Introduction of a Method of Valvuloplastic Esophagogastrostomy in Proximal Gastrectomy

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HATAFUKU, T., HIGUCHI, T. and SETA, K. Introduction of a Method of Valvuloplastic Esophagogastrostomy in Proximal Gastrectomy. Tohoku J. exp. Med., 1978, 124 (2), 129-138 — A technique of valvuloplastic esophagogastrostomy in proximal gastrectomy to control postoperative reflux esophagitis is reported. After proximal resection of the stomach, the medial stump is closed in two layers. The mucosal layers of the lateral stump are sewn but leaving the seromuscular layers open. The esophagus is anastomosed to the mucosal stoma at the middle of the gastric stump. The distal esophagus is wrapped by the lateral stump like Nissen’s fundoplication to create the artificial fundus. Intragastric esophageal wall facing the fundus acts as a long one-way flap valve to prevent reflux. Ten dogs were prepared with this method and were compared with end-to-end and end-to-side anastomosis prepared in five dogs each. Cinefluoroscopy and esophageal pH demonstrated various degrees of reflux in all the dogs with end-to-end and end-to-side anastomosis, and mild reflux in one out of the ten dogs with valvular anastomosis. A sharp rise in pH at the anastomotic site was consistent in the remaining nine valvuloplastic dogs. High pressure zone, 9.9 mmHg on an average at the site of anastomosis was present in valvuloplastic dogs, while the pressure was 0 mmHg in end-to-end and 5.2 mmHg in end-to-side anastomosis dogs. Clinical application of this procedure in ten patients obtained satisfactory results. The technique offers a reliable method of valvuloplastic anastomosis in esophagogastrostomy. ——— valvuloplastic esophagogastrostomy; proximal gastrectomy; lower esophageal sphincter; esophageal pH

When proximal gastric resection is indicated for the lesion of the cardia or upper stomach, elimination of postoperative reflux esophagitis has been a matter of extreme importance. Our detailed clinical as well as experimental studies on the postoperative pathophysiology following proximal gastric resection has revealed that not only end-to-end but also even end-to-side esophagogastrostomy would result in gastroesophageal reflux. The result of the study urged us to devise another method of valvuloplastic esophagogastrostomy in a hope to eliminate undue sequela of reflux esophagitis following proximal gastric resection (Hatafuku et al. 1975a, b; Seta and Hatafuku 1975; Hatafuku et al. 1976).

Up until present, experimental evaluation of the reflux prevention mechanism

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of our valvuloplastic anastomosis has been made with later trial of the procedure in 10 clinical cases. Results of the experimental as well as clinical studies were fairly reasonable with the minimum incidence of reflux and without no noticeable complication. The present paper is to report the detailed technique of our valvuloplastic esophagogastrotomy.

**Operative Technique**

*Position and skin incision.* Preoperative preparation is made similar to the one for ordinary gastric resection. A naso-gastric tube is inserted prior to the operation. Patient is laid on a supine position with a pillow placed at the level underneath the xyphoid process. The abdomen is entered through an upper midline incision with or without excision of the xyphoid process and, if necessary, sternotomy is added to secure the best view of the operative field. If the distal esophagus cannot be secured for more than 5 cm in length, it is advisable to perform the anastomosis through the left anterolateral thoracotomy through the 7th intercostal space.

*Mobilization of the distal esophagus and the proximal stomach.* Upon laparotomy, careful observation is made to assure the possibility of the proximal gastric resection. Procedures to be described below are for benign lesions. In handling malignant lesions, lymphnode dissection or combined resection of the adjacent organs should be considered.

Freening of the stomach is started alongside the greater curvature from the pyloric region up to the level of transection where the right gastroepiploic vessels should be carefully preserved. Beyond this level, the gastrolienal ligament including the short gastric vessels is severed to skeletonize the fundus. Freeing along the lesser curvature is made with preservation of the right gastric artery and the left gastric vessels are tied and severed at their roots. The triangular ligament of the left hepatic lobe is severed, the esophageal hiatus is opened to visualize the esophagus, both vagi are cut and the esophagus is pulled down to its extreme extent into the abdominal cavity.

*Resection of the proximal stomach.* As shown in Fig. 1, transection of the stomach is angulated at the middle of the transection line so as to preserve the greater curvature side in a triangular form. This triangular redundant portion is used to wrap around the

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**Fig. 1.** Transection line for proximal gastrectomy.

**Fig. 2.** Closure of the gastric stump.
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Fig. 3. Freeing of the seromuscular layers.

Fig. 4. Esophagogastrostomy.

esophagus approximately 5 cm in length in the later procedure.

The anastomotic stoma is scheduled at the middle of the gastric stump and the medial stump is closed in two layers except 2 cm in length next to the anastomotic stoma where seromuscular layers are left open. The mucosal layers of the lateral stump are sewn but leaving the seromuscular layers open. The length of the lateral stump should be approximately 7 cm in length (Fig. 2). Next step is to free both the anterior and posterior seromuscular layers around the anastomotic stoma and down to the end at the greater curvature approximately 2 cm in width on both sides (Fig. 3). This is done with the aid of saline infiltration into the submucosal layer and dissecting with a pair of Metzenbaum scissors. Careful hemostasis is achieved by electric cautery. At the end of this step, the esophagus is transected and the specimen is removed.

Esophagogastrostomy with creation of the mucosal valve. Esophagogastrostomy is carried out between the whole layer of the esophageal stump and the mucosal stoma at the middle of the gastric stump as shown in Fig. 4. Fig. 5 shows the technique to create the mucosal valve. The subserosal layer previously dissected approximately 2 cm apart from the anastomotic line is inverted and tacked to the stomal line with a few stitches. This is to produce the mucosal protrusion inside the lumen of the stomach and let it act like the cardiac rosette at the normal gastroesophageal junction for the prevention of reflux.

Enclosure of the distal esophagus with triangular gastric stump. Next step is the most important part of the whole procedure. The distal esophagus at least 5 cm in length is wrapped around by the triangular stump from the left like Nissen’s fundoplication to form the artificial fundus (Fig. 6). Fixation is done sewing the margin of seromuscular layer to the esophagus with interrupted sutures and now half the circumference of the left lateral esophageal wall is expected to function as a one-way flap valve which will be discussed later more in detail (Fig. 7).

Closure of the esophageal hiatus and pyloroplasty. Widely open esophageal hiatus is sewn to the serosal layer of the artificial fundus where care should be taken not to constrict the artificial fundus so that it can be distended well on the supine position by the gastric contents or by the higher intragastric pressure. Lastly, Heineke-Mikulicz’s type of pyloroplasty is added to facilitate better gastric emptying (Fig. 8). When the extent of resection is less than one-third of the whole stomach, pyloromyotomy will suffice the drainage effect.
Postoperative care of the patient. There is no special postoperative care referable to the present technique. As soon as the gas is passed out, a nasogastric tube is removed and a patient is put on liquid diet starting the following day. In some cases, mild dysphagia due to submucosal edema of the artificial fundus encircling the distal esophagus may be encountered. This is, however, of transient phenomenon and usually subsides in two to three weeks after the date of operation.
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Reflux Prevention Mechanism of the Valvuloplastic Anastomosis

Before describing the reflux prevention mechanism of our valvuloplastic anastomosis, clinical result of the conventional methods of anastomosis in proximal gastric resection will be stated below. Primarily, we employed end-to-end esophagogastrostomy which led to a high incidence of reflux esophagitis. In this regard, a method of anastomosis was switched later to end-to-side anastomosis between the esophageal stump and the anterior wall of the gastric remnant in a hope to reduce the incidence of reflux esophagitis (Seta and Kawamura 1969).

Follow-up results of the 18 patients who were previously subjected to proximal gastric resection with end-to-side anastomosis were superior to those of end-to-end anastomosis (Hatafuku et al. 1975a). Recent questionnaire study of the 18 patients revealed that six (33.3%) of them complained of heartburn and 12 (66.7%) were asymptomatic. Fiberscophagoscopy was performed in 15 of the 18 patients. Reflux esophagitis of various types were confirmed in seven patients (46.7%) which was detailed in Table 1.

<table>
<thead>
<tr>
<th>Questionnaire study:</th>
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<tbody>
<tr>
<td>Heartburn or regurgitation present in 12 out of 18 cases (67%)</td>
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<tr>
<td>Heartburn or regurgitation absent in 6 out of 18 cases (33%)</td>
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<th>Findings of fiberscophagoscopy:</th>
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<tr>
<td>Esophagitis absent in 8 out of 15 cases (53%)</td>
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<tr>
<td>Esophagitis confirmed in 7 out of 15 cases (47%)</td>
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<table>
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<tr>
<th>Discoloring type:</th>
<th>1 case</th>
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<tr>
<td>Erosive and/or ulcerative type:</td>
<td>5 cases</td>
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<tr>
<td>Uneven type:</td>
<td>1 case</td>
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In short, the worst result was obtained after end-to-end anastomosis and even end-to-side anastomosis resulted in the development of reflux esophagitis in approximately half a number of the patients. These findings prompted us to devise another effective method of anastomosis for preventing reflux beside the addition of pyloric drainage either by pyloroplasty or pyloromyotomy.

The following is to explain the reflux prevention mechanism of our valvuloplastic anastomosis. Fig. 9 is the section of the canine stomach one month after one-third proximal gastric resection and valvuloplastic anastomosis. There is seen a formation of the thin flexible flap valve, 5 cm in length which is facing to the large artificially made fundus with a reinforced angle of His. Fig. 10 is the schema to demonstrate the reflux prevention mechanism. Bolus of food propelled by the esophageal peristalsis enters the stomach opening and pushing aside the flap valve. On supine position, not necessarily food in the artificial fundus but the higher intragastric pressure gives side pressure to close the flap valve and prevent reflux. Mucosal protrusion around the anastomotic stoma also acts like the cardiac rosette of the normal gastroesophageal junction.
Fig. 9. Section of the canine stomach after valvuloplastic anastomosis.

Fig. 10. Reflux prevention mechanism of the valvuloplastic anastomosis.
Left: Food enters the stomach opening and pushing aside the flap valve.
Right: On supine position, food in the artificial fundus gives side pressure to close the flap valve.

EXPERIMENTAL EVALUATION OF THE VALVULOPLASTIC ANASTOMOSIS

Efficacy of our valvuloplastic anastomosis was evaluated experimentally. Ten dogs were prepared with this procedure and were compared with conventional end-to-end and end-to-side anastomosis done in five dogs each after one-third resection of the proximal stomach. Fig. 11 shows withdrawal pH curves of these dogs. According to our criteria for classifying the degree of reflux on pH curves, a rise of pH above 5 within 3 cm proximal from the site of anastomosis is
Fig. 11. Withdrawal pH curves after various types of anastomosis.

classified as Grade 0. A rise of pH above 5 between 3 and 5 cm is classified as Grade I, between 5 and 10 cm as Grade II, between 10 and 15 cm as Grade III, and those in which the pH rises above 5 at the point more than 15 cm from the site of anastomosis is classified as Grade IV. Fluoroscopically, reflux of contrast media is usually noticeable in those with withdrawal pH curves of Grades II, III and IV with severer reflux in the latter.

As for the control dogs, four out of five dogs were classified as Grade 0 and one dog as Grade I, and all were free from reflux upon cinefluoroscopy. All the five dogs with end-to-end anastomosis showed free reflux of Grade IV except one dog of Grade II. Of the five dogs with end-to-side anastomosis, two were classified as Grade I, one as Grade II and two as Grade IV. Three dogs with Grades II and IV showed reflux upon fluoroscopy. Of the 10 dogs with valvuloplastic anastomosis, nine were classified as Grade 0 and one as Grade III. Cinefluoroscopy study revealed that one dog of Grade III had moderate reflux. In summary, the incidences of reflux judged from withdrawal pH curves and cinefluoroscopy study were 100% after end-to-end anastomosis, 60% after end-to-side anastomosis and 10% after valvuloplastic anastomosis (Table 2).

Results of the withdrawal gastroesophageal intraluminal pressure study in relation to the mode of anastomosis are shown in Table 2. Formation of the high pressure zone which, in our opinion, is important for the prevention of gastro-
esophageal reflux was absent in all the five dogs after end-to-end anastomosis. High pressure zone, 5.2 mmHg on an average, was noticed after end-to-side anastomosis and the mean of 11.6 mmHg was obtained after valvuloplastic anastomosis which was lower than 11.6 mmHg of the control dogs, while the length of the high pressure zone was longer than those of the control dogs.

As for the significance of the high pressure zone, it is our opinion that, for the prevention of reflux, both the pressure itself and enough length of the high pressure zone are equally important. In this regard, we are measuring the area of the high pressure zone for the comparison of anti-reflux effect. The mean areas were 1.3 cm² for the control dogs, 0 cm² after end-to-end anastomosis, 0.4 cm² after end-to-side anastomosis and 1.7 cm² after valvuloplastic anastomosis which exceeded the value of the control dogs. Anti-reflux effect of the high pressure zone has the following correlation. That is, when the pressure is low, length of the high pressure zone is needed to be longer for the same anti-reflux effect. Conversely, when the pressure is high, shorter length of the zone suffices and measurement of the area of high pressure zone simply represents the correlation between the two parameters of pressure and length of the high pressure zone.

In summary, experimental evaluation with the use of withdrawal pH and pressure as well as cinefluoroscopy studies disclosed that the valvuloplastic esophagogastrostomy was most reliable in the prevention of reflux. Though not detailed in the present report, clinical application of the present technique in 10 cases yielded satisfactory result in all the cases and none showed any findings of reflux.

**DISCUSSION**

The present method of valvuloplastic anastomosis was devised based on the certain anti-reflux effect of the fundic patch operation (Hatafuku et al. 1972; Hatafuku et al. 1975c). The main anti-reflux mechanism of the valvuloplastic anastomosis lies in the valvular action of the left lateral wall of the distal esophagus which is closed by the side pressure from the artificial fundus. It is understood that the electrical intraluminal pressure curve well demonstrates the physiological sphincteric function of the gastroesophageal junction. And recently, the view that the formation of the high pressure zone (lower esophageal sphincter)
is important for the prevention of gastroesophageal reflux has drawn more 
attention of several investigators (Cohen 1971; Behar et al. 1974).

The view stated above is quite in accordance with the result of our intraluminal 
pressure studies. What we would like to stress here is the fact that, even after 
resection of the cardia, there is seen formation of the artificial high pressure zone 
at the site of esophagogastrostomy if it is done not to allow reflux such as our 
valvuloplastic anastomosis. Theoretically, the maximum pressure of the high 
pressure zone should be in proportion to the side pressure of the artificial fundus, 
and the length of the high pressure zone should coincide with the length of the 
esophageal wall which receive the side pressure. So far, our actual values of 
measurement show a tendency to reach this theoretical goal though minor deflection 
in each measurement should be admitted at the present moment. Recognizing 
the importance of not only the pressure but also the length of the high pressure zone, an attempt has been made to measure the area of the high pressure 
zone as shown in Table 2 which, we believe, well represents the anti-reflux effect.

For the sake of safety, the length of the esophageal flap valve has been kept 
at least 5 cm and with this length of the valve, creation of the mucosal valve as 
shown in Fig. 5 may be omitted. It was done so in one clinical case whose post-
operative examinations failed to show any sign of reflux even on Valsalva's 
maneuver. Should the enclosure of the distal esophagus be limited to less than 
5 cm, an additional creation of the mucosal valve is advised. As for the pyloric 
drainage, the Heineke-Mikulicz's type of pyloroplasty has been added routinely 
except in one case which received pyloromyotomy. Pyloromyotomy though its 
drainage effect is less but prevents bile reflux is thought more ideal as a drainage 
procedure if the anti-reflux effect of the valvuloplastic anastomosis is reliable. As 
advocated by Maki et al. (1968), a policy may be considered to adopt pyloro-
myotomy for those cases with less than one-half proximal resection of the stomach 
and pyloroplasty for those with more than one-half resection of the proximal 
stomach.

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