

A Method of Valvuloplastic Esophagogastrostomy to Prevent Reflux after Proximal Gastrectomy

Koichi Seta, M.D., Tetsuhiko Hatafuku, M.D., Takahiro Higuchi, M.D., and Masatoshi Watanabe, M.D.

Department of Surgery I, Iwate Medical University School of Medicine, Morioka, Japan

This is a report of our new method of valvuloplastic esophagogastrostomy for the prevention of postoperative reflux esophagitis, and the clinical results in 10 patients. After proximal resection of the stomach, the medial side of the cut end of the gastric remnant is closed in the usual fashion. The mucosal layer of the lateral side of the gastric remnant is partially closed, but the seromuscular layers are left open. The esophagus is anastomosed to the gastric remnant mucosa, which is inverted so as to form a mucosal valve. The seromuscular layers of the gastric remnant are then wrapped around the distal esophagus, similar to a Nissen fundoplication, so as to create an artificial fundus. The intragastric esophageal wall facing the fundus acts as a long one-way flap valve to prevent reflux. The 10 patients who have undergone valvuloplastic esophagogastrostomy have remained free of postoperative complications due to reflux. X-ray fluoroscopy and esophagoscopy done at the time of discharge from the hospital revealed no evidence of reflux or esophagitis. Withdrawal pH studies performed in 5 of the patients showed a sharp rise in pH starting at the site of the anastomosis. Withdrawal intraluminal pressure studies performed in 7 patients showed a high pressure zone with a mean pressure of 11.3 mm Hg and a mean length of 4.0 cm. These results indicate that the new method of esophagogastrostomy effectively prevented postoperative reflux esophagitis after conventional methods of proximal gastric resection.

During the period from 1970 to 1977, our method of valvuloplastic esophagogastrostomy [1-3] was used in 10 patients following proximal gastric resection. Four patients had carcinoma of the stomach, 2 had a high gastric ulcer, 2 had a leiomyoma of the stomach, 1 had a leiomyosarcoma, and 1 patient had a stomal ulcer after proximal gastric resection with end-to-end esophagogastrostomy for achalasia of the esophagus. There were 6 males and 4 females, and their ages ranged from 36 to 58 years. The extent of proximal gastric resection ranged from 1/5 to 1/2 of the stomach. A drainage procedure was performed in all patients and consisted of a pyloroplasty in 9 and a pyloromyotomy in 1 patient, the latter following a minimal gastric resection. The characteristics of the 10 patients are summarized in Table 1.

Operative Technique

The operation is performed through an upper midline abdominal incision. When a 5-cm length of distal esophagus cannot be brought below the diaphragm, the incision is extended into a standard left thoracotomy through the 7th intercostal space. The level of esophageal transection is determined by the location of the lesion. Mobilization of the upper stomach is started from the greater curvature side by severing the gastrosplenic ligament, including the short gastric vessels and a part of the left gastroepiploic vessels. The lesser curvature is freed by

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Reprint requests: Koichi Seta, M.D., Department of Surgery I, Iwate Medical University School of Medicine, 19-1 Uchimaru, Morioka 020, Japan.

Table 1. Summary of patients who underwent valvuloplastic proximal gastrectomy.

Case/age/sex	Diagnosis	Extent of resection	Drainage procedure
1. K.I., 53 yr., female	Gastric cancer	1/2	Pyloroplasty
2. G.M., 44 yr., male	Stomal ulcer after proximal gastrectomy	1/2	Pyloroplasty
3. K.Y., 58 yr., male	Gastric cancer	3/5	Pyloroplasty
4. S.K., 58 yr., male	Gastric cancer	1/3	Pyloroplasty
5. H.M., 36 yr., female	Gastric cancer	1/2	Pyloroplasty
6. O.F., 36 yr., male	Leiomyoma of the stomach	1/2	Pyloroplasty
7. S.N., 52 yr., female	Leiomyoma of the stomach	1/4	Pyloroplasty
8. T.A., 58 yr., female	Gastric ulcer	1/3	Pyloroplasty
9. Y.K., 39 yr., male	Gastric ulcer	1/3	Pyloroplasty
10. A.G., 44 yr., male	Leiomyoma of the stomach	1/5	Pyloromyotomy

dividing the hepatogastric ligament, including the left gastric vessels up to the level of the esophageal hiatus. The esophageal hiatus is opened, both the anterior and posterior trunks of the vagus nerve are cut, the abdominal esophagus is freed from the adjacent tissues, and the esophagus is drawn downward as far as possible. Transection of the stomach in its midportion is angulated approximately 45° so as to preserve a larger amount of greater curvature than in the ordinary gastric resection (Fig. 1A). The preserved triangular portion of the greater curvature is used for wrapping around the distal esophagus from the left to form the artificial fundus later in the procedure. The esophagus is transected and the specimen of the upper stomach is removed.

The anastomotic stoma is designated in the middle of the cut surface of the gastric remnant. Except for the designated stoma, the mucosal layer of the gastric stump is closed by a continuous suture of chromic catgut. The gastric stump medial to the designated site of anastomosis is further closed by a series of interrupted silk sutures involving the seromuscular layers, leaving open a 2-cm segment adjacent to the designated anastomotic stoma (Fig. 1B). On the greater curvature side, a saline solution is infiltrated into the submucosal layer of both the anterior and posterior walls, and the seromuscular

layers are elevated for a distance of approximately 2 cm in width on both sides. The width of lysis is made narrower as the greater curvature is approached. During this procedure, care is taken not to damage the small submucosal vessels; when they are damaged, hemostasis is obtained with electric cautery (Fig. 1C).

The next step involves an anastomosis between the full thickness of the esophageal stump and the mucosal stoma of the remnant stomach (Fig. 1D). The gastric mucosa approximately 2 cm on each side of the anastomotic line is inverted and sutured to the stomal line to create a mucosal protrusion about 1 cm in length inside the anastomosis which is expected to act as a mucosal valve (Fig. 2A).

Next, the lateral end of the triangular portion of the stomach is fixed to the left lateral wall of the esophagus at a point 5 cm orad from the anastomosis. The distal esophagus is then wrapped circumferentially with the previously freed seromuscular layers of the triangular portion of the stomach. In this way, 5 cm of distal esophagus is wrapped by the stomach to form an artificial fundus (Fig. 2B).

The remnant stomach is reduced into the abdominal cavity and the hiatus is closed with a few sutures

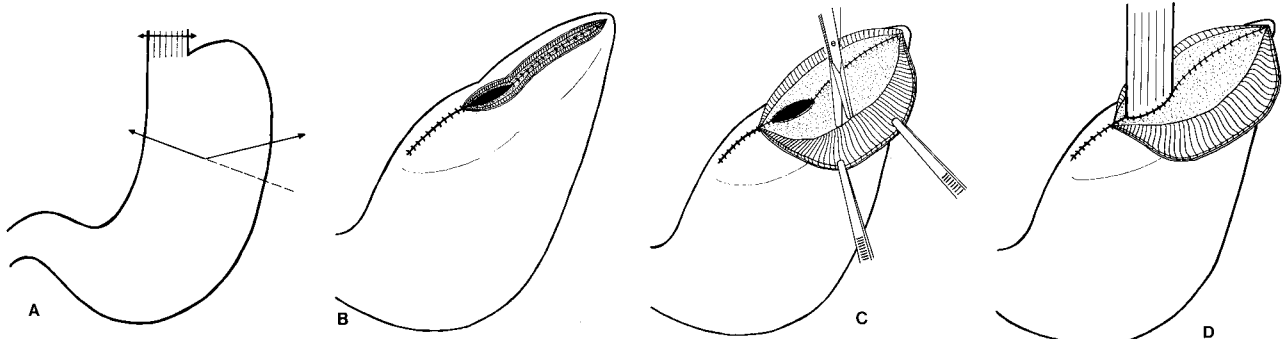
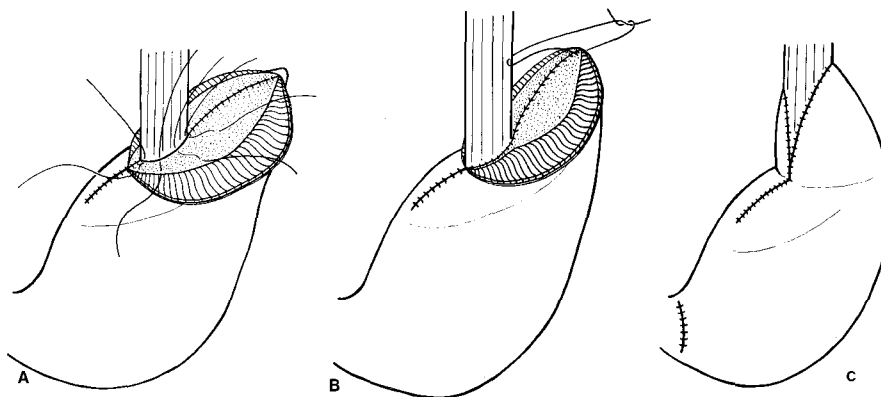


Fig. 1. Technique of valvuloplastic esophagogastrostomy. **A.** Lines of transection of the stomach. Gastric transection is angulated 45° to preserve more of the greater curvature. **B.** Closure of the gastric remnant, leaving a designated stoma in the middle for subsequent anastomosis to the esophagus. **C.** Separation of the seromuscular and mucosal layers. **D.** Esophagogastrostomy. The full thickness of the esophageal stump is anastomosed to the mucosa of the stomach.

Fig. 2. Technique of valvuloplastic esophagogastrostomy (continued). **A.** Creation of a mucosal valve by inversion of the mucosa. **B.** Fixation of the artificial fundus to the esophagus as the starting point for wrapping the seromuscular layers of the stomach around the distal esophagus. **C.** Completed procedure showing artificial fundus, enclosure of distal esophagus in wrapping of stomach, and pyloroplasty.



fixed to the esophagus. When reduction of the stomach is difficult because of its high location, the opened hiatus is fixed to the artificial fundus. Finally, a drainage procedure consisting of either a pyloroplasty or pyloromyotomy is added to assure emptying of the gastric contents. Figure 2C shows the completed procedure.

Three factors are involved in preventing reflux in our valvuloplastic anastomosis, namely, the artificial fundus, flap valve, and mucosal valve. The artificial fundus is formed by wrapping the distal esophagus with the triangular portion of the stomach on the greater curvature side. The thin flap valve, which consists of the left lateral wall of the distal esophagus lined by the gastric mucosa, is fairly flexible and higher pressures in the stomach than in the esophagus produce side pressure to close this flexible flap valve. The mucosal valve mimics the cardiac rosette of the normal gastroesophageal junction which is a part of the closing mechanism. It is presumed that all 3 of these mechanisms together prevent reflux. The antireflux mechanism is shown schematically in Fig. 3.

Results

Clinical Response

There was no mortality. A few patients had mild dysphagia on swallowing food for 1 or 2 weeks postoperatively. In 1 patient, anastomotic stricture persisted for 1 month postoperatively and required forceful dilatation under esophagoscopy. In this patient, the stricture was caused by too tight a continuous suture at the anastomosis and the forceful dilatation is presumed to have successfully broken down the suture material. The patient became free of dysphagia immediately after the dilatation. None of the patients had anastomotic leakage, and none complained of symptoms of reflux, such as heartburn, substernal pain, nausea, or vomiting.

X-ray Fluoroscopy

Fluoroscopy with barium contrast was performed at the time of discharge from the hospital. Including the patient whose anastomotic stenosis was corrected by forceful dilatation, passage of the contrast medium through the anastomotic site was satisfactory in all of the patients. None of the patients had gastric stasis, and none had gastroesophageal reflux of barium, even in the head-down position or with the Valsalva maneuver. The artificial fundus was observed to fill with barium, giving side pressure to the flap valve. Figure 4 shows a barium swallow x-ray.

Esophagoscopy

Postoperative esophagoscopy with biopsy of the distal esophageal mucosa was carried out in all 10 patients. None showed findings of reflux esophagitis.

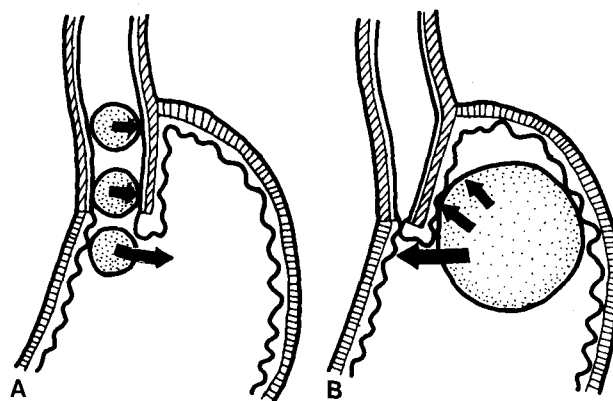


Fig. 3. Mechanism of prevention of reflux by valvuloplastic esophagogastrostomy. **A.** Food enters stomach opening flap valve. **B.** Flap valve is closed by side pressure from artificial fundus.

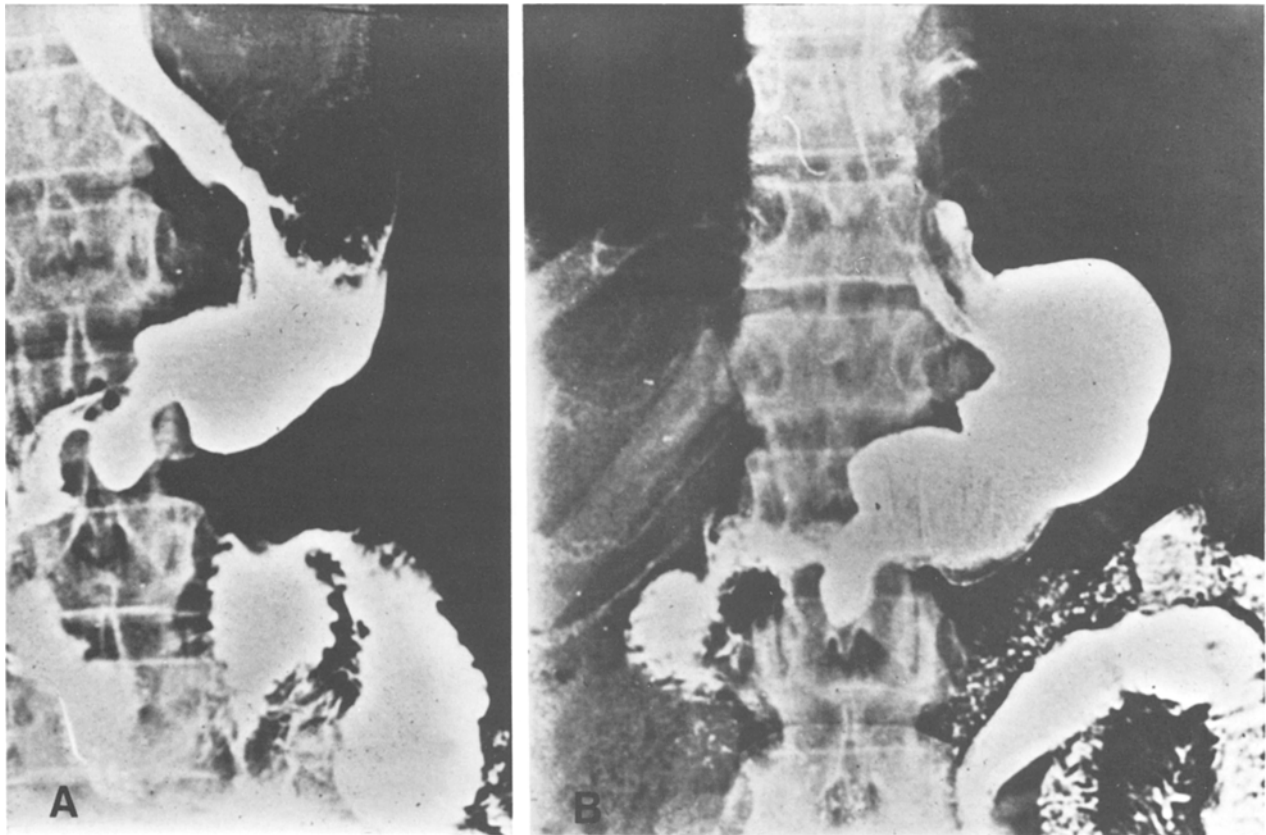


Fig. 4. Postoperative x-ray fluoroscopy after valvuloplastic esophagogastrostomy, showing (A) barium passing into the stomach in the upright position, and (B) absence of reflux in the supine position.

Withdrawal pH Study

A pH electrode was introduced into the remnant stomach and then withdrawn slowly at the speed of 15 mm/min. The pH was recorded continuously by a polygraph. When the intragastric pH was above 2, an injection of 50 mg of Histalog was made intramuscularly to stimulate acid secretion, or 0.1 N hydrochloric acid was instilled into the stomach through a fine Levin tube. Our criterion for absence of reflux was elevation of the pH above 5 within 5 cm from the site of anastomosis. Figure 5 shows the pH curves of 5 patients. Each curve shows a sharp rise of pH to 5 or higher within 5 cm from the anastomotic site. The length of esophagus between the site of anastomosis and the point where the pH reached 5 ranged from 1.6 to 4.2 cm and averaged 2.7 cm.

Withdrawal Intraluminal Pressure Study

The open-tip method was employed for the measurement of intraluminal pressures of the stomach and esophagus. A bundle of 3 polyethylene tubes with the sideholes at 0, 5 and 10 cm from the tip was introduced into the remnant stomach and then withdrawn at the speed of 75 mm/min. Six of 7 patients

subjected to this study demonstrated the presence of a high pressure zone at the site of the anastomosis. Figure 6 shows the high pressure zone in each patient. Except for Case No. 4, pressures in the high pressure zone ranged from 7 to 18 mm Hg, and the mean pressure of the 7 patients was 13.2 mm Hg. Except for Case No. 4, the length of the high pressure zone ranged from 1.8 to 5.0 cm with a mean of 4.0 cm. These values were similar to those observed in control patients.

Follow-up Study

Follow-up study was done in 8 of the 10 patients; two patients were lost to follow-up. The follow-up period ranged from 6 months to 6.5 years. All but 1 of the 8 patients were free of symptoms. One patient, a fisherman who was free of reflux at the time of discharge, complained of heartburn only when diving to collect shells at the bottom of the sea. The patient who had anastomotic stenosis postoperatively and was relieved by forceful dilatation was free of dysphagia and heartburn.

Discussion

Proximal gastric resection is indicated for lesions of

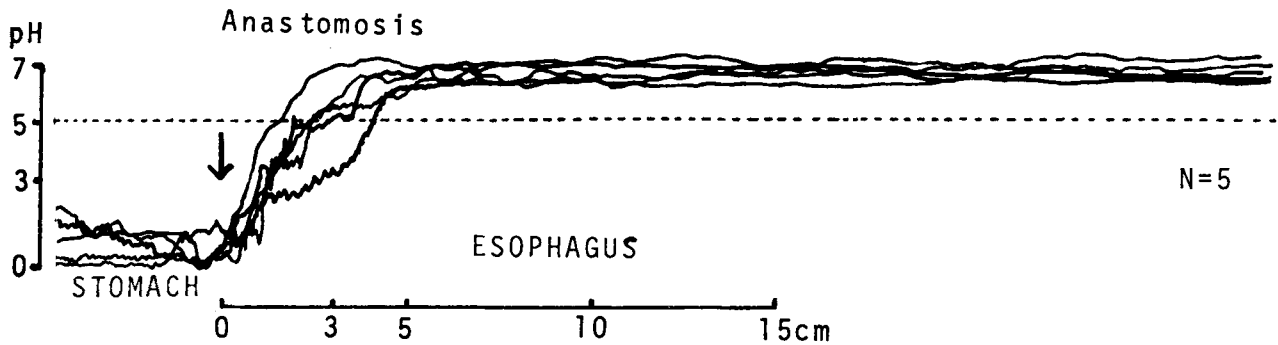


Fig. 5. Postoperative withdrawal pH curves in patients after valvuloplastic esophagogastrostomy showing a sharp rise of pH indicative of the absence of reflux.

the upper stomach such as peptic ulcer, leiomyoma, and cancer, and it may also be indicated for stricture of the distal esophagus and, rarely, for esophageal varices. Ablation of the cardia is often followed by esophagitis due to reflux of either acid peptic juice or alkaline bile. Our valvuloplastic anastomosis was devised to accomplish the same objective as the fundic patch operations of Thal and Hatfuku [4, 5]. Reflux after the valvuloplastic anasto-

mosis was evaluated by x-ray fluoroscopy, esophagoscopy, withdrawal pH and pressure studies. The most sensitive test for detecting reflux is the withdrawal pH study. Skinner and Booth [6] reported that reflux is absent if the esophageal pH at a point 5 cm proximal to the gastroesophageal junction is above 4. We used a stricter criterion, namely, pH 5 instead of pH 4 at the same point. Moreover, the results of the withdrawal pH study were

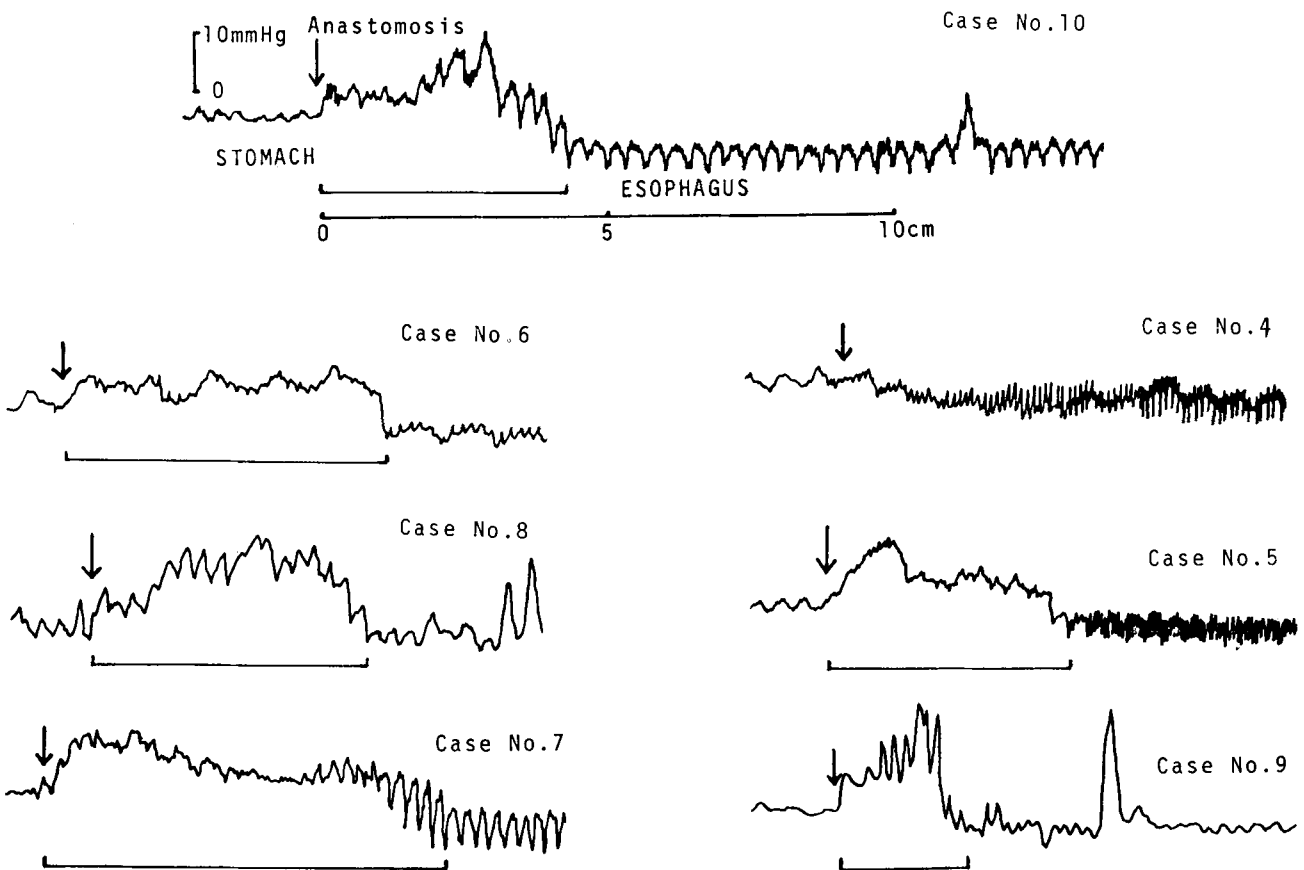


Fig. 6. Postoperative intraluminal pressure curves in 7 patients after valvuloplastic esophagogastrostomy. A high pressure zone is seen in all but Case No. 4. — indicates length of high pressure zone, ↓ indicates site of anastomosis.

correlated with the withdrawal pressure curves.

Since the report of Fyke et al. [7], it has been generally accepted that the lower esophageal sphincter is a barrier to reflux. It is noteworthy that, after resection of the cardia, the valvuloplastic esophagogastronomy produced a high pressure zone at the anastomotic site, while other methods of anastomosis, such as end-to-end or end-to-side esophagogastronomy, fail to have such a zone and allow free reflux. It is probable that the artificially created fundus prevents reflux in a manner similar to the lower esophageal sphincter in normal subjects. The length of the high pressure zone observed after our valvuloplastic anastomosis corresponded to the length of esophageal enclosure by the artificial fundus.

Our method of anastomosis does not present greater technical problems than other anastomotic methods. Separation of the seromuscular layers from the mucosal layer may seem difficult, but it is easily accomplished by infiltrating saline solution into the submucosal layer. It should be emphasized that anastomotic leakage did not occur in any of our 10 patients or in any of our experimental studies in dogs, probably because the anastomosis is covered and reinforced by the seromuscular layer of the stomach. It is important, when closing the hiatus, to avoid constriction of the artificial fundus for effective valvular action. Regarding the addition of a gastric drainage procedure, our current policy is to add a pyloroplasty when the extent of proximal resection exceeds $\frac{1}{2}$ of the stomach, and to employ pyloromyotomy for resections between $\frac{1}{3}$ to $\frac{1}{2}$ of the stomach. For resection of less than $\frac{1}{3}$ of the stomach, a drainage procedure may be omitted.

Reflux esophagitis can be prevented by two types of procedures. The first type is a valvuloplastic anastomosis [8-12], such as the method described in this report, and the second type involves interposition of a jejunal or colonic segment between the esophagus and the stomach [13, 14]. The interposition procedures are more difficult technically and have a greater risk of anastomotic leakage. Their use should be limited to situations in which the extent of resection exceeds $\frac{1}{2}$ of the stomach or when the length of esophagus that can be brought below the diaphragm is too short so that it is not feasible to perform the direct valvuloplastic anastomosis. In all other cases, it is our opinion that the direct valvuloplastic esophagogastronomy is the operation of first choice.

Résumé

Nous présentons les résultats obtenus, chez 10 malades, par notre nouvelle technique d'oesogastrostomie avec valvuloplastie pur la prévention de

l'oesophagite par reflux postopératoire. Après résection de la partie proximale de l'estomac, la partie interne de la tranche de section gastrique est suturée de la manière habituelle. La muqueuse de la partie externe est partiellement fermée, mais la séromusculaire est laissée ouverte. L'oesophage est anastomosé à la muqueuse du moignon gastrique, et cette suture est invaginée pour former la valve muqueuse. La couche séromusculaire vient ensuite entourer l'oesophage distal, comme dans une fundoplicature à la Nissen, pour former une nouvelle poche à air. La paroi oesophagienne, en position intragastrique dans la nouvelle poche à air, forme une longue valve unidirectionnelle qui s'oppose au reflux. Les 10 malades qui ont subi cette oesogastrostomie avec valvuloplastie n'ont présenté aucune complication attribuable au reflux. Les examens radiologiques et endoscopiques au moment de la sortie n'ont montré ni reflux, ni oesophagite. Chez 5 malades, des mesures de pH faites de long de l'anastomose et de la valve révèlent une brusque élévation de pH au moment où l'électrode atteint le niveau de la suture. Chez 7 malades, des mesures de pression au même endroit montrent une zone de pression élevée (en moyenne 11.3 mm Hg sur une hauteur moyenne de 4.0 cm). Ces résultats indiquent que cette nouvelle technique d'oesogastrostomie est efficace dans la prévention de l'oesophagite par reflux après gastrectomie proximale conventionnelle.

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Invited Commentary

Tom R. DeMeester, M.D.

University of Chicago Medical School,
Chicago, Illinois, U.S.A.

This report on a new method of valvuloplastic esophagostomy for the prevention of postoperative reflux esophagitis is intriguing. An incompetent cardia after resection of the proximal stomach or distal esophagus can result in severe postoperative discomfort from gastroesophageal reflux and is well known by any surgeon who does a significant amount of this type of work. It is not surprising, therefore, that various efforts have been made to reconstruct a competent cardia following its resection. One of the problems associated with reconstruction is that the size of the gastric remnant is usually insufficient to allow performance of a classical gastric fundoplication, although on occasion, I have been able to perform this even when there was a small gastric pouch.

Basic in the reconstruction of the cardia is an anastomotic technique that will heal without leaking or becoming stenotic. It appears that the authors have achieved this goal with their mucosal anastomosis and seromuscular wrap. Caution must be exercised in this regard, however, since only 10 patients were reported, one of whom developed a stenosis. Practical experience leads to concern about the integrity of only a mucosal anastomosis and the vascularity of an elevated seromuscular flap, particularly in a stomach whose blood supply has been somewhat compromised due to partial resection.

I am genuinely impressed with the manometry tracings the authors have obtained following reconstruction of the cardia. Indeed, the tracings have the appearance of a normal distal esophageal high

pressure zone. The mean pressure measured in the patients is similar to that measured in normal subjects. These findings suggest that the authors, in their reconstruction of the cardia, have simulated the normal cardia. This lends support to the theory that the distal esophageal high pressure zone is mechanical in origin due to the geometry of the esophagogastric junction and its location within the positive pressure environment of the abdomen [1]. It would be particularly informative to know, on the basis of respiratory excursions recorded on the pressure tracings, the length of the distal esophagus exposed to the positive pressure environment of the abdomen. Based on our own experience, the amount of distal esophagus exposed to the positive pressure of the abdomen is the basic principle upon which competency of any reconstructed cardia depends [2].

The authors have attempted to demonstrate the competency of the cardia with the pH gradient measured by a retrograde withdrawal of the pH probe from the stomach into the esophagus. We have shown that such measurements are not related to the competency of the cardia when performed in a retrograde manner [3]. In a series of 71 patients, only antegrade pH gradients, in which the probe was passed in an oral to aboral direction, showed a relationship to the competency of the cardia. This was true for the general population of patients only and was of no help in assessing the competency of the cardia in any individual patient. A better method would have been the performance of a standard acid