

Esophageal Surgery: A Procedure for Posterior Invagination Esophagogastrostomy in One-Stage Without Positional Change

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IN THE FIELD OF ESOPHAGEAL SURGERY various techniques for esophageal reconstruction have been designed. In spite of continued efforts on the part of the surgeons, an operation for esophageal cancer still remains one of the most difficult procedures because of the high incidence of post-operative complications. Some post-operative complications such as anastomotic leak, reflux esophagitis, etc. have a close relationship with the operative procedure and therefore some complications may be prevented by an improved surgical technique.

This paper presents an operative technique entitled "posterior invagination esophagogastrostomy" and discusses the merits of this procedure in preventing some of the above mentioned complications as well as eliminating a change of body position during the resection and primary reconstruction of the esophagus.

Operative Technique

With the patient in the right lateral position, a single thoraco-abdominal incision is made in the left 6th intercostal space for a lower esophagectomy and in the left 5th intercostal space for an upper or middle esophagectomy. The costal cartilage is cut, and the diaphragm is opened to the esophageal foramen, providing a large operative field from the left thoracic cavity to the epigastric region. The distal segment of the esophagus is pulled out with a Nelaton catheter.

In cases of malignant tumors, blunt and sharp ablation of the esophagus to within 10 cm of the tumor border is performed, and at the same time the adjacent lymph-nodes are extirpated. After completing the mobilization of the stomach, the esophagus and stomach are

divided near the cardia by use of the Petz sewing instrument and pyloroplasty is then carried out. The residual stomach is elevated into the thoracic cavity bringing the lesser curvature to the ventral side and the greater curvature to the dorsal side. The apex of the remaining stomach is bent forward as illustrated in Fig. 1. The proximal segment of the esophagus is placed on the posterior wall of the stomach and fixed in position with three lines of mattress sutures, each line consisting of three sutures to total nine sutures (Fig. 1). After this fixation, the distal segment of the esophagus with the lesion is excised and an all-layer anastomosis between the esophagus and the posterior wall of the stomach at a distance about 5 cm from the apex of the remaining stomach is carried out (Fig. 2). A nasal catheter is introduced into the stomach to provide nutrition and for aspiration purposes. The apex of the stomach is then extended up onto the left esophageal wall and fixed in position with several sutures in order to cover the anastomosis (Fig. 3). In this manner the anastomosed region is completely blocked from the thoracic cavity. A catheter for drainage is inserted into the thoracic cavity and the chest and abdomen are closed.

In cases of esophagogastric anastomosis at the level of the neck, the decollement of the esophagus and the mobilization of the stomach are best carried out under a left fifth thoracotomy. After dividing the esophagus and the stomach, a new incision is made at the left cervical region along the posterior margin of the sternocleidomastoid muscle. The entire thoracic esophagus is pulled out from the neck incision and the stomach is elevated to the cervical level through the posterior mediastinum across the aortic arch. The anastomosis between the cervical segment of the esophagus and the posterior wall

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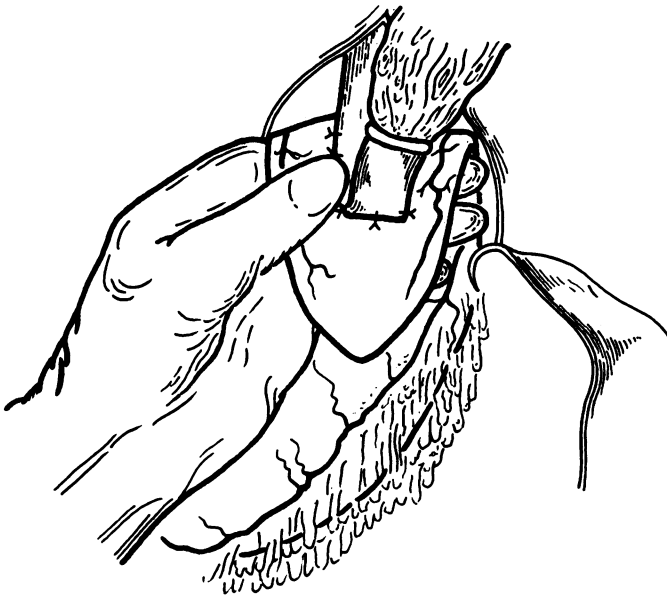


FIG. 1. The proximal segment of the esophagus is placed on the posterior wall of the stomach, and fixed in 3 lines with 3 mattress sutures. (Left lateral view.)

of the stomach is constructed similarly to the procedure described above.

The right lateral position of the patient remains unchanged throughout the operative procedure.

Clinical Cases

The posterior invagination esophagogastrostomy without positional change was performed on a total of 43 cases during the almost 5-year period from October 1967 to July 1972. All but one underwent the one-stage operation (Table 1).

Resection for malignancy was performed on a total of 38 cases while 5 cases had a benign condition. One case had a diverticulum in addition to esophageal cancer.

Thirty-eight cases were operated upon under thoracolaparotomy on the left and the remaining 5 underwent laparotomy. There were 6 cases of Iu (upper seg-



FIG. 2. The anastomosis between the esophagus and the posterior wall of stomach is carried out about 5 cm distant from the apex of the remaining stomach. (Left lateral view.)

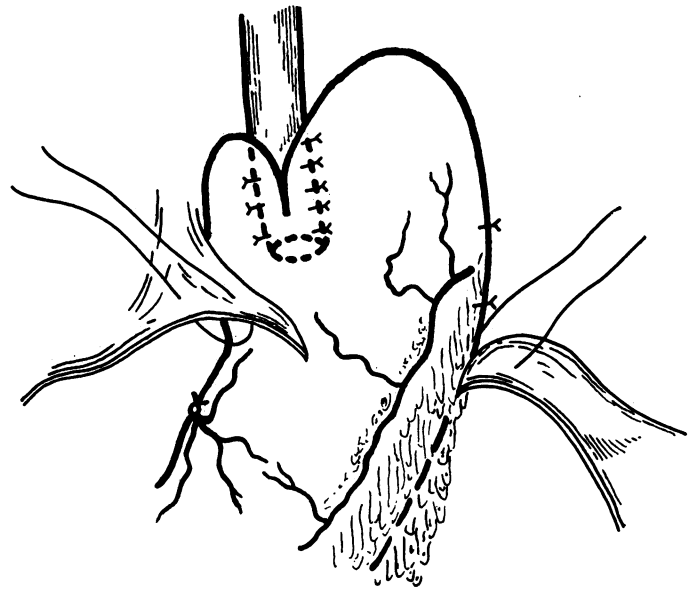


FIG. 3. The apex of stomach is extended upon the left esophageal wall and fixed with several stitches to cover the anastomosis. (Anterior view.)

TABLE 1. *Clinical Cases with Posterior Invagination Esophagogastrostomy*

	No. of Patients
Esophagus	
Cancer	18 1*
Myoma	1
Cancer plus diverticulum	1
Cardia	
Cancer	19
Ulcer	4
Total	43

* Two-stage operation

ment), 12 cases of Im (middle segment), six cases of Ei (lower segment), and 27 cases of Ea+C (abdominal segment and cardia). In 5 cases the lesion was extended to Iu+Im, in one case to Iu+Im+Ei and in one case to Im+Ei (Table 2, Fig. 4). Anastomosis at neck level was done in four cases of Iu and in five cases of Im. Pyloroplasty was carried out in only 28 of the 43 cases.

The post-operative complications of anastomotic leak and circulatory insufficiency were not encountered in 42 cases of the one-stage operation and the only operative death was due to pneumonia which occurred in a pa-

TABLE 2. *Site of Lesion*

Location	No. of Patients
Upper segment (Iu)	6
Middle segment (Im)	12
Lower segment (Ei)	6
Abdominal segment and cardia (Ea + C)	27
Total	51

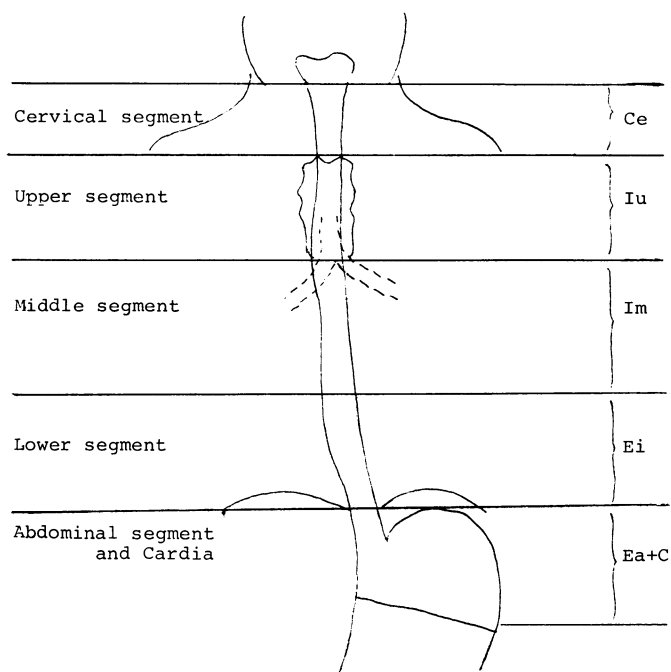


FIG. 4. Division of esophagus.

tient nine days after total thoracic esophagectomy with anastomosis at the neck level (Table 3).

The patients were examined post-operatively by radiography to examine free passage through the anastomosis

TABLE 3. Postoperative Complications (41 Patients with One-stage Operation)

Complication	No. of Patients
Anastomatic leak	0
Respiratory	
Atelectasis	1
Pneumonia	1*
Circulatory insufficiency	0
Stricture	3
Reflux esophagitis	8

* Operative death.

and pyloric region and also were placed in various body positions to examine gastroesophageal reflux. Gastroesophageal manometrical and pH studies were also used to examine reflux. The appearance of the esophageal mucosa at the site of anastomosis was checked by use of the esophagoscope.

The following cases are representative of the technique described in this report.

Case without Pyloroplasty

1) *Case 12 (Adenocarcinoma, Ea+C, Anastomosis in Left Thoracic Cavity).* During the post-operative radiographic examination, the contrast medium descended along the lesser curvature and moved rapidly into the duodenum. A good formation of the stomach bubble was observed. No gastroesophageal reflux oc-

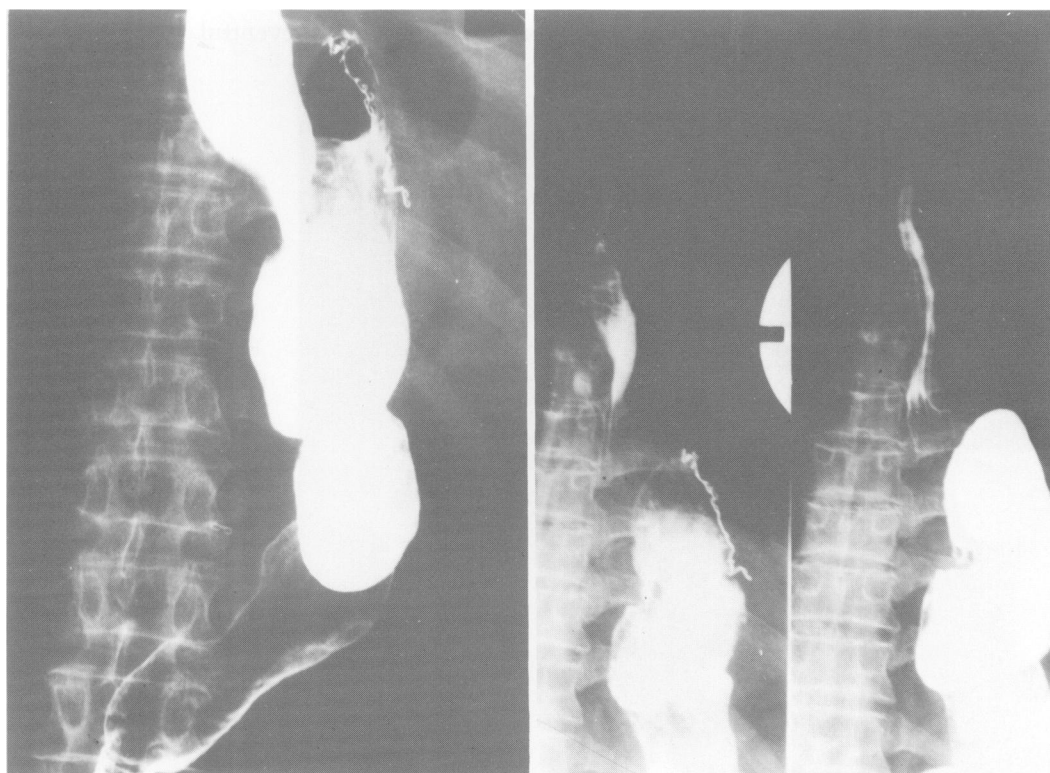


FIG. 5. Radiographs of a satisfactory anastomosis. On the left, a good formation of the stomach bubble was noticeable. On the right, reflux did not occur in a head down position of 20 degrees.

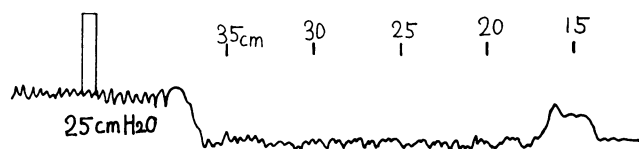


FIG. 6. Postoperative esophageal pressure showing a high pressure zone at the anastomotic area.

curred, even in head down position of about 20 degrees (Fig. 5). The gastroesophageal pressure curve showed an elevated pressure at the anastomosed area (Fig. 6).

Cases with Pyloroplasty

1) *Case 23 (Epidermoid Carcinoma Plus Esophageal Diverticulum, Iu+Im, One-stage Cervical Anastomosis)*. This case had a cancer at Iu in combination with a diverticulum at Im. Anastomosis was created at the level of the neck (Fig. 7). Post-operative course was uneventful without anastomotic leak or demonstrable reflux.

2) *Case 24 (Adenocarcinoma, Ea+C, Anastomosis in Left Thoracic Cavity)*. The contrast medium passed rapidly through the pylorus with a good formation of the stomach bubble. There was no reflux with the patient in head down position (Fig. 8). At the site of anastomosis, a high pressure zone was indicated by gastroesophageal pressure curve and an abrupt elevation of the pH curve was seen (Fig. 9). There was no evidence of reflux esophagitis.

3) *Case 26 (Epidermoid Cancer, Iu+Im+Ei, One-*

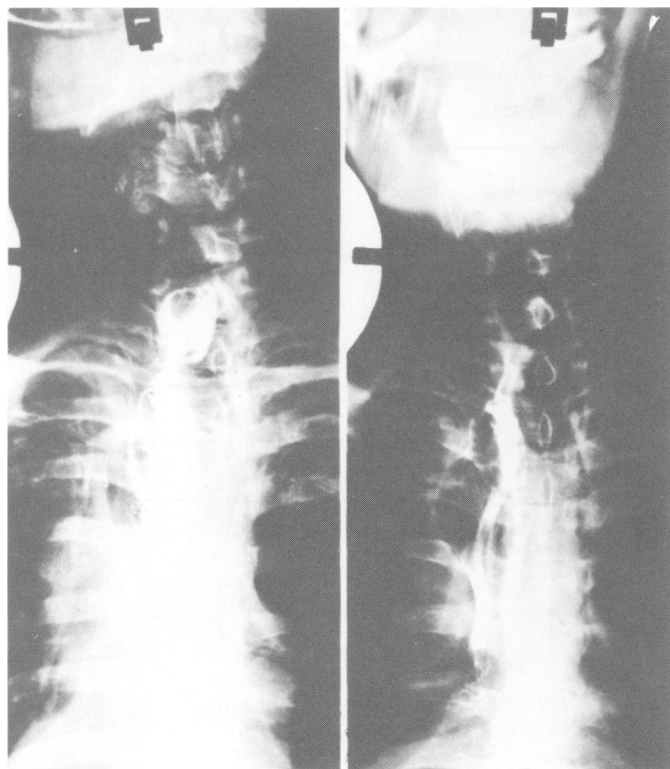


FIG. 7. Anastomosis was created at the level of the neck with no positional change. No reflux occurred.

stage Cervical Anastomosis). This case had a giant lesion involving the entire thoracic esophagus which radiography showed to be about 20 cm in length (Fig. 10). The post-operative course was uneventful.

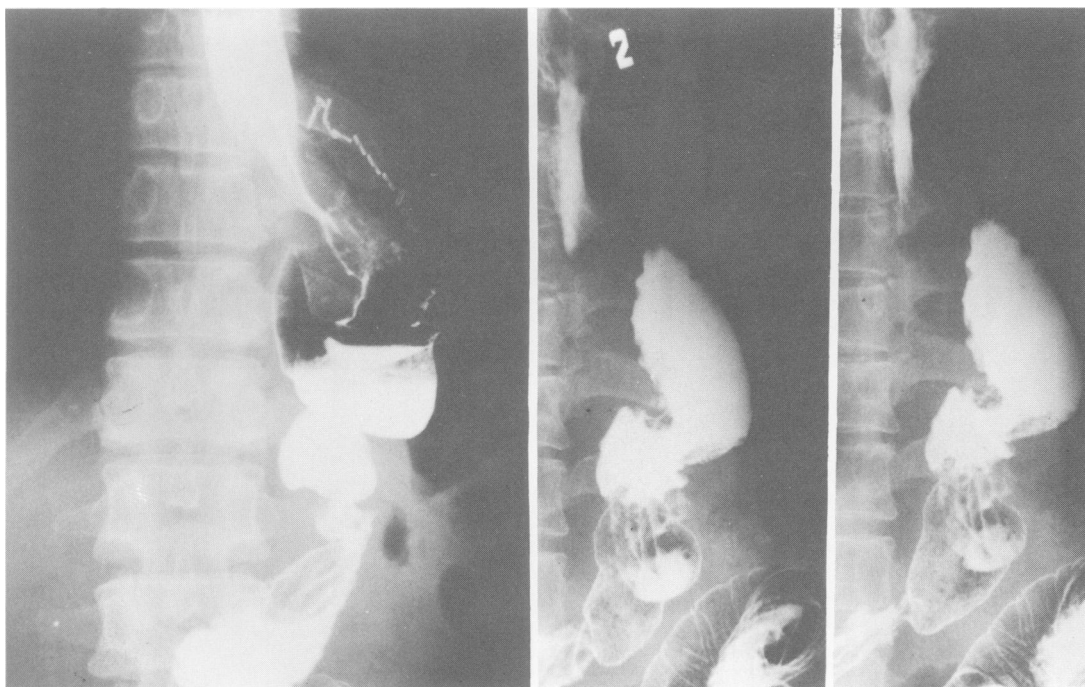


FIG. 8. On the left, a formation of the stomach bubble was well demonstrated. On the right, the patient was positioned 20 degrees head down and the fundus was filled with barium. Reflux could not be elicited.

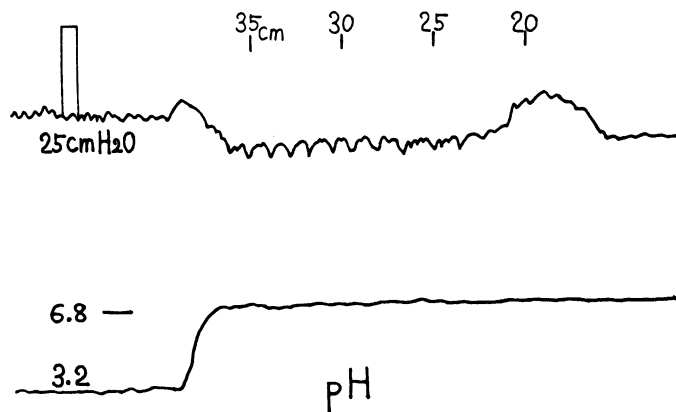


FIG. 9. Postoperative esophageal pressure and pH study show a zone of increased pressure and an abrupt rise in pH at the esophagogastric junction.

Cases with Regurgitation

1) *Case 6 (Ulcer, C, Anastomosis in the Abdominal Cavity)*. The anastomosis was created near the apex of the residual stomach, but because the apex was brought to the right side of the esophagus, a physiological bubble was not formed. There was no reflux with the patient in horizontal position, but reflux developed when placed in about a 10 degree head down position (Fig. 11). The patient complained of post-operative heartburn which was relieved by medication administered over a one month period. No intragastric-intraesophageal pressure barrier was indicated six months after operation (Fig. 12).

2) *Case 21 (Epidermoid Carcinoma, Im, Left Thoracic Cavity Anastomosis)*. The anastomosis was created adjacent to the lower margin of the aortic arch and the angle of His became obtuse because of the presence of the aorta between the esophagus and the gastric convexity (Fig. 13). There was regurgitation of barium with the patient in head down position.

Animal Experiments

Esophagogastronomy was performed on adult dogs divided into four groups as shown in Table 4. Gastroesophageal reflux developed in the groups with end-to-end anastomosis, anterior and posterior wall anastomosis. Post-operative ulcers formed in these 3 groups.

In the group undergoing posterior invagination anastomosis, no evidence of reflux was observed in radiographic examination and endoscopic, intraesophageal pressure and pH studies. Histological examination one year after operation showed no evidence of ulcer formation.

Discussion

Anastomotic leak, pulmonary complication, and circulatory insufficiency are the three major post-operative complications of esophageal cancer. Among these, anastomotic leak has the most direct relation to operative technique, in spite of surgical efforts to prevent this complication.^{5,6,11,20} Nakayama¹² reported a 20% incidence of this complication and Nabeya¹⁰ reported an 11.7% incidence in his cases.

In the present series of 42 cases undergoing posterior invagination anastomosis in a one-stage operation, the absence of anastomotic leak is attributed to the following factors:

- 1) The anastomosis was constructed on the posterior wall of the mobilized stomach which is an area with sufficient blood flow.
- 2) The anastomosed area was invaginated and completely blocked from the thoracic cavity.
- 3) Tension on the suture line of the anastomosis was avoided.
- 4) The wide field of operation.

Reflux esophagitis is another important surgical problem and among the numerous techniques designed to prevent this complication, Ellis and co-workers³ carried out pyloroplasty for early elimination of the gastric

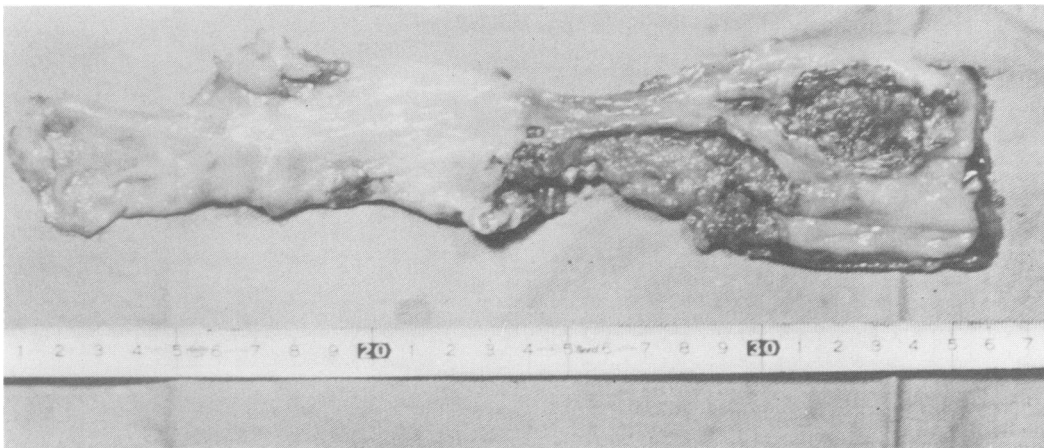


FIG. 10. Resected specimen of a giant cancer involving the entire thoracic esophagus.

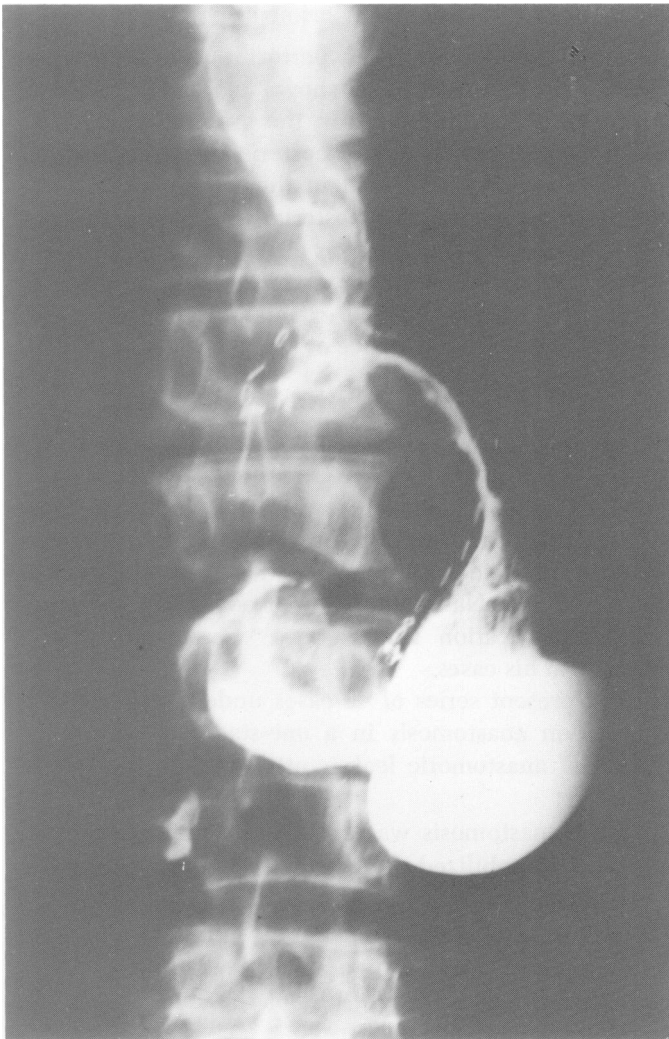


FIG. 11. Anastomosis was created near the apex of the residual stomach, and the apex was brought to the right side of the esophagus. Reflux developed in a 10 degree head down position.

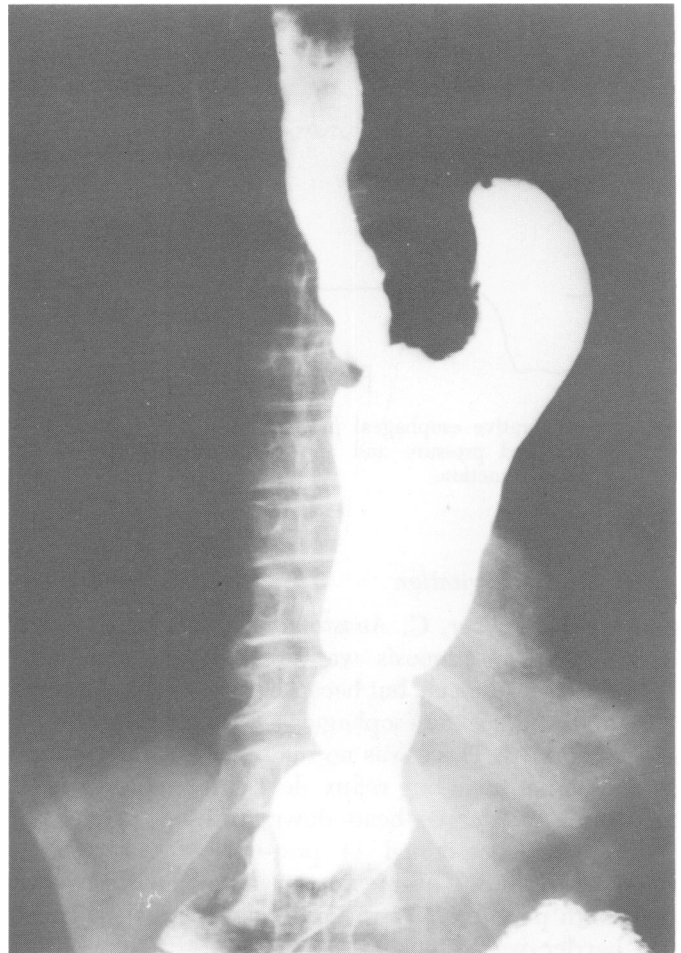


FIG. 13. Anastomosis was created at the aortic arch. Because of the presence of the aorta between the esophagus and gastric convexity, there was regurgitation of barium with the patient in head down position.

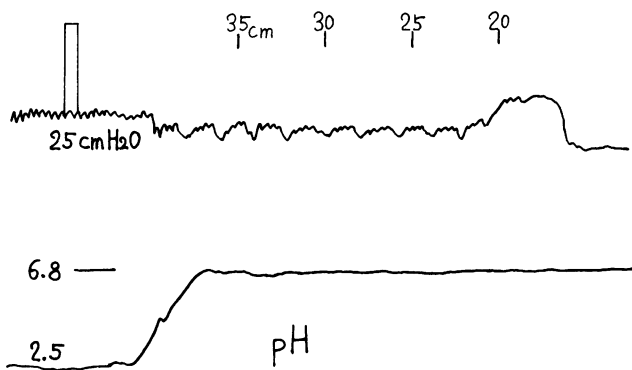


FIG. 12. Postoperative pressure and pH study don't show a zone of increased pressure and an abrupt rise in pH at the esophago-gastric junction.

contents. Woodward and associates¹⁰ stated that the pyloroplasty is but an auxiliary method since the occurrence of esophagitis is incompletely prevented. Watkins,¹⁸ Dillard,² and their co-workers devised a valvular esophagogastrostomy. Sirak and co-workers¹⁵ interposed the colon, which is more resistant to digestive fluids than the esophagus, between the proximal esophagus and the stomach. Skinner,¹⁶ Merendino,⁹ and their co-workers placed the jejunum between the esophagus and stomach. Lee⁷ used the right colon with the ileocecal

TABLE 4. *Esophagogastrostomy Performed on Adult Dogs*

Group	No. of dogs
End-to-end anastomosis	5
Anterior wall anastomosis	5
Posterior wall anastomosis	5
Posterior invagination anastomosis	5
Total	20

valve as a substitute for the stomach. Pearson and associates¹⁴ reported satisfactory results obtained with his ink-well anastomosis. In cases of diaphragmatic hernia, Baue¹ and Nissen¹³ attempted to prevent reflux by carrying out plication or fundoplication.

The survey of the literature suggested that an invagination technique may also be effective in preventing reflux esophagitis in cases of esophagogastrctomy.

According to Maki,⁸ the components of the physiological mechanism which prevent gastroesophageal regurgitation include: 1) the circular musculature at the lower end of the esophagus, 2) oblique muscle fibers of the stomach, 3) angle of His, 4) cardiac rosette, 5) right crus of the diaphragm, and 6) phrenicoesophageal ligament, etc.

Of these, only the angle of His is able to be recreated at esophagocardiectomy, and it was found in the present series of operations that by varying the degree of the esophagogastric angle and the length of the invaginated segment the effectiveness of the posterior invagination anastomosis was assured. Pyloroplasty was not performed in the first fifteen cases but in the succeeding 28 cases: assessment of the result in each of all the cases was made by subjective symptoms, radiographical findings, esophageal manometry, pH recordings, and esophageal endoscopy.

Reflux esophagitis was demonstrated in 8 of 42 cases. Five cases exhibited reflux on radiographic examination; 3 developed symptomatic reflux. No reflux esophagitis occurred in cases in which the angle of His was sharp, the stomach bubble formed above the anastomosis, and the invaginated segment of the esophagus exceeded 3 cm in length, regardless of pyloroplasty.

Reflux esophagitis was exhibited radiographically in head down position in two cases in which the anastomosis was constructed at the level of the inferior margin of the aortic arch and because of the position of the aorta between the esophagus and the fundus of the stomach, the fundus was unable to exert pressure upon the esophagus.

Various techniques for esophageal reconstruction are available in instances of total thoracic esophagectomy. A right thoracotomy is most commonly used for cases with upper or middle esophageal cancer. Because change of body position during the operative procedure is time-consuming and undesirably influences circulation, esophageal resection and reconstruction without body change has been attempted in the present series in cases undergoing a left thoracotomy with neck incision. Even in a case showing a giant cancerous lesion invading almost the whole segment of the thoracic esoph-

agus, total thoracic esophagectomy and cervical esophagogastrctomy was safely performed. Except for the anastomotic method, an almost similar operative procedure was originally described by Garlock⁴ and also by Sweet¹⁷ who resected the inner half of the left clavicle and corresponding segment of the first left rib; in both descriptions the stomach lay anterior and left of the aortic arch. In the present series, the stomach was placed in the posterior mediastinum between the aortic arch and the azygos vein, preventing postoperative disturbance of pulmonary function.

The ideal technique for surgery of the esophagus combined with posterior invagination anastomosis is a one-stage operation without positional change.

Summary

Resection and reconstruction of the esophagus with a posterior invagination anastomosis was performed in 42 cases using a one-stage procedure without change of body position. Results of postoperative examinations on these patients show that by use of this technique anastomotic leak is completely prevented and the occurrence of gastroesophageal reflux markedly reduced. This technique is applicable in all cases of thoracic esophagectomy involving total resection of the thoracic esophagus.

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