

# Comparative evaluation of different types of gastric conduits used for single-stage reconstruction during oesophageal cancer esophagectomy. Review

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In the treatment of local and local-regional oesophageal cancer, esophagectomy takes centre stage. It is a complex procedure with a high rate of postoperative complications. There are different methods for oesophageal reconstruction, including colon interposition, supercharged jejunal interposition, and gastric pull-up. Each has both advantages and disadvantages. However, a gastric graft is the preferred option due to the less traumatic nature of the operation. Currently, there are different methods for forming a gastric graft. Gastric conduits are classified based on their shape and can be categorised as whole-stomach, sub-total stomach, or gastric tube. Previous research on the functional characteristics of gastric conduits revealed that the most effective solution is a typical gastric tube. Due to its width (3–6 cm), the gastric tube limits its impact on lung movement within the pleural cavity, hence decreasing the incidence of postoperative respiratory complications (e.g., *pneumonia*). Pulmonary complications and anastomotic leaks are the main contributing causes of postoperative morbidity and mortality after esophagectomy. Other complications include technical and functional issues, as well as delayed problems such as anastomotic strictures and disease recurrence. However, the rate of complications remains between 20 and 80%, prompting oncologic surgeons to develop new methods for gastric conduit formation. Over the past 5 years, innovative methods using a special-shaped gastric tube have been suggested. They appear to decrease the incidence of postoperative complications and enhance nutritional outcomes. This study aimed to evaluate the advantages of using special-shaped gastric tubes in clinical practice as opposed to whole-stomach and typical gastric tubes.

## KEYWORDS

oesophageal cancer, esophagectomy, oesophageal reconstruction, gastric conduit, gastric tube.

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Oesophageal cancer is the ninth most common cancer and the sixth leading cause of cancer-related death worldwide [18]. As the sixth most fatal malignancy, oesophageal cancer represents a serious oncological burden. Today, despite multimodal therapeutic approaches, the overall five-year survival rate has been estimated to be 15–20% worldwide, and it varies widely according to cancer site [25]. The established treatment for oesophageal cancer is chemoradiotherapy combined with surgery. Esophagectomy as a surgical treatment remains the only curable option for local and locoregional disease stages [9, 16, 19, 22].

The overall incidence of postoperative complications after esophagectomy varies widely between 20

and 80 percent and includes systemic complications (e.g., *pneumonia*) and complications specific to the surgical procedure (e.g., anastomotic leak, gastric conduit necrosis). Pulmonary complications are the most common postoperative complications and occur in 16 to 67 percent of patients, but the most feared is anastomotic leakage, which occurs in 0 to 40 percent of patients [11, 15, 23, 27, 29].

The anastomosis of the oesophageal remnant with the stomach, which guarantees a dependable blood supply, is the most appropriate technique for reconstructing the digestive tract following esophagectomy for oesophageal cancer [3, 10, 13, 20].

Despite strong evidence that the gastric conduit is the best option for one-stage reconstruction after

|| site of vessels dissection ● excised area

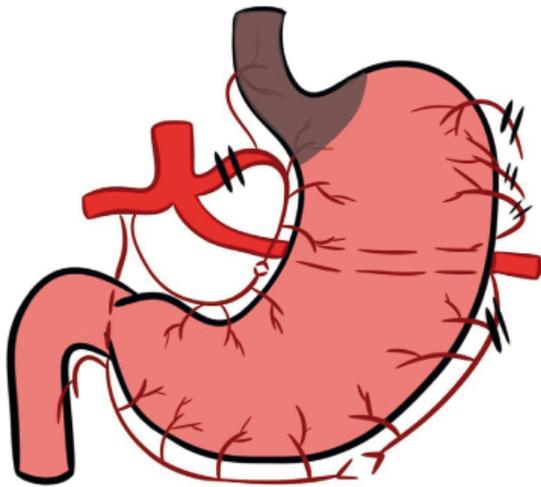


Figure 1. **Sub-total gastric conduit**

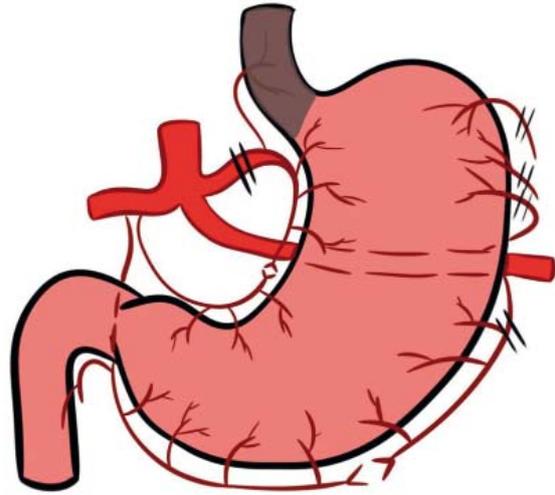


Figure 2. **Whole-stomach**

esophagectomy, the technique of gastric conduit formation remains controversial [2].

The whole stomach, sub-total stomach, conventional gastric tube, and special-shaped gastric tube are the different types of gastric conduits available today for oesophageal reconstruction. Few studies have concentrated on the comprehensive analysis and comparison of various types of gastric conduits.

This study addresses the clinical application status and research advancements related to various types of gastric grafts, focusing on surgical techniques, anatomical studies, and perioperative outcomes. It also analyses existing challenges and provides insights into future prospects.

## Preparation methods

### Whole-stomach and sub-total stomach

Akiyama et al. were the first to describe oesophageal reconstruction with a whole stomach [1]. During mobilisation of the stomach, all short gastric arteries, the left gastric artery, and the left gastroepiploic artery are ligated near their origin, with the right gastric artery and right gastroepiploic artery preserved. The oesophagus is cut at the level of the gastroesophageal junction (whole stomach) or 3–4 cm below (sub-total stomach), and the incision at the cardia is closed by a sero-muscular suture. The esophagogastric anastomosis is placed at the fundus of the stomach (Fig. 1, 2). The place of transection can be left without sero-serosal or sero-muscular sutures due to the use of endoscopic linear staplers via laparoscopic or, even, open approach.

### Gastric tube

The gastric tube refers to the section of the stomach that has been transected along the lesser curvature and cardia, following a path that runs parallel to the greater curvature. The width of the gastric tube usually varies from 3 to 6 cm. During mobilisation of the stomach, all short gastric arteries, the left gastric artery, and the left gastroepiploic artery are also ligated at the point of their origin. The transection line starts near the first branch of the right gastric artery and goes symmetrically along the greater curvature at a distance of 3–6 cm (Fig. 3). The gastric tube improved nutritional outcomes due to low rates of gastric emptying disorder and thoracic

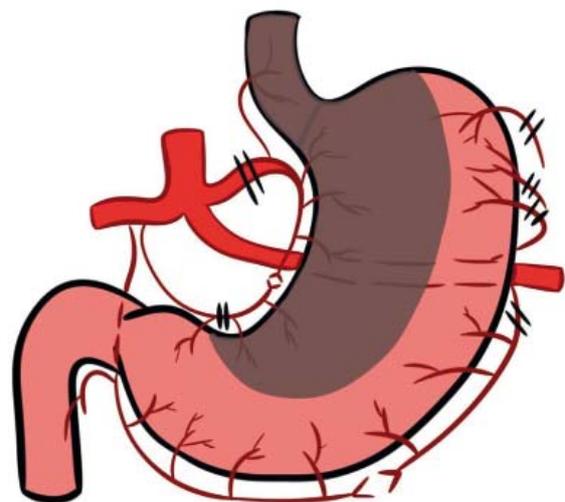


Figure 3. **Typical gastric tube**

gastric syndrome. These complications are associated with food or even liquid intake and cause life-threatening accumulation of air inside the stomach (in the chest cavity) and displacement of the mediastinum, which imitates a tension pneumothorax. As a result, the gastric tube has become the preferred method for oesophageal reconstruction [8].

### Special-shaped gastric tubes

The new studies on the optimal shape of the gastric tube consider such parameters as tension, storage function, and blood supply. Over the past five years, researchers have proposed several special-shaped gastric tubes, including the fusiform gastric tube, coniform gastric tube, and flexible gastric tube [6, 17, 33].

The fusiform and coniform gastric tubes appear to be the most promising options since they have a low incidence of systemic complications and issues associated with the surgical procedure.

### Coniform gastric tube

The first preparation technique belongs to Zheng et al. and was reported in 2019 [20]. The transection line starts at approximately 2–3 cm proximal to the pylorus and then goes towards the fundus along the cardia (Fig. 4). The right gastric artery is dissected as close as possible to its second branch origin. The left gastroepiploic artery is crossed as close as possible to the place of its origin. All the short gastric arteries are dissected. The authors declare that resection of the fundus improves the blood supply of the whole gastric tube. The wide lower segment seems to store more food and improve the postoperative nutritional outcomes of the patients. Among

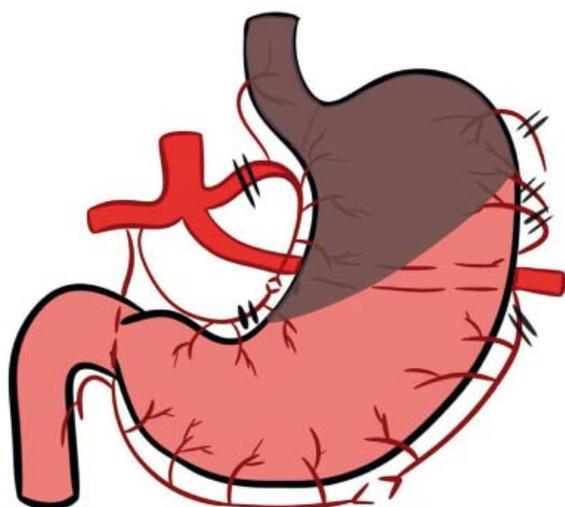


Figure 4. Coniform gastric tube

the 122 patients who have been treated with this method, anastomotic leak and pulmonary complications rates are 2.5 % and 7.8 %, respectively.

### Fusiform gastric tube

Fengfeng et al. reported a fusiform gastric tube preparation technique in 2018 [6]. The principle of symmetrically equal length and tension in the lesser and greater curvatures (optional site of vessel dissection) determines the number of preserved branches of the right gastric artery. Most often, the starting point of the resection line is the last branch of the right gastric artery. The resection line crosses the vertical axis symmetrically between the arcades of the left gastric and left gastroepiploic arteries midway and ends between 2/3 and 1/3 of the stomach fundus, closer to the greater curvature. The left gastroepiploic artery is crossed as close as possible to the place of its origin (Fig. 5). All the short gastric arteries are dissected. The authors believe that the right gastric artery branches provide additional blood supply to the gastric conduit. The authors evaluated fusiform gastric tube blood flow compared to a typical gastric tube with non-contrast laser Doppler line imaging and declared that the first group had better blood supply to the body and the antrum of the gastric remnant. The reported anastomotic leak rate was 0 %, and the rate of pulmonary complications was 7.8 %. Despite the good results, the sample size and lack of subgroup analysis (it is not specified which interventions and for what reason were performed on patients with Clavien-Dindo III–IV (n = 4)) don't allow us to ascertain the statistical validity of the published results. Although the methodology looks promising and could

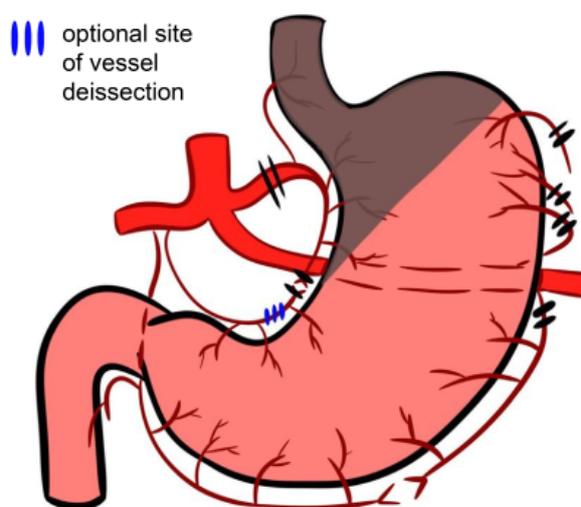


Figure 5. Fusiform gastric tube

probably be implemented in clinical practice after a larger sample size and a more thorough and detailed analysis of the research findings.

## Postoperative complications

Collard et al. first raised the issue of oesophageal reconstruction using a whole stomach versus a gastric tube in 1995 [4]. In a series of 112 patients who underwent gastric tube pull-ups versus 112 whole gastric pull-ups, he reported a 7.9 % incidence of anastomotic leak and 6.0 % of stricture versus 1.0 % and 22.3 %, respectively. However, the study belongs to the formative period of thoracic oncology and does not allow us to evaluate the performance of radical lymphodissection. There is also no data on median or recurrence-free survival. Taking into account the above-mentioned information, it can be stated that such a number of postoperative complications are due to the absence of radical lymphatic dissection at the abdominal and thoracic stages, which undoubtedly favourably affected the reduction of the incidence of anastomosis failure. The authors also reported nutritional outcomes: sensation of early fullness at meals (52.4 % versus 17.8 %), ratings given to long-term alimentary comfort (presymptomatic condition = 10 points) (7.6 versus 8.8 out of 10 on average), and calories consumed in 1 minute at a test meal (59 % versus 77 % of those consumed by control subjects). In the authors' opinion, such results were associated with the maintenance of the submucosal vascular network.

The study by Collard et al. has spurred other studies comparing the two preparation methods.

## Anastomotic leakage

Anastomotic leak (AL) is the most severe postoperative complication after esophagectomy among surgery-related complications. The presence of AL significantly increases morbidity and affects the long-term survival rates associated with malignancy [23].

According to Shu et al. and Zhang et al., gastric tubes significantly reduce the incidence of AL [24, 31]. However, a recent meta-analysis found no difference in the incidence of AL between the gastric tube and whole-stomach groups [32].

The rate of AL occurrence involves several factors, such as the anastomosis method and reconstruction route. In terms of the latter factor, the posterior mediastinal route (PM) seems to be a better choice compared to the retrosternal route (RS). According to Kikuchi et al., the AL rate was 11.7 % vs. 13.8 % in the PM and RS groups, respectively [12].

Recent studies of the anastomosis technique concluded that the anastomosis method is not a main factor and there is no significant difference in AL rate after plateauing [14].

## Pulmonary complications

Pulmonary problems are the most frequent and serious complications after esophagectomy among systemic complications. According to the current theory, a narrow gastric tube in the pleural cavity has less effect on the lung. This allows the lung to properly expand to its physiological volume, which reduces the rate of complications related to hypoventilation (e.g., atelectasis, *pneumonia*) [26].

## Quality of life (QoL)

Zhang et al. conducted a prospective study that lasted 10 years. The primary aim of the research was to determine the influence of gastric remnants on the quality of life of patients who underwent esophagectomy [30].

The researchers found that patients with a gastric tube compared to the whole-stomach had a better QoL score, but only from a short-term perspective. There was no difference in the QoL score between patients who survived for 5 years. The only exception was swallowing scores, which were better in the gastric tube group.

Since there was only one study on the QoL assessment, it makes sense to investigate reflux-esophagitis as a separate problem. It is the most annoying complication that seriously decreases the QoL score and nutritional outcomes because of emesis, low intake volume, and night aspirations.

The concept of a gastric tube implies resection of the lesser curvature, resulting in a decreased level of parietal cells and, as a result, a decreased level of peptic acid.

Flanagan et al. studied gastric emptying with contrast roentgenoscopy. Results showed that gastric tubes have significantly faster emptying functions; thereby, gastric tubes are associated with lower reflux-esophagitis rates [7].

## ERAS

ERAS can improve perioperative care, decrease complications, and speed up recovery. There are no special recommendations regarding gastric preparation methods in the ERAS guidelines. Special attention should be paid to Yin Li et al. No Tube, No Fasting Concept (NTNF): a pattern involving no nasogastric/nasointestinal/jejunoscopy tube, no thoracic/abdominal/cervical drainage tube,

and no fasting. The pattern appears to significantly improve postoperative clinical and nutritional outcomes [28]. Despite the above-mentioned results, the absence of a nasogastric tube may lead to delayed gastric emptying, increasing the risk of pulmonary complications. Nasogastric tube placement remains a method of choice based on the width of the gastric tube and surgeon experience.

## Conclusions

The gastric tube became the main preparation method due to equal rates of anastomotic insufficiency and significantly higher QoL scores compared to the whole-stomach approach.

There is insufficient data to compare a typical gastric tube to a subtotal stomach or a special-shaped gastric tube. The studies analysed in the review do not allow for the establishment of the optimal method of forming a gastric conduit.

The results presented by other authors cannot be considered reliable because of the extended time since the study and the limited sample size. It is also important to note the lack of studies comparing three methods of gastric conduit development in individuals with high heterogeneity. The aforementioned factors necessitate additional research.

## DECLARATION OF INTERESTS

The author declares that they have no conflicts of interest.

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All figures included in the publication are original and were created by the author.

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## Порівняльний огляд шлункових кондуїтів при одноетапній реконструкції стравоходу при езофагектомії з приводу раку стравоходу

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Езофагектомія посідає центральне місце в лікуванні місцевого та місцево поширеного раку стравоходу. Існує багато методів реконструкції стравоходу (інтерпозиція товстої кишки, інтерпозиція тонкої кишки з анастомозуванням судинної ніжки, транспозиція шлунка). Усі вони мають переваги та недоліки, але шлунок є кращим трансплантатом при одномоментній реконструкції стравоходу. Є кілька методик створення шлункового трансплантата, які прийнято класифікувати за формою: весь шлунок, субтотально збережений шлунок, типова шлункова трубка. Історія досліджень функціональних особливостей шлункових кондуїтів дала підстави для висновку, що найфункціональнішою є типова шлункова трубка. Завдяки ширині (3—6 см) шлункова трубка мінімально впливає на екскурсію легень всередині плевральної порожнини, що зменшує частоту післяопераційних ускладнень, пов'язаних із дихальною системою (наприклад, пневмонії). Легеневі ускладнення та неспроможність анастомозу — основні причини післяопераційної морбідності та смертності після езофагектомії. Іншими ускладненнями є технічні та функціональні проблеми, а також відстрочені ускладнення (стриктури анастомозу та рецидиви захворювання). Велика частота ускладнень (близько 80 %) змушує онкохірургів винаходити нові методи формування шлункового трансплантата. В останніх 5 років запропоновані нові методи — так звані шлункові трубки спеціальної форми, які, на перший погляд, знижують частоту післяопераційних ускладнень і в подальшому поліпшують нутритивні результати. Розглянуто переваги клінічного застосування шлункових трубок спеціальної форми порівняно з поширенішими методиками (наприклад, використання всього шлунка та типової шлункової трубки).

**Ключові слова:** рак стравоходу, езофагектомія, пластика стравоходу, шлунковий кондуїт, шлункова трубка.

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