus and the remnant stomach appeared after the R-Y conversion [14]. It was thus speculated that the R-Y conversion affected not only duodenogastric reflux but also gastroesophageal reflux. In the present study, we evaluated the findings that cause gastroesophageal reflux using endoscopy and CT scans. The laxation of the cardia affects gastroesophageal reflux, and the presence of a hiatus hernia plays a key role in reflux esophagitis [16–18]. We analyzed the pre- and postoperative findings of the cardia in patients with B-I or R-Y procedures using the K-form and V-grades related to the endoscopic findings of reflux esophagitis [1].

In the B-I group, the incidence of reflux esophagitis increased after the operation. The postoperative findings of the K-form and V-grades in the B-I group were significantly worse than the pre-

$p < 0.01$ 

(a) Billroth-I

N. S.



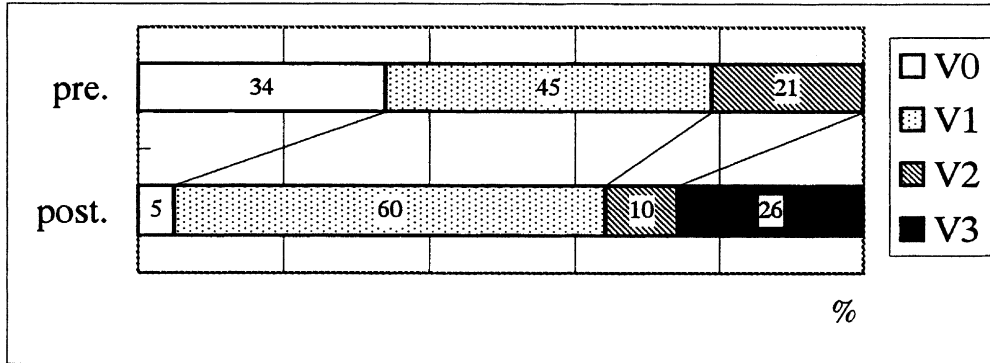
(b) Roux-en-Y

Fig. 5. a. Postoperative findings of hiatus hernia (K-form) were compared with the preoperative findings using the chi-squared test. The postoperative K-form findings were worse than the preoperative K-form findings in the B-I group. b. There was no statistical difference between the pre- and postoperative K-forms in the R-Y group.

operative findings. By contrast, no change in the incidence of reflux esophagitis was observed in the R-Y group. In most patients in the R-Y group, the postoperative appearance of the cardia was preserved. Our findings suggest that the worse endoscopic findings observed regarding the valvular appearance and hiatus hernia may thus possibly be causes of gastroesophageal reflux. The worse appearance of the cardia is thus related to gastroesophageal reflux, and it thereby affects the incidence of postoperative reflux esophagitis. In contrast, the R-Y operation

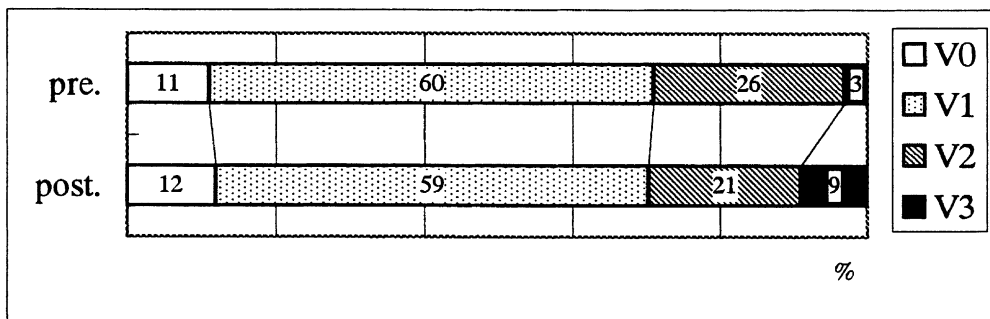
preserved the gastroesophageal valve and prevented reflux esophagitis.

In addition, gastroesophageal reflux that occurs during the nighttime in patients who have undergone a distal gastrectomy has been found to be an important factor in the occurrence of reflux esophagitis. We evaluated the height of the remnant stomach on CT scans obtained with the patient supine. We measured the distance between the top of the remnant stomach and the esophagus. In the B-I group, the remnant stomach had

$p < 0.01$ 

(a) Billroth-I

N. S.



(b) Roux-en-Y

Fig. 6. a. Postoperative appearance of the cardia (V-grades) was compared with the preoperative appearance using the chi-squared test. The postoperative V-grades were worse than the preoperative V-grades in the B-I group. b. No statistical difference was shown in the R-Y group.

been pulled to the right upper cavity perform gastroduodenal anastomosis, and it was therefore positioned over the vertebra. Hence the remnant stomach was located in a higher position in the B-I group, and as a result gastroesophageal reflux tended to occur more easily. A high position of the remnant stomach in the supine position may thus be a cause of reflux esophagitis after distal gastrectomy. On the other hand, in the most patients from the R-Y group, the remnant stomach was located in the left upper abdominal cavity where the fundus was originally located, and the distance between the esophagus and the remnant stomach was less than in the B-I group. R-Y therefore has some physical advantages for preventing gastroesophageal reflux.

Conclusion

Two anatomic changes that promote gastroesophageal reflux occur because of the tension caused by the gastroduodenal anas-

tomosis. One of these changes was the presence of abnormal findings in the cardia affected by the enlarged angle of HIS. The other change was the position of the remnant stomach. In the present study, determination of the cardia with B-I reconstruction and the position of the remnant stomach were therefore considered important factors contributing to the occurrence of reflux esophagitis after distal gastrectomy. In contrast, R-Y was shown to preserve the endoscopic findings of the cardia and position of the remnant stomach. R-Y might therefore help prevent not only the occurrence of duodenogastric reflux but also gastroesophageal reflux.

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