

Esophagectomy with gastric conduit reconstruction for benign disease: extreme but important

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Abstract: Esophagectomy is usually performed to resect esophageal cancer. However, there are numerous other indications for esophagectomy, including Barrett's esophagus with high-grade dysplasia (HGD) and some benign diseases such as obstruction, end-stage achalasia, esophagus perforation or disruption, benign neoplasm, and severe caustic injury. For these patients, esophagectomy could relieve their symptom obviously. However, esophagectomy causes huge trauma, induces quite high morbidity and mortality, and may decrease patients' quality of life obviously due to postoperative reflux, dumping, anastomotic stricture and other complications. Accordingly, the considerations of a surgery must be carefully deliberated, including the underlying disorder, lesions localization, extent of disease, and options for esophageal replacement. For patients received esophagectomy and alimentary tract reconstruction, gastric conduit is the most common used replacement organ, then colon and jejunum. This review demonstrated the importance and technical experience of esophagectomy with gastric conduit reconstruction for benign diseases.

Keywords: Esophagectomy; gastric conduit; benign disease; esophageal reconstruction

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Factors leading to esophageal failure in benign disease

Esophagectomy requires dissection of esophagus and replacement with other digestive tract organs. It also poses high complication and mortality rate (1). Hence, for patients with benign esophageal diseases, the judgement need serious consideration.

A number of mechanisms can lead to esophageal failure. One of them is esophageal stricture, which finally leads to disordered motility with contraction amplitudes or loss of peristalsis. These end-stage abnormalities result from a variety of esophageal diseases, such as caustic injury (2,3), chronic reflux disease (4), achalasia (5), giant mass in the esophagus (6), or scleroderma of connective tissue disease (7).

Another common cause to esophagectomy is multiple previous esophageal procedures such as repetitive dilatation, aggressive sclerotherapy, and poorly executed antireflux procedures. Other causes including esophagus perforation or rupture (8), preventive resection of Barrett's esophagus with high-grade dysplasia (HGD) (9).

Preoperative assessment

Besides the indications, preoperative assessment is necessary to make sure the surgery could be successfully accomplished. Before esophagectomy, patients were routinely assessed by esophagography, gastroscopy, enhanced computed tomography, ultrasonography in each patient. Furthermore, patients' tolerance to the esophagectomy was routinely

evaluated by electrocardiogram, pulmonary function tests, laboratory tests such as liver and renal functions.

Esophageal substitute: stomach, colon or jejunum

Stomach is the ideal esophageal replacement for alimentary reconstruction after esophagectomy, because of its sufficient length, sufficient vascular supply, and requirement of only one anastomosis (10,11). The use of the stomach as esophageal replacement was first introduced by Dr. Kirschner in 1920. He mobilized the stomach and brought it subcutaneously up to the amputated cervical esophagus (12). The application of gastric pull-up using the posterior mediastinum route or the retrosternal space after esophagectomy was popularized and standardized by Akiyama *et al.* (13). Remarkably, the stomach may be used as an esophageal substitute only if it has not been operated on previously. In all cases in which the use of stomach is doubtful, the colon or jejunum should be prepared for the esophageal substitute. As mentioned, colon and jejunum are other two kinds of alternative substitute for esophageal replacement. Colonic interposition has been used for esophageal reconstruction for decades of years (14,15). And the jejunum has been used since the times of Roux in the early 1900s as a conduit for reconstruction after esophagectomy.

Esophagectomy for benign diseases

Benign tumors of the esophagus are on the whole rather rare, making up only approximately 1% of all esophageal tumors. These tumors are a heterogeneous group, and as such the surgical management, when indicated, may take a variety of approaches. Most of the benign tumors could be resected by endoscopic resection or enucleation. The choice of the surgical management depends on factors such as whether they are symptomatic and their type, size, and location. Because of this, it is necessary to discuss the surgical techniques in the context of the different types of benign esophageal tumor.

Leiomyoma

Esophageal leiomyomas are the most common benign intramural esophageal tumors (16). It counts for 0.4% of all esophageal tumors. Esophageal leiomyomas are more common in men, most of them are solitary, 90% of them occur in the lower two-thirds of the esophagus (17).

They are typically asymptomatic and rarely get malignant transformation. Esophageal leiomyomas that are larger than 5 cm will cause dysphagia. Most esophageal leiomyoma could be resected by polypectomy, rubber band ligation and tumor ablation via endoscopic approaches (18), or enucleation through either a thoracoscopic or laparoscopic approach (19). Esophagectomy may be necessary for tumors that are large more than 8 cm, adherent to overlying mucosa, or when diffuse leiomyomatosis of the esophagus is present. However, esophagectomy causes many significant postoperative morbidity, including anastomotic strictures, dumping syndrome, reflux esophagitis, diarrhea, malnutrition and so on. Many of these morbidities are regarded as results of injured vagal nerves during esophagectomy. To avoid these complications, some surgeons advocate the use of a vagal-sparing technique. Patients with benign esophageal tumors underwent vagal-sparing esophagectomy were found free of dumping, diarrhea and had normal bowel function.

Esophageal achalasia

The esophagus is the tube that carries food from the throat to the stomach. The lower esophageal sphincter (LES) is a valve that closes off the esophagus from the stomach. Esophageal achalasia is a motility disorder characterized by the absence of esophageal peristalsis and ectasia, due to the failure of the LES to open up during swallowing which it's supposed to do. These abnormalities lead to emptying obstacle and backup of food and liquid within the esophagus. This condition may relate to damaged nerves of esophagus or damage of the LES. Most patients experience severe dysphagia, which can cause coughing and raises the risk of aspiration, or inhaling or choking on food. Patients with esophageal achalasia always have a low quality of life. The prevalence of achalasia is about 1/100,000 (20). The most common primary presenting symptom is dysphagia to both solids and liquids, with gradual symptom progression. Other non-specific symptoms include regurgitation, chest pain (predominantly in younger patients), heartburn, and halitosis. With the progression of dysphagia, the stasis may lead to a progressive esophageal dilatation. For these patients, an esophageal myotomy may cannot improve esophageal emptying and relieve dysphagia. Hence, some surgeons advocate esophagectomy as the first selection. Devaney and his colleagues reported a study of 93 patients with achalasia who underwent esophagectomy (21). In this study, gastric conduit was used in 91% of patients.

Indications for esophagectomy were a tortuous mega-esophagus in 64% of patients, failure of a prior myotomy (63%) and peptic stricture (7%). After esophagectomy, 80 patients (88%) were pleased with operative result and 85 patients (93%) felt better than preoperative condition.

Esophageal perforation

The most common cause of esophageal perforation is iatrogenic injury to the esophagus during medical procedure. Other less common causes include accidentally swallowing of foreign matter, tumor rupture, ulcers in the esophagus and violent vomiting. Esophageal perforation is uncommon, but it is a serious medical condition associated with high morbidity and mortality. Overall mortality after an esophageal perforation ranges from 18% to 22% even with urgent recognition and treatment (22). Initial treatment ranges from conservative treatment to esophagectomy. Nonsurgical treatments range from conservative medical management with antibiotics to endoscopic stenting with or without percutaneous drainage of infected pleural effusions (23-25). Surgical options include primary repair of the perforation with decortication and drainage, as well as esophagectomy with either immediate or delayed reconstruction (22,26,27). Dr. Seo *et al.* reported a study of 3,015 esophagectomies, 90 of which were for acute perforation (28). As a result, the median length of stay in the emergency group was higher (13 versus 10 days, $P < 0.0001$), and the complication rates were higher (51.1% versus 35.6%, $P = 0.003$). However, emergent esophagectomy did not decrease the survival rates at 30 days, 1 year, and 5 years compared with nonemergent esophagectomy. The study indicates that emergent esophagectomy is safe for the treatment of esophageal perforation, with tolerate mortality compared with elective esophagectomy.

Barrett's esophagus with HGD

Barrett's esophagus with HGD is regarded as precancerous lesions. Traditionally, this kind of disease could be managed by endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD). But some surgeons advocate that prophylactic esophagectomy for HGD in Barrett's esophagus is necessary. Dr. Richard reported a study involved 30 patients who diagnosed with HGD in Barrett's esophagus and received esophagectomy (9). As a result, invasive adenocarcinoma was found in 13 patients. This study indicated that Barrett's esophagus with HGD was

an indication for prophylactic esophagectomy in suitable surgical candidates because of its premalignant potential and the high proportion of patients who have invasive adenocarcinoma.

Surgery techniques: transhiatal esophagectomy

Transhiatal esophagectomy is the preferred approach for patients with benign esophageal disorders. Transhiatal esophagectomy is developed and refined at the University of Michigan since 1976 (29). The biggest advantage of transhiatal esophagectomy is without thoracic incisions. Dr. Orringer *et al.* published a study involved 166 patients received transhiatal esophagectomy (30). In this study, transhiatal esophagectomy was possible in 97% of patients in whom it was attempted, 13 patients required addition of a transthoracic esophagectomy. Stomach was the main substitute for esophageal, then colon. As a result, good or excellent functional results were achieved in nearly 70% after a cervical esophagogastric anastomosis.

Briefly, transhiatal esophagectomy is performed in four procedures. First, to open the abdomen and assess for resectability. The stomach is mobilized in preparation for resection. In the second phase, the esophageal hiatus is widened and mediastinal esophagus is mobilized. Then through a cervical incision, the cervical esophagus is mobilized and upper mediastinal dissection is performed. Finally, the esophagus is resected and a gastric conduit is created. The gastric conduit is brought up to the neck and esophagogastric anastomosis is completed.

Surgery techniques: transthoracic esophagectomy

If the surgeon feels that it is unsafe to perform a transhiatal esophagectomy, there should be no hesitation for conversion to thoracotomy. Such as esophagus that is adherent to adjacent mediastinal structures, which is usually caused by mediastinal fibrosis after previous surgery or radiation therapy.

Preparation of the stomach

First, dissect the lesser omentum and prepare the right diaphragmatic crus. After incision of the peritoneal coverage of the abdominal esophagus, the hiatus is prepared and the esophagus taped. Then, the left crus is prepared, and neighbored upper short gastric vessels can

also be dissected at this step. The skeletonization of the stomach is performed stepwise from fundus to the pylorus. After dividing the left gastroepiploic artery and vein, the preparation of the short gastric vessels may be performed close to the gastric wall. Then dissect the gastrosplenic and gastrocolic ligament. Also, the adhesions of the stomach and the duodenum to the gallbladder have to be dissected. The right colonic flexure must be freed, and the duodenum should be mobilized.

Formation of the gastric conduit

If an intrathoracic anastomosis is planned, the final tailoring of the conduit can be done in the chest, whereas for a cervical anastomosis, the conduit has to be finished in the abdomen. The proper diameter of a gastric conduit is 4 to 5 cm. And if you use the whole stomach rather than a gastric conduit, the pyloroplasty is necessary.

Intrathoracic final conduit formation

If an intrathoracic esophagectomy is planned, the fat issue of the lesser curvature between the middle and distal third is dissected in oral direction for 2 cm. Then the *en bloc* esophagectomy is performed with the dissection of the esophagus high up in the thorax. Pull up the stomach, insert the circular stapler through an incision at the upper third of the lesser curvature. The sharp tip of the stapler is perforated through the left anterior wall of the fundus, the anastomosis is performed after the connection and closure.

Gastric conduit for cervical anastomosis

For cervical anastomosis, the gastric conduit need to be completely finished before gastric pull-up. Pull out the esophagus through hiatus for the final preparation of the gastric tube. Dissect the fat tissue and the vessels at the lesser curvature between the middle and distal third for 2 cm, the stomach is stretched by careful pulling at the highest point. One or 2 TA90 stapler lines are now placed between the area of skeletonization at the lesser curvature and right to the highest point of the gastric fundus. The pull-up of the gastric conduit should be done with special carefulness in order to maintain the intramural vascularization.

Route of reconstruction

The best route of reconstruction after esophagectomy is the

posterior mediastinum because it is the most physiologic and the shortest way. Main disadvantage of this route is the issue of local tumor recurrence, especially in the cases of incomplete resection of the esophageal cancer. Other routes include retrosternal pathway and antesternal pathway which is nearly out of use.

Conclusions

Esophagectomy for benign diseases, although extreme, is necessary and important for relevant patients. It provides a quite long survival time with better quality of life. The crucial point of esophagectomy for benign diseases is optimizing the indications.

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Footnote

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