



## RESULTS OF THREE-STAGE ESOPHAGECTOMY WITH ONE-PHASE ESOPHAGOCOLONOPLASTY IN ESOPHAGEAL AND GASTROESOPHAGEAL JUNCTION CARCINOMAS TREATMENT

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**Цель.** Оценить результаты трехуровневой эзофагэктомии с одноэтапной эзофагоколонопластикой при хирургическом лечении карцином пищевода и пищеводно-желудочного перехода в зависимости от пути проведения трансплантата на шею.

**Материал и методы.** Эзофагэктомии с одноэтапной эзофагоколонопластикой выполнены у 30 пациентов. В зависимости от пути проведения толстокишечного трансплантата на шею сформированы две группы: 1-я — с ретростернальным (n=13) путем и 2-я — с заднемедиастинальным (n=17) путем. Группы не различались по морфологии, pT и pN, стадиям злокачественной опухоли, возрасту, индексу массы тела и полу.

**Результаты.** Длительность вмешательств в 1-й и 2-й группах составила 435,0 (390,0; 477,5) и 425,0 (352,5; 467,5) минуты (p=0,691), объем кровопотери — 400 (325,0; 525,0) и 500,0 (475,0; 725,0) мл (p=0,020), длительность стационарного лечения — 30,0 (23,0; 36,0) и 32,0 (20,0; 57,5) дня (p=0,900). Несостоятельность пищеводно-толстокишечного анастомоза и некроз проксимальных отделов трансплантата выявлялись клинико-рентгенологически на 7-е сутки после операции. Несостоятельность анастомоза в 1-й и 2-й группах развилась в 2 (15,4%) и 2 (11,8%) наблюдениях (p=0,776), некроз — в 1 (7,7%) и 1 (5,9%) (p=0,846). Поздние рубцовые стриктуры пищеводно-толстокишечного анастомоза, определявшиеся эндоскопически спустя 3 месяца после операции, сформировались у 2 (15,4%) и 1 (5,9%) пациентов соответственно (p=0,398). Госпитальная и 30-дневная летальность в группах не различалась — по 1 (7,7%) и 1 (5,9%) случаю соответственно (p=0,846). Общая 5-летняя выживаемость в 1-й и 2-й группах составила 18,6% и 20,6% (p<sub>logrank</sub>=0,804).

**Заключение.** Эзофагэктомия с одноэтапной эзофагоколонопластикой при хирургическом лечении карцином пищевода и пищеводно-желудочного перехода независимо от пути проведения трансплантата является сложным вмешательством, позволяющим добиться отдаленных результатов лечения, сопоставимых с таковыми при выполнении стандартных операций.

**Ключевые слова:** карцинома пищевода, карцинома пищеводно-желудочного перехода, трехуровневая эзофагэктомия, одноэтапная эзофагоколонопластика, путь проведения трансплантата, заднемедиастинальный путь проведения, заградный путь проведения

**Objective.** To evaluate the results of three-stage esophagectomy with one-phase esophagocolonoplasty in surgical treatment of esophageal and gastroesophageal junction carcinomas depending on graft translocation route to the neck.

**Methods.** Esophagectomy with one-phase esophagocolonoplasty was performed in 30 patients. Depending on the graft translocation route to the neck, two groups of patients were formed: the 1st group — with retrosternal route (n=13) and the 2<sup>nd</sup> — with posterior mediastinal one (n=17). The groups did not differ in morphology, pT and pN, stages, age, body mass index and sex.

**Results.** Time of procedures in the 1<sup>st</sup> and 2<sup>nd</sup> groups was 435.0 (390.0, 477.5) and 425.0 (352.5, 467.5) minutes (p=0.691), blood loss volume — 400 (325.0, 525.0) and 500.0 (475.0, 725.0) ml (p=0.020), in-hospital stay — 30.0 (23.0, 36.0) and 32.0 (20.0, 57.5) days respectively (p=0.900). Esophago-colonic anastomotic leakage and graft proximal necrosis was detected by physical examination and X-rays on 7th day after the procedure. Anastomotic leakage in the 1<sup>st</sup> and 2<sup>nd</sup> groups developed in 2 (15.4%) and 2 (11.8%) cases (p=0.776), graft necrosis — in 1 (7.7%) and 1 (5.9%) (p=0.846). Late anastomotic stricture of the esophageal-colonic anastomosis, determined endoscopically 3 months after the procedure developed in 2 (15.4%) and 1 (5.9%) patients respectively (p=0.398). Hospital and 30-day mortality did not differ — 1 (7.7%) and 1 (5.9%) (p=0.846); overall 5-year survival made up 18.6 and 20.6% respectively (p<sub>logrank</sub>=0.804).

**Conclusions.** Esophagectomy with one-stage esophageal replacement by primary coloplasty in surgical treatment of esophageal and gastroesophageal junction carcinomas regardless of graft translocation route to the neck is a complex procedure that allows achieving long-term treatment results comparable to those in the standard procedures.

**Keywords:** esophageal carcinoma, gastroesophageal junction carcinoma, three-stage esophagectomy, one-phase esophageal replacement by primary coloplasty, graft translocation route, posterior mediastinal route, retrosternal route

#### Научная новизна статьи

Впервые изучены результаты трехуровневой эзофагэктомии с одноэтапной эзофагоколонопластикой при хирургическом лечении карцином пищевода и пищеводно-желудочного перехода в зависимости от пути проведения трансплантата на шею. Установлено, что данный тип оперативных вмешательств в условиях дефицита пластического материала при нетрансплантабельном желудке и тонкой кишке позволяет добиться отдаленных результатов лечения, сопоставимых с таковыми при выполнении стандартных операций.

#### What this paper adds

The results of three-stage esophagectomy with one-phase esophagocolonoplasty in esophageal and gastroesophageal junction carcinomas treatment depending on graft translocation route to the neck were studied for the first time. It was established that this type of surgical procedure in conditions of plastic material deficiency with non-transplantable stomach and small intestine allows to achieve long-term treatment results comparable to those in performing standard procedures.

### Introduction

Malignant tumors of the esophagus and gastroesophageal junction are an indication for various types of radical surgeries, where the main stage is the removal of a malignant tumor (the esophagus resection or esophagectomy) in accordance with the basic principles of cancer radicalism. No less important is the stage of restoring the continuity of the digestive tract, esophagoplasty. The most preferred material for the primary reconstruction of the esophagus is a transplant, formed from its own stomach with good blood supply. The technology of esophagogastroplasty itself requires the formation of just one anastomosis. The situation is complicated if, due to various circumstances, the stomach is unsuitable for replacing the resected or removed esophagus. In this case, other more complex interventions can be used, implying the possibility of using the available plastic reserve in the form of a large or small intestine, taking into account the specific features of the vascular anatomy of the visceral graft chosen for plasty. To restore the continuity of the digestive tract after esophagectomy with the nontransplantability of the stomach and small intestine, a variety of techniques can be used with the use of the colon as a graft, which makes it possible to cut out the segment necessary for translocation along the neck length.

All variants of non-gastric plasty are accompanied by a high frequency of postoperative life-threatening complications, where the main role is assigned to ischemic complications from the esophageal-organ anastomosis (failure) and the used graft (partial or total necrosis). Thus, the frequency of coloruc graft necrosis reaches 14% [1], and the incidence of the esophageal-colonic anastomosis failure on the neck is 35.7% [2]. Cardiac (rhythm disturbances, heart failure), respiratory (polysegmental pneumonia) and purulent-septic (mediastinitis, empyema) complications develop secondary, which can lead to postoperative mortality.

A number of works of the last 10 years demonstrate a certain advantage of using methods of vascular amplification that allow improving the blood supply of the formed graft and thereby reducing the incidence of ischemic complications [2, 3, 4, 5, 6, 7, 8, 9].

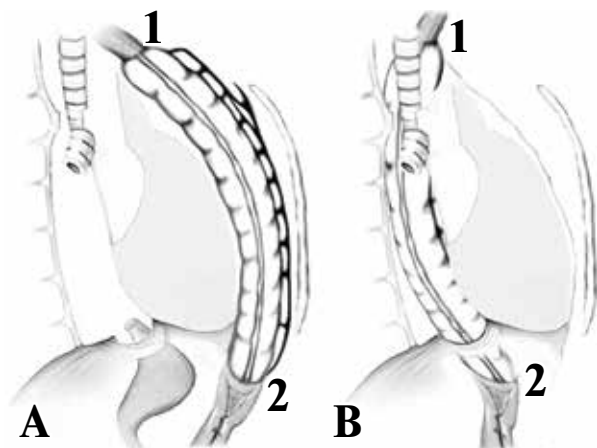
The development of new methods of esophagoplasty is potentially capable of improving immediate and long-term results of treatment, as well as improving the quality of patients' life in non-standard conditions with a deficiency of plastic material and altered vascular anatomy. The necessity of studying the indicated problem determines the relevance of the material presented.

**Objective.** To evaluate the results of three-stage esophagectomy with one-phase esophageal replacement by primary coloplasty in surgical treatment of esophageal and gastroesophageal junction carcinomas depending on graft translocation route to the neck.

### Methods

Three-stage esophagectomy from the thoraco-abdomino-cervical access with one-phase esophagocolonoplasty in surgical treatment of the esophageal carcinoma and gastroesophageal junction carcinoma was performed in 30 patients. Depending on the route of the colonic graft to the neck, two groups of patients were formed: the 1<sup>st</sup> group – with retrosternal route (n=13) and the 2<sup>nd</sup> – with posterior mediastinal one (n=17) - the diagram is shown on Fig. 1.

Squamous cell carcinoma of the esophagus prevailed in both groups, 9 (69.2%) and 15 (88.2%) (p=0.357), less frequently adenocarcinoma of the gastroesophageal junction – 4 (30.8%) and 2 (11.8%), respectively (p=0.360). According to the pT criterion in the 1st and 2<sup>nd</sup> groups, the patients were distributed as follows: pT1 – 0 (0%) and 4 (23.5%) (p=0.113), pT2 – 5 (38.5%) and 7 (41.2%)



**Fig. 1** Scheme of a one-phase esophagocoloplasty with retrosternal (A) and posterior mediastinal (B) ways of translocation routes to the neck. 1 – esophageal-colonic anastomosis, 2 – colo-jejunal anastomosis.

( $p=1.0$ ), pT3 – 8 (61.5%) and 6 (35.3%) patients ( $p=0.269$ ); by the pN criterion: pN0 – 6 (42.7%) and 10 (58.8%) ( $p=0.715$ ), pN1 – 7 (53.8%) and 7 (41.2%) cases ( $p=0.714$ ); by stages: stage III – 6 (46.2%) and 4 (23.5%) ( $p=0.256$ ), stage II – 4 (30.8%) and 6 (35.3%) ( $p=1, 0$ ), stage I – 3 (23.1%) and 7 (41.2%) of observations ( $p=0.441$ ). The age of the patients in the groups was 57.0 (49.0, 61.0) and 57.0 (54.0, 62.0) years ( $p=0.426$ ), the body mass index was 21.8 (20.0, 25.9) and 22.5 (20.0, 27.1) units ( $p=0.802$ ). Male patients predominated in both groups – 11 (84.6%) and 13 (76.5%) people ( $p=0.857$ ).

The reasons for using the colon as a plastic material for creating an artificial esophagus in groups 1 and 2 were the following: the lesion of the upper third of the thoracic esophagus by the malignant tumor – 7 (53.8%) and 10 (58.8%) ( $p=1.0$ ), non-transplantable stomach due to previous interventions on it – 4 (30.8%) and 5 (29.4%) ( $p=0.995$ ), recurrence of cancer in the zone of esophageal organ anastomosis – 2 (15.4%) and 1 (5.9%) ( $p=0.564$ ), synchronous cancer of the esophagus and stomach – 0 (0%) and 1 (5.9%), respectively ( $p=0.997$ ).

In the 1<sup>st</sup> group, transplants in the isoperistaltic position were used more often than in the second group 11 (84.6%) versus 6 (35.3%) ( $p=0.010$ ), and less frequently in the anti-peristaltic position – 2 (15.4%) versus 11 (64.7%) ( $p=0.011$ ). When forming the graft in the 1<sup>st</sup> group, the right flank of the large intestine was often used – 10 (76.9%) versus 4 (23.5%) in the 2<sup>nd</sup> group ( $p=0.009$ ); on the contrary, in the 2<sup>nd</sup> group with the posterior mediastinal plasty, the grafts were more often cut from the left flank of the colon – 13 (76.5%) compared to 3 (23.1%) in the 1<sup>st</sup> group ( $p=0.008$ ). As the feeding pedicle for the transplant, the left colonic vessels were used in the 1<sup>st</sup> group – 11 (84.6%) versus 6

(35.3%) ( $p=0.010$ ) in the 2<sup>nd</sup>; in the second group, the role of the feeding pedicle was more often performed by the middle colonic vessels – 11 (64.7%) versus 2 (15.4%) in the 1<sup>st</sup> group ( $p=0.011$ ).

The 1<sup>st</sup> and 2<sup>nd</sup> groups did not differ in the frequency of formation of proximal digestive anastomoses with the end-to-end graft – 10 (76.9%) and 7 (41.2%) ( $p=0.071$ ), end-to-side graft – 3 (23.1%) and 10 (58.8%) cases ( $p=0.054$ ). In the 1<sup>st</sup> and 2<sup>nd</sup> groups, distal digestive anastomoses with a graft were formed as follows: end in the anterior wall of the stomach – 6 (46.2%) and 13 (76.5%) ( $p=0.132$ ), end in the side of the small intestine loop – 5 (38.5%) and 1 (5.9%) ( $p=0.060$ ), end in the side on the Roux-en-Y -1 (7.7%) and 2 (11.8%) ( $p=0.999$ ), the end in the anterior wall of the duodenum – 1 (7.7%) and 1 (5.9%), respectively ( $p=1.0$ ). According to the frequency of pyloroplasty, the 1<sup>st</sup> and 2<sup>nd</sup> groups did not differ – 2 (15.4%) and 5 (29.4%) cases ( $p=0.426$ ).

Vascularization of the graft was used in the patients of the 1<sup>st</sup> group in case of its retrosternal location – 8 (61.5%) of 13 patients in cases of non-main type of blood supply to the colon. As the source of additional blood supply, internal thoracic vessels were used. Arterial anastomoses with the right colonic artery were formed in 2 (25%) patients, with the middle colonic artery in 6 (75%). Additional drainage intervenous anastomoses were used in 2 patients: in 1 (12.5%) – from the middle colonic vein and in 1 (12.5%) – from the right colonic vein.

When analyzing the immediate treatment results in groups, the evaluation criteria were the duration of surgical interventions, the amount of intraoperative blood loss, the duration of inpatient treatment, the incidence of cardiac and respiratory postoperative complications. The incidence of the esophageal-colonic anastomosis failure and the frequency of necrosis of the transplant were also assessed on the 7<sup>th</sup> day after the operation. The long-term treatment results were assessed by the frequency of the esophageal-colonic anastomosis late cicatricial strictures development 3 months after the operation and by the indicators of the overall 5-year survival, median survival, life expectancy after a 60-month follow-up period.

### Statistics

The distribution normality of traits was checked using the Kolmogorov-Smirnov test. For  $p < 0.05$ , the distribution of the trait was considered to be different from normal. The studied quantitative characteristics did not obey the normal distribution, and nonparametric methods were used when comparing them. The quantitative parameters in the work are presented in the form of the median (Me)

and quartiles (Q) – Me (Q25; Q75). When comparing two independent groups with an abnormal distribution of quantitative traits, a nonparametric method was used using the Mann-Whitney U test. For the analysis of qualitative traits, the Pearson's chi-squared test was used. Differences were considered significant at  $p < 0.05$ .

Survival rates are calculated by the Kaplan-Meier method with the display of the survival function in the form of a stepped graph and with specifying on the curve of the censored observations to which the survived patients were referred. The starting point was the onset of surgical treatment. Using survival tables, life expectancy and median survival were calculated with the indication of a standard error. A comparative survival analysis was performed according to the Mantel-Cox log-rank test.

## Results

The duration of surgical interventions in the 1st and 2nd groups was 435.0 (390.0, 477.5) and 425.0 (352.5, 467.5) minutes ( $p=0.691$ ), the volume of intraoperative blood loss was 400.0 (325.0, 525.0), and 500.0 (475.0, 725.0) ml, respectively ( $p=0.020$ ).

The esophageal-colonic anastomosis failure in the 1st and 2nd groups developed in 2 (15.4%) and 2 (11.8%) observations ( $p=0.776$ ), necrosis of the proximal colonic grafts – 1 (7.7%) and 1 (5.9%) case respectively ( $p=0.846$ ). The average time for diagnosis of the above complications in the groups was 6 (1.5, 9.0) and 5.0 (0.0; 9.5) days ( $p=0.457$ ). Late cicatricial strictures of the esophageal-colonic anastomosis in groups 1 and 2 developed in 2 (15.4%) and 1 (5.9%) patients ( $p=0.398$ ).

Among non-surgical postoperative complications, the most significant in groups 1 and 2 were respiratory ones (pneumonia) – 4 (30.8%) and 4 (23.5%) cases ( $p=0.662$ ). Cardiac complications in the form of the rhythm disturbances did not occur in the 1st group of patients and developed in 2 (11.8%) cases in the 2nd group ( $p=0.208$ ).

The average length of hospitalization in the patients of the 1st and 2nd groups was 30.0 (23.0, 36.0) and 32.0 (20.0, 57.5) days ( $p=0.900$ ). Hospital and 30-day mortality in groups 1 and 2 did not differ and amounted to 1 (7.7%) and 1 (5.9%), respectively ( $p=0.846$ ). The 60-day mortality in the 1st and 2nd groups was 3 (23.1%) and 2 (11.8%) observations ( $p=0.418$ ). The causes that led to fatal outcomes in the groups also did not differ: necrosis of the proximal segments of the colon-graft with mediastinitis in 1 (7.7%) and 1 (5.9%), bilateral polysegmental pneumonia-2 (15.4%) and 1 (5.9%), respectively ( $p=0.401$ ).

The overall 5-year survival statistically in the 1st

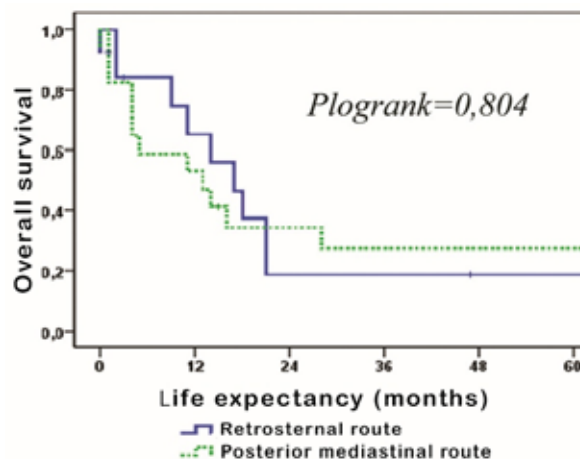


Fig. 2. Overall survival of patients in groups, depending on the route of the colonic graft to the neck.

and 2nd groups did not differ significantly – 18.6% and 20.6%, respectively (Fig. 2).

The median survival was 17.0 (95% CI 10.7-23.3) months and 13.0 (95% CI 1.0-25.1) months, the average life expectancy was  $20.3 \pm 6.5$  (95% CI 9.5-35.0) months and  $40.8 \pm 13.9$  (95% CI 13.5-68.1) months respectively ( $p_{\text{logrank}}=0.804$ ).

## Discussion

Any visceral graft used for esophagoplasty should be sufficient to move to the neck without tension, which is not always feasible. If the length of the formed graft is insufficient, the tension arising on the proximal anastomosis with the esophagus often leads to the disruption in the blood supply of the graft with the development of secondary anastomosis incompetence and / or necrosis of the graft - the most dangerous complications of these types of surgical interventions.

For example, the use of the small intestine for distant displacement to the neck is far from always possible, since the technique of forming a small intestinal graft requires crossing up to 4 small intestinal arteries, which increases the risk of developing ischemic complications. In addition, the presence of short mesenteric arcades also prevents straightening of the small intestine transplant and limits the length of the derived intestinal segment. All these anatomical features may require the creation of a source of additional blood supply, in the case of using the small intestine for esophagoplasty [10].

The use of the colon as a plastic material to create an artificial esophagus is often a forced benefit – "salvage" procedure operation, when other variants of esophagoplasty by the stomach or small intestine are inapplicable for their nontransplantability.

When assessing different options for creating a transplant from the colon, it is necessary to take

into account the technical complexity and duration of operations. The question of the advisability of using the right or left half of the large intestine for plasty should be decided individually, depending on the characteristics of the colon's blood supply, the length of the intestinal segment potential for the esophagus substitution, and the level of the esophagus lesion.

The formation of a transplant from the right half is technically simpler and takes less time, since the operation does not require the mobilization of the entire colon. To cut the transplant from the left half of the colon, the entire large intestine, including the sigmoid colon, must be mobilized. Only under this condition the anastomosis between the remaining segments of the colon can be formed without tension.

In turn, subtotal mobilization of the colon helps to reduce the traumatic nature of the intervention by decreasing the volume of intraoperative blood loss. The volume of hemorrhage in the 2<sup>nd</sup> group with posterior-mediastinal plastic surgery exceeded that in the 1<sup>st</sup> group – 500.0 (475.0, 725.0) ml vs. 400.0 (325.0, 525.0) ml ( $p=0.020$ ), which is explained by more frequent total mobilization of the colon in the 1<sup>st</sup> group 13 (76.5%) versus 5 (38.5%) in the 2<sup>nd</sup> group ( $p=0.038$ ).

Taking into account the heterogeneity of the information presented in the literature concerning colonic plasty of the esophagus, it must be understood that the results on the frequency of postoperative complications and mortality will differ greatly between the experiences of various surgical schools.

According to the literature, the frequency of colonic necrosis after esophagoplasty reaches 14% [8], according to our data – 6.7% of cases from 30 patients in the general cohort. In the comparison groups, depending on the route of the transplant dislocation to the neck (retrosternal and posterior mediastinal) the incidence of necrosis of the anastomotic segment of the graft did not differ – 7.7% versus 5.9% of the observations, respectively ( $p=0.846$ ).

According to the literature, the incidence of esophageal-colonic anastomosis failure on the neck can occur up to 35.7–50% of the operated patients [2, 8, 11]. The percentage depends largely on the experience of the clinic, the amount of such interventions performed, the number of observations provided. Such a digital divergence is explained by the fact that many authors include in the analysis clinically insignificant microscopic inconsistencies of anastomoses, diagnosed only radiologically in the form of a streak of a contrast agent without any clinical picture. In this study, the incidence of anastomosis failure was 13.3% (4/30) of the observations. Secondary healing of the neck wound through

microfistula due to a partial inconsistency of the esophageal-colonic anastomosis in size up to 1/3 of its circumference was observed in the 1<sup>st</sup> and 2<sup>nd</sup> groups and did not differ depending on the route of the transplant to the neck – 15.4% and 11.8 %, respectively ( $p=0.776$ ).

Postoperative lethality after esophagocoloplasty can reach 16.7–27.8% [8, 11]. In general, this indicator in the available literature varies widely, which largely depends on the specialization of the medical institution. In centers with a high volume of interventions, this kind of lethality is 7% [8]. When analyzing our own material, hospital and 30-day postoperative mortality was 6.7% (2/30), 60 days – 16.7% (5/30). In addition, most authors in their publications clearly do not differentiate the rates of postoperative mortality, which can be either hospital, 30- or 60-day, which is of key importance in a comparative analysis.

The development of late cicatricial strictures of the cervical esophageal-colonic anastomosis is observed in practically every third patient after esophagocoloplasty – up to 32.1% [8, 12]. In the presented work, the frequency of strictures development was registered in 3 (10%) patients. Clinically significant bile reflux by endoscopic data was mainly diagnosed in the 2<sup>nd</sup> group of patients with orthotopic (posterior mediastinal) graft localization in the antiperistaltic position – 6 (35.3%) vs. 1 (7.7%) ( $p=0.082$ ). At the same time, the frequency of strictures development in the groups did not differ – 2 (15.4%) and 1 (5.9%) cases ( $p=0.398$ ). The isoperistaltic position was more often used in the retrosternal location of the transplant – 11 (84.6%), less often in the posterior mediastinal pathway – 6 (35.3%) ( $p=0.008$ ).

An antiperistaltic version of plastics requires the setting of a nasointestinal catheter to prevent the bile reflux and the development of cicatricial strictures of the anastomosis subsequently. As a rule, transplants in the isoperistaltic position provide more physiological function than those located antiperistaltic ones. This is due to the persistence of peristaltic activity of the grafted intestinal segments in the distant periods, despite their denervation when an artificial esophagus is cut out. The transplant from the left half of the large intestine, as a rule, can be located precisely in the antiperistaltic position, which is often the cause of bile reflux. In this case, the positive aspect is the smaller diameter and more stable blood supply of such an intestinal segment, which conformally "fits" into the posterior mediastinum and is characterized by a lower risk of redundancy development inherent for the transplants from the right flank.

The frequency of repeated operations because of transplant necrosis, anastomosis failure or

transplant redundancy occurs up to 14.2-32.1% of observations [8, 12, 13]. The need to perform emergency interventions for the above reasons in this paper arose in 2 (6.7%) cases. In one follow-up, a discontinuity operation was required with the removal of the retrosternally located colonic graft because of the necrosis of its proximal segment due to compression in the canal of the upper aperture of the thorax, and in the other case – the removal of the zone of the complicated esophageal-colonic anastomosis with inconsistency, size up to 2/3 of its circumference because of transient ischemia of the oral end of the transplant in the form of the cervical esophageal-colonic fistula.

The most frequently mentioned in the literature non-surgical complication is the development of aspiration pneumonia – up to 32% of observations [8]. In this study of the total number of patients (n=30) pneumonia was diagnosed in 8 (26.7%) people, of which 3 (37.5%) patients died within 60 days after the intervention. In general, respiratory complications after such interventions reach 36.4-42.8% [7, 14].

Restoring natural oral ingestion was achieved in 93.3% of cases. According to the literature, this indicator varies between 75-80% of cases [7, 8, 12].

In cases where there is a high risk of local recurrence in the posterior mediastinum (cT3-4aN2M0) and the possible irradiation of this zone is implied, one should use the transplant dislocation outside the tumor bed and place it extra-pleurally (retrosternally or subcutaneously).

The retrosternal placement of the transplant during moving to the neck provides reliable protection against trauma and is more preferable in cosmetic terms. However, this method is more dangerous than the subcutaneous route. With the formation of a retrosternal tunnel, it is possible to damage the pleura with the development of one- or two-sided pneumothorax. This can lead to the transplant fall into the pleural cavity, its bending and rotating along the longitudinal axis with circulatory disturbance and necrosis. Another cause of disturbances in the blood supply to the graft may be the compression in the upper aperture of the chest, more often at the level of the sternum, which may also be a cause of impaired patency of the artificial esophagus.

It should be noted that the retrosternal position in many respects makes it difficult to control the condition of the transplant when necrosis is suspected, especially when mediastinitis and pleural empyema develop, which complicates and sometimes makes it impossible to perform the interventions on the artificial esophagus. In this case, it is often necessary to perform a discontinuity operation with the removal of the ischemic transplant.

An important advantage of the retrosternal route is the isolation of the graft from the anterior mediastinum and pleural cavities due to the location in the created prefascial space. At the same time, the borderline role is played by the intrathoracic fascia and pleural sacs.

It is advisable to use the posterior mediastinal plasty in small tumors with single affected lymph nodes (cT1b-2N0-1Mo), when the risk of local recurrence is minimal, as well as with two-level resections of the esophagus, when intrapleural esophageal-colonic anastomosis is applied in the dome of the right hemithorax. Also, posterior mediastinal route can be used in cases where it is possible to create the most direct and long transplant without signs of redundancy when it can maximally conformally take the bed of the removed esophagus.

With both ways of carrying the graft to the neck, there is a possibility of squeezing the upper aperture of the chest in the canal. For the prevention of muscular compression on the transplant, a wide dissection of the group of the neck anterior straight muscles group in the left side, which led to a shift of the median complex of the neck organs to the right and allowed releasing the space for manipulation on the organs of the superior mediastinum from the side of the neck wound.

The carrying out of long segmental one-stage reconstructions of the esophagus in conditions of nontransplantability of the stomach and small intestine requires individual planning. Such operations do not always require vascular enhancement, and the indication can be a non-vital type of blood supply to the colon with the presence of breaks in the edge (marginal) feeding vessel. To prevent the development of ischemic complications due to insufficiency of the blood supply, preoperative planning of the most suitable variant of the reconstruction is expedient based on the analysis of data obtained in selective angiography in combination with intraoperative study of angioarchitectonics and trial clamping of feeding vessels.

Thus, the individualized approach in choosing a variant of esophagoplasty in conditions of plastic material deficiency has the potential for long-term survival by reducing the frequency of postoperative complications and improving the life quality of patients suffering from esophageal carcinomas and esophageal-gastric junction carcinomas.

## Conclusions

Three-stage esophagectomy with one-phase esophageal replacement by primary coloplasty in surgical treatment of esophageal and gastroesophageal junction carcinomas irrespective of the way the graft displacement to the neck is a complicated

surgical intervention that allows achieving satisfactory long-term treatment results comparable to those of standard operations and should be performed in conditions of the deficit in the plastic material (non-transplantable stomach and small intestine).

The choice of the route of the transplant moving to the neck (posterior mediastinal or retrosternal) should be decided individually, depending on the local prevalence of the malignant tumor and the presence of affected regional lymph nodes. At the same time, the route itself does not have a significant effect on the frequency and structure of postoperative complications, lethality, and also on long-term treatment results.

According to the indications, one-phase retrosternal esophagocolonoplasty can be supplemented with vascularization of the transplant by anastomosing the colon-intestinal vessels of the colonic graft with the internal thoracic vessels.

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### Conflict of interest

The authors declare that they have no conflict of interest.

### Ethics Committee approval

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### ЛИТЕРАТУРА

1. Reslinger V, Tranchart H, D'Annunzio E, Poghosyan T, Quero L, Munoz-Bongrand N, Corte H, Sarfati E, Cattani P, Chirica M. Esophageal reconstruction by colon interposition after esophagectomy for cancer analysis of current indications, operative outcomes, and long-term survival. *J Surg Oncol*. 2016 Feb; 113(2):159-64. doi: 10.1002/jso.24118
2. Awsakulstutthi S, Havanond C. A retrospective study of anastomotic leakage between patients with and without vascular enhancement of esophageal reconstructions with colon interposition: Thammasat University Hospital experience. *Asian J Surg*. 2015 Jul;38(3):145-49. doi: 10.1016/j.asjsur.2015.01.005
3. Чакиев АМ. Возможность применения микрохирургических сосудистых анастомозов при эзофагопластике. *Вестн КРСУ*. 2008;8(5):26-28.
4. Воробей АВ, Чепик ДА, Вижинис ЕИ, Лурье ВН. Клиническое обоснование одноэтапной заградной эзофагоколопластики в лечении больных с послеоперативной рубцовой стриктурой пищевода. *Медицина*. 2009;(4):52-56.
5. Uchiyama H, Shirabe K, Morita M, Kakeji Y, Taketomi A, Soejima Y, Yoshizumi T, Ikegami T, Harada N, Kayashima H, Morita K, Maehara Y. Expanding

the applications of microvascular surgical techniques to digestive surgeries: a technical review. *Surg Today*. 2012 Jan;42(2):111-20. doi: 10.1007/s00595-011-0032-5

6. Аверин ВИ, Подгайский ВН, Нестерук ЛН, Гриневич ЮМ, Рылюк АФ. Первый опыт реваскуляризации трансплантата при пластике пищевода у детей в нестандартных ситуациях. *Новости Хирургии*. 2012;20(1):80-84. [http://www.surgery.by/pdf/full\\_text/2012\\_1\\_14\\_ft.pdf](http://www.surgery.by/pdf/full_text/2012_1_14_ft.pdf)

7. Kesler KA, Pillai ST, Birdas TJ, Rieger KM, Okereke IC, Ceppa D, Socas J, Starnes SL. "Supercharged" isoperistaltic colon interposition for long-segment esophageal reconstruction. *Ann Thorac Surg*. 2013 Apr;95(4):1162-68; discussion 1168-9. doi: 10.1016/j.athoracsur.2013.01.006

8. Bakshi A, Sugarbaker DJ, Burt BM. Alternative conduits for esophageal replacement. *Ann Cardiothorac Surg*. 2017 Mar;6(2):137-43. doi: 10.21037/acs.2017.03.07

9. Ильин ИА, Малькевич ВТ. Повторная и отсроченная эзофагопластика в лечении карцином пищевода и пищеводно-желудочного перехода. *Вестн НАН Беларуси. Сер Мед Наук*. 2016;(2):15-22.

10. Blackmon SH, Correa AM, Skoracki R, Chevray PM, Kim MP, Mehran RJ, Rice DC, Roth JA, Swisher SG, Vaporciyan AA, Yu P, Walsh GL, Hofstetter WL. Supercharged pedicled jejunal interposition for esophageal replacement: a 10-year experience. *Ann Thorac Surg*. 2012 Oct;94(4):1104-11; discussion 1111-13. doi: 10.1016/j.athoracsur.2012.05.123

11. Черноусов АФ, Хоробрых ТВ, Черноусов ФА, Вычужанин ДВ. Хирургическое лечение рака кардии. Москва, РФ: Практ медицина; 2016. 128 с.

12. Reslinger V, Tranchart H, D'Annunzio E, Poghosyan T, Quero L, Munoz-Bongrand N, Corte H, Sarfati E, Cattani P, Chirica M. Esophageal reconstruction by colon interposition after esophagectomy for cancer analysis of current indications, operative outcomes, and long-term survival. *J Surg Oncol*. 2016 Feb;113(2):159-64. doi: 10.1002/jso.24118

13. Saeki H, Morita M, Harada N, Egashira A, Oki E, Uchiyama H, Ohga T, Kakeji Y, Sakaguchi Y, Maehara Y. Esophageal replacement by colon interposition with microvascular surgery for patients with thoracic esophageal cancer: the utility of superdrainage. *Dis Esophagus*. 2013 Jan;26(1):50-56. doi: 10.1111/j.1442-2050.2012.01327.x

14. Ceroni M, Norero E, Henriquez JP, Vicuela E, Briceco E, Martínez C, Aguayo G, Araos F, González P, Díaz A, Caracci M. Total esophagogastrectomy plus extended lymphadenectomy with transverse colon interposition: a treatment for extensive esophagogastric junction cancer. *World J Hepatol*. 2015 Oct 8;7(22):2411-17. doi: 10.4254/wjh.v7.i22.2411

### REFERENCES

1. Reslinger V, Tranchart H, D'Annunzio E, Poghosyan T, Quero L, Munoz-Bongrand N, Corte H, Sarfati E, Cattani P, Chirica M. Esophageal reconstruction by colon interposition after esophagectomy for cancer analysis of current indications, operative outcomes, and long-term survival. *J Surg Oncol*. 2016 Feb; 113(2):159-64. doi: 10.1002/jso.24118
2. Awsakulstutthi S, Havanond C. A retrospective study of anastomotic leakage between patients with and without vascular enhancement of esophageal reconstructions with colon interposition: Thammasat University Hospital experience. *Asian J Surg*. 2015 Jul;38(3):145-49. doi: 10.1016/j.asjsur.2015.01.005



3. Chakiev AM. Vozmozhnost' primeneniia mikrokhirurgicheskikh sosudistykh anastomozov pri ezofagoplastike. *Vestn KRSU*. 2008;8(5):26-28. (in Russ.)
4. Vorobei AV, Chepik DA, Vizhinis EI, Lur'e VN. Klinicheskoe obosnovanie odnoetapnoi zagrudinnoi ezofagokoloplastiki v lechenii bol'nykh s posleozhegovoii rubtsovoi strikturoi pishchevoda. *Meditsina*. 2009;(4):52-56. (in Russ.)
5. Uchiyama H, Shirabe K, Morita M, Kakeji Y, Taketomi A, Soejima Y, Yoshizumi T, Ikegami T, Harada N, Kayashima H, Morita K, Maehara Y. Expanding the applications of microvascular surgical techniques to digestive surgeries: a technical review. *Surg Today*. 2012 Jan;42(2):111-20. doi: 10.1007/s00595-011-0032-5
6. Averin VI, Podgaiskii VN, Nesteruk LN, Grinevich IuM, Ryliuk AF. Pervyi opyt revaskuliarizatsii transplantata pri plastike pishchevoda u detei v nestandardnykh situatsiakh. *Novosti Khirurgii*. 2012;20(1):80-84. [http://www.surgery.by/pdf/full\\_text/2012\\_1\\_14\\_ft.pdf](http://www.surgery.by/pdf/full_text/2012_1_14_ft.pdf) (in Russ.)
7. Kesler KA, Pillai ST, Birdas TJ, Rieger KM, Okereke IC, Ceppa D, Socas J, Starnes SL. "Supercharged" isoperistaltic colon interposition for long-segment esophageal reconstruction. *Ann Thorac Surg*. 2013 Apr;95(4):1162-68; discussion 1168-9. doi: 10.1016/j.athoracsur.2013.01.006
8. Bakshi A, Sugarbaker DJ, Burt BM. Alternative conduits for esophageal replacement. *Ann Cardiothorac Surg*. 2017 Mar;6(2):137-43. doi: 10.21037/acs.2017.03.07
9. Ilyin IA, Malkevich VT. Repeated and delayed esophagoplasty in esophageal and gastroesophageal cancer treatment. *Vesti NAN Belarusi. Ser Med Nauk*. 2016;(2):15-22. (in Russ.)
10. Blackmon SH, Correa AM, Skoracki R, Chevray

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11. Chernousov AF, Khorobrykh TV, Chernousov FA, Vychuzhanin DV. Khirurgicheskoe lechenie raka kardii. Moscow, RF: Prakt Meditsina; 2016. 128 p. (in Russ.)
12. Reslinger V, Tranchart H, D'Annunzio E, Poghosyan T, Quero L, Munoz-Bongrand N, Corte H, Sarfati E, Cattan P, Chirica M. Esophageal reconstruction by colon interposition after esophagectomy for cancer analysis of current indications, operative outcomes, and long-term survival. *J Surg Oncol*. 2016 Feb;113(2):159-64. doi: 10.1002/jso.24118
13. Saeki H, Morita M, Harada N, Egashira A, Oki E, Uchiyama H, Ohga T, Kakeji Y, Sakaguchi Y, Maehara Y. Esophageal replacement by colon interposition with microvascular surgery for patients with thoracic esophageal cancer: the utility of superdrainage. *Dis Esophagus*. 2013 Jan;26(1):50-56. doi: 10.1111/j.1442-2050.2012.01327.x
14. Ceroni M, Norero E, Henríquez JP, Vicuela E, Bricoco E, Martínez C, Aguayo G, Araos F, González P, Diaz A, Caracci M. Total esophagogastrectomy plus extended lymphadenectomy with transverse colon interposition: a treatment for extensive esophagogastric junction cancer. *World J Hepatol*. 2015 Oct 8;7(22):2411-17. doi: 10.4254/wjh.v7.i22.2411

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