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The Revision Surgery of the Digestive Tract after Failed Prior Gastric Reconstruction

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Abstract--- Aim: *to develop an integrated concept of physiological reconstruction of the gastrointestinal tract by the preserving the duodenal passage after failed prior gastric reconstructive surgery.*

Materials and Methods: *52 patients, who had undergone resection, drainage and anti-reflux surgery, were performed redo-operations between 2011 and 2017 years at the A.V. Vishnevsky National Research Scientific Surgical Center. The redo surgery included different types of reconstruction: the Billroth-I - for 5 patients (9.6%), the Hofmeister-Finsterer – for 1 patient (1.9%) and Roux-en-Y reconstruction – for 4 patients (7.7%) who had previous radical resection of the gastric stump. The surgical procedure of interposition of graft was done in 40 cases (76,9%): by the pedicled jejunal flap for 30 patients (57.7%), by the transverse colon graft for 2 patients (3.8%) and by the left colon graft for 8 patients (15.4%) after esophagectomy. 1 patient (1.9%), who had had prior gastric bypass surgery, underwent the resection of the tumor affected the gastric pouch and the thoracic esophagus, the bypassed stomach was used as a gastric conduit for esophageal replacement. It was impossible to technically perform the reconstructive procedure in 1 case (1.9%) due to the absence of the visceral organs after multivisceral resection for the local recurrence of gastric cancer.*

Results: *Post-operative complications were developed in 5 patients (9.6%). The esophagojejunal anastomosis leakage was observed in 2 patients (3.8%) and the duodenojejunal anastomosis leakage – in 1 patient (1.9%). The transplant thrombosis was diagnosed on POD 1 in 1 patient (1.9%) and led to the colon graft necrosis, which required emergency removal transplant. It was postoperative mortality rate which connected with the progressing of the multiple organ dysfunction failure. At the end of the study, there were 44 (86.2%) patients out of 51 under observation. Patient examination revealed good results in 26 patients (59.9%) and satisfactory results in 12 patients (27.4%). The result of the redo surgery was failed in 6 cases (13.7%).*

Conclusion: *The assessment of the results demonstrated the relief of pathological syndromes developed after gastric surgery in the majority of patients, which indicated the feasibility of redo surgery by inclusion of the duodenal passage.*

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Keywords--- *Pedicled Interposition, Jejunal Flap, Colon Graft, Redo Surgery, Postgastrectomy Syndrome, Failed Prior Gastric Reconstructive Surgery, Physiology of Digestion, Inclusion of the duodenal Passage, Revision Surgery, Preserved Duodenal Passage, Restoration of Duodenal Passage.*

I. INTRODUCTION

The revision surgery or redo surgery of the digestive tract is traditionally allocated as a separate section of gastrointestinal surgery. These reconstructive procedures are still technically complicated and unique without loss their practical significance. The gastric surgery remains the main method of the treatment of complicated forms of ulcer disease, benign gastric tumors and gastric cancer [1,2]. The resection is a standardized procedure, while the choice of the reconstruction have been leading to discussion. Some researchers emphasize the dissatisfaction with the results of the reconstructive method with exclusion of duodenal passage from digestive physiology [3,4]. Severe digestive disorders after primary gastric surgery lead to the long-term disability in 25% of cases and require medical rehabilitation in 100% of the cases [5]. The pathogenesis of post-gastectomy syndromes is based on operation-induced abnormalities which due to the loss of part or whole of the stomach. These disorders are caused by the motor disfunction of the stomach, including disturbances in the gastric reservoir function, in the mechanical-digestive function and in the transporting function of the food. The cumulative damage to the digestion exceeds its compensatory capabilities and inevitably leads to the development of the pathological conditions such as dumping syndrome, malabsorption syndrome, agastric asthenia, cachexia and etc. [6,7,8,9]. The radical treatment of the disorders after gastric surgery (post-gastrectomy syndrome) and after surgical procedure of the local recurrence of gastric cancer is the revision surgery of the digestive tract. The aim of the study was to develop an integrated concept of physiological reconstruction of the gastrointestinal tract by the preserving the duodenal passage after failed prior gastric reconstructive surgery.

II. MATERIALS AND METHODS

52 patients, who had undergone resection, drainage and anti-reflux surgery, were performed redo-operations between 2011 and 2017 in A.V. Vishnevsky National Research Scientific Surgical Center. The average age of patients was 55 years old (was 55 years. The study group consisted of 30 men (57.7%) and 22 women (42.3%).

The distribution of patients according to the prior gastric reconstructive surgery for the different disease of stomach is presented in **Table 1.**

Table 1: Indications for the Prior Gastric Surgery

Disease	**Number of patients**	
	n	**%**
Stomach cancer	30	57.7
Ulcer disease	18	34.6
Hiatal hernia	3	5.8
Morbid obesity	1	1.9
TOTAL	**52**	**100.0**

The primary surgical intervention was distal gastrectomy: modified Billroth II – to 21 patients (41.3%) and total gastrectomy (GE) – to 12 patients (23.5%). The primary proximal gastrectomy was performed for 11 patients (21.6%), gastric drainage procedures (including gastric bypass) – to 5 patients (9.6%) and Nissen fundoplication – to

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3 patients (5.8%). The indications for the redo surgery were postgastrectomy syndromes in 27 cases and the remnant gastric cancer and the local recurrence of gastric cancer in 25 cases (48.1%).

The patients' complaints were variable: weight loss, physical weakness and rapid fatigability. All patients were thoroughly examined prior to the revision surgery using general clinical, laboratory and instrumental methods. Diagnostic procedures included esophagogastroduodenoscopy (EGD) with biopsy, esophageal and gastric X-ray imaging, multi-slice spiral computed tomography of the abdomen if it was indicated. According to the results of preoperative medical assessment, all the patients underwent surgical interventions.

The redo surgery included not only the physiological reconstruction of the digestive tract but also the removal of the pathological focus (tumors, ulcers, fistulas, corrosive strictures and etc.) in some cases. The pathological process involved adjacent organs in 17 patients (36.1%), which required combined resection of the involved organs: pancreas and colon – in 9 cases (32.1%), liver – in 4 cases (14.3%), diaphragm – in 3 cases (10.7%) and lung – in 1 case (3.6%). The local recurrence of gastric cancer was the reason for the resection of celiac trunk in 1 patient (3.6%) and portal vein – in 1 patient (3.6%). As a result the extent of resection was determined by the distribution of the pathological process. Multivisceral resection (MVR) was characterized by certain difficulties at the reconstructive stage which required a conduit for the restoration of the continuity of the digestive tract.

The preference was given to the method of Billroth I reconstruction as the most physiological method in a situation with the reconstructive stage of the gastric resection after primary gastric drainage procedures and after resection of the gastric stump. On the one hand, this approach allowed keeping an initial segment of the jejunum intact and suitable for redo surgery. On the other hand, it preserved the duodenal passage of the food.

The method of redo surgery after distal gastrectomy and total gastrectomy in the absence of any organic disorders included the interposition of the efferent intestinal loop and the connection with its distal end to the duodenal stump (**Figure 1**). The afferent intestinal loop was cut off at the gastro-(esophago-)enteral anastomosis (GEA and EEA) and the intestinal continuity was reestablished by "end-to-end" entero-entero anastomosis.

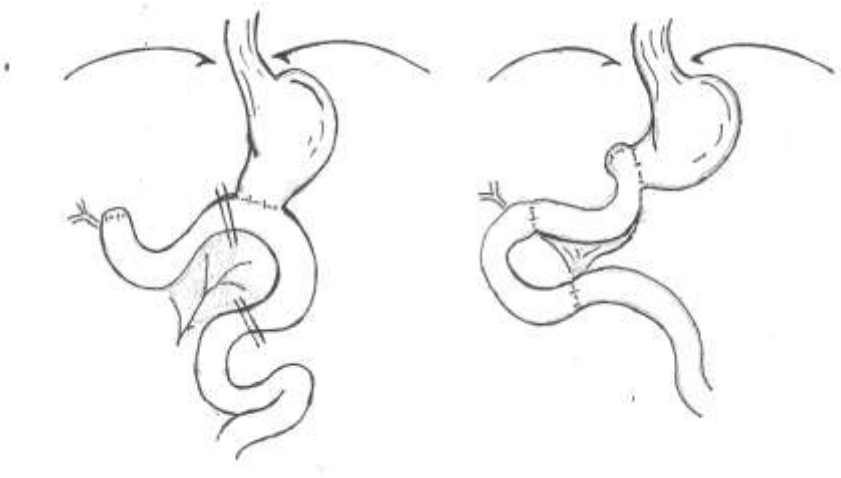

Figure 1: The Scheme of the Interposition of Efferent Intestinal Loop with Restoration of the Duodenal Passage

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The Braun anastomosis was dismantled and the defects of jejunum were sutured. Further, the efferent limb was crossed on the level of 30-40 cm from the esophageal or gastric anastomosis, and its distal end was connected with the duodenal stump. The afferent loop, which had been cut off near GEA or EEA, was placed in orthotopic position with subsequent restoration of the continuity of jejunum.

It was not difficult to preserve the duodenal passage for the patients who had modified Roux-en-Y reconstruction. The significant length of the efferent loop allowed its dissection directly above the entero-entero anastomosis without damage to the continuity of jejunum and the distal end was sutured to the duodenal remnant. This reconstruction approach included the formation of only one anastomosis – jejunoduodenal anastomosis. It is possible to preserve the entero-entero anastomosis if it does not contain pathological alterations and rough cicatricial deformity that could further cause anastomosis obstruction. In the cases when the efferent loop was short, the entero-entero anastomosis was separated and a loop with sufficient length was used for restoration of the duodenal passage.

For the patients with organic lesions of the EEA or gastric stump, the reconstruction of Braun loop was not more complicated or time-consuming than the reconstruction with jejunal interposition. After mobilization and determination of extent of resection, the entero-entero anastomosis was dissociated with suturing of the defects of the small intestine, and the afferent and efferent loops were resected within macroscopically clear surgical margin. When the intestinal anastomosis was affected by the pathological process, the Braun's loop or Roux-en-Y efferent loop was completely removed.

After resection the efferent loop was cut off distally 30-40 cm a second time for the creation an isoperistaltic jejunal conduit. The proximal end of the conduit was anastomosed to the esophagus and the distal end – to the duodenal stump (**Figure 2**).

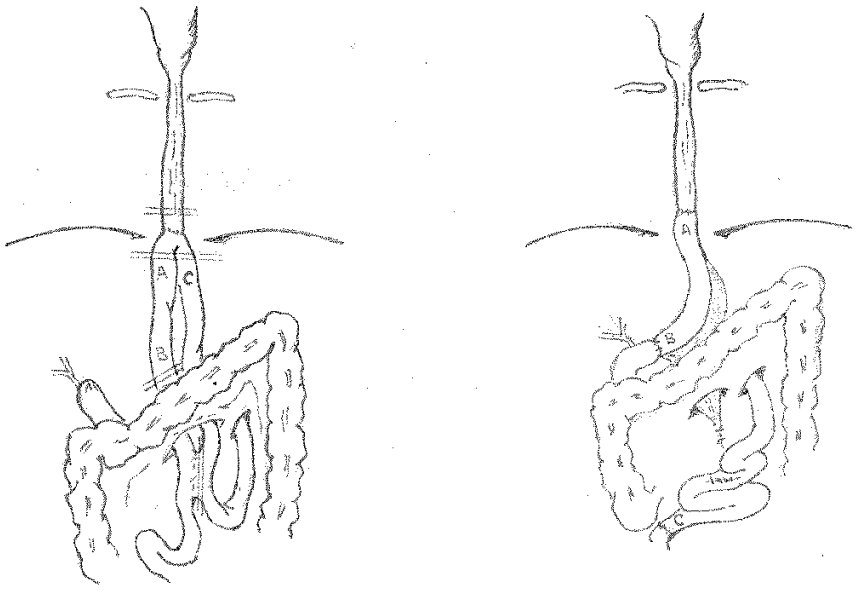

Figure 2: The Scheme of Resection of Esophago-entero Anastomosis with Intestinal Conduit Reconstruction

Under the conditions of resection of the inferior thoracic segment of esophagus and creation of esophago-entero anastomosis in the abdominal cavity, there was no any problem with the length of the jejunal conduit and its mesen-

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tery or with the tension of the vascular pedicle. However there was a situation when the use of an isoperistaltic jejunal segment on a vascular pedicle as a segment of the digestive tract for replacement of the stomach was limited. An isoperistaltic transverse colon graft was used as an alternative conduit in cases when the extensive resection had been previously performed or in cases of diffuse type of jejunal blood supply. If this option was also impossible, Roux-en-Y reconstruction was completed. A relative contraindication for preservation of the duodenal passage was the severe condition of patient combined with significant anatomic changes in the abdominal cavity.

The redo surgery after proximal gastrectomy and after operations on the gastric cardia have always contained resection stage. After the elimination of the sphincter mechanism of the cardia favorable conditions are created for the development of the gastroesophageal reflux disease. It is believed that a short (10-15 cm) isoperistaltic jejunal graft interposed between the esophagus and the gastric remnant reliably performs valve function and prevents the development of severe reflux esophagitis (**Figure 3**).

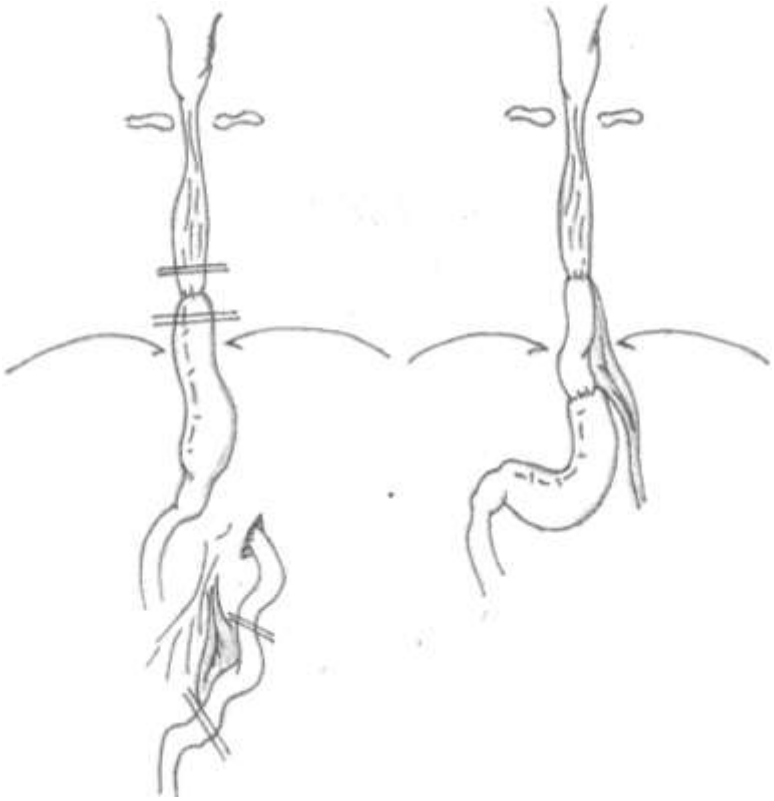

Figure 3: The Scheme of Resection of Esophago-gastric Anastomosis with Merendino Procedure

For the patient with a previous total gastrectomy who required a subtotal esophagectomy the left colon in isoperistaltic position was used as a graft with direct colo-duodenal anastomosis. This approach was chosen due to reliable blood supply of the left colon and its adequate length. The isoperistaltic position of the graft with direct duodenal anastomosis prevents the risk of the development of bile reflux (**Figure 4**). From our point of view, a short-segment of jejunal pedicled graft (including, intrathoracic) after simultaneous esophagectomy and gastrectomy is a limited option. It can be used only in case of absence of colon or in cases when any segment of the colon is unavailable for esophageal substitutes for reconstruction.

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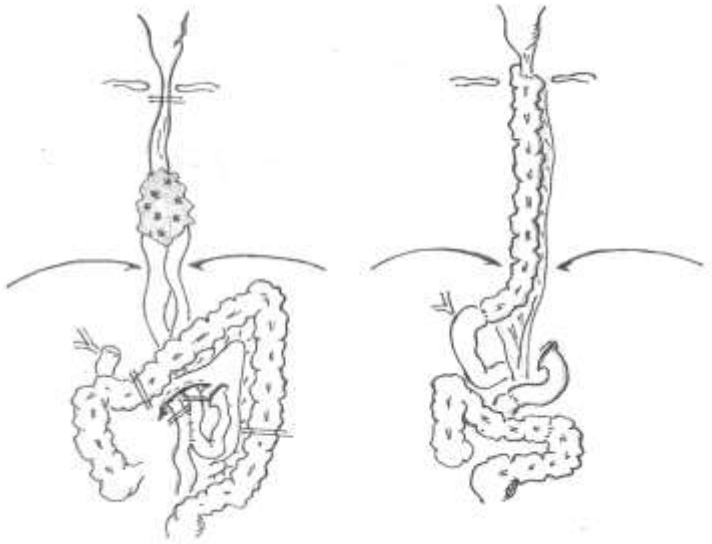

Figure 4: The Scheme of Reconstruction in the Patient with Local Recurrence after Previous Total Gastrectomy: Esophagectomy with the Resection of Braun loop and Reconstruction by the left colon in an Isoperistaltic Position

However, when the colon graft had insufficient length or its antiperistaltic position, the duodenal passage was preserved by jejunal interposition in an isoperistaltic position performing the anti-reflux barrier. We do recommend avoiding intrathoracic anastomosis due to the high risk of mortality in the case of the anastomotic leakage.

Table 2 provides an overview of the final reconstruction techniques and the used graft.

Table 2: Extent of surgery and option of redo-surgery

Option of redo-surgery	**Number of patients**	
	n	**%**
Transposition of the efferent loop to the duodenum	3	5.8
Billroth I gastrectomy (re-resection)	5	9.6
Hofmeister-Finsterer operation	1	1.9
Re-resection of the stomach + interposition of jejunal flap	8	15.4
Total resection of gastric stump + interposition of jejunal flap (* in 1 case transverse colon graft was used, in 4 cases - Roux-en-Y reconstruction)	11	21.2
Resection of esophago-jejunal anastomosis + Roux-en-Y reconstruction by using a transverse colon graft.	1	1.9
Resection of esophago-jejunal anastomosis + interposition of jejunal flap	2	3.8
Subtotal resection of gastric stump and jejunogastric anastomosis (proximal resection) + Merendino procedure	11(2)	21.2
Esophagectomy with resection of esophagogastric anastomosis + reconstruction by the left colon graft (+without reconstruction)	6(1)	11.5
Subtotal resection of gastric stump + reconstruction by the left colon graft	3	5.8
Esophagectomy with "small" gastric remnant (partial resection of gastric stump) + reconstruction by gastric pull-up	1	1.9
TOTAL	**52**	**100.0**

The short-term outcomes of the revision surgery were the evaluation criteria of its safety and completeness, while long-term outcomes - its physiological efficacy.

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III. RESULTS

In the early postoperative period, surgical complications were observed in 5 (9.6%) patients. Esophagojejunal anastomotic leakage occurred in 2(3.8%) patients, surgical side infection - in 1 (1.9%) patient and subphrenic abscess – in 1 case (1.9%). These complications were resolved by adequate ultrasound-guided percutaneous drainage and endoluminal vacuum therapy without any operation. Only 1 patient (1.9%) required emergency surgery on the POD 9 due to colon graft necrosis. The graft was removed and feeding colo- and cervical esophagostomy were performed. The postoperative mortality rate was 1,9% and it connected with the progressing of multiple organ dysfunction failure. A significant evaluation criterion of the redo-surgery was its completeness. In 1 patient (1.9%), following simultaneous esophagectomy and resection of entero-esophageal anastomosis, the operation remained without reconstruction due to the total absence of available visceral esophageal substitutes. Thus, 2 patients (3.8%) without reconstruction were discharged.

Long-term follow-up was conducted for 44 patients (86.3%): 35 (68.6%) of them were alive, while 9 patients (20.5%) had died before the final patient contact. Cause of death was distant metastasis of cancer at different periods after redo surgery for 7 patients (77.8%). 1 patient (11.1%) died of multiple organ dysfunction failure, which developed due to cachexia and lack of enteral nutrition. Thoracic aortic rupture was the cause of death for 1 patient (11.1%). The long-term follow-up period ranged from 1 to 6 years (median follow-up periods - 22 + 2.3 months).

The following criteria were considered more objective in order to make the evaluation of the efficiency of redo surgery: change in body mass; frequency and character of pathological syndromes; late postoperative complications, including those that required redo surgery; X-ray signs of the motor function of the upper digestive tract. This evaluation serves as effective means of the abuse of revision surgery and gives possibility not only to reduce the severity of post-gastrectomy syndromes but also to completely eliminate some of them. For these reasons, it is believed that this approach is feasible.

Increase in body mass is an objective criterion that characterizes a patient's nutritional status and indicates normalization of the digestive processes after revision surgery (**Table 3**).

Table 3: Long-term Change in Body Mass

Change in body mass		**Number of patients**	
		n	**%**
Continued to lose weight		9	25.7
Weight gain	1 - 5 kg	19	54.2
	6 - 10 kg	5	14.3
	> 10 kg	2	5.8
TOTAL		**35**	**100.0**

The results demonstrate that 26 patients (74.3 %) had a tendency to an increase in body mass, which served an objective criterion of the normalization of digestive processes.

Having regard to the patient complaints in the long-term period, clinical evaluation was based on the observed pathological syndromes: agastric asthenia and reflux esophagitis. The typical characteristic features (clinical and laboratory) of agastric asthenia were observed in 24 patients (68.6%): mild in 15 patients (62.5%), moderate – in 6

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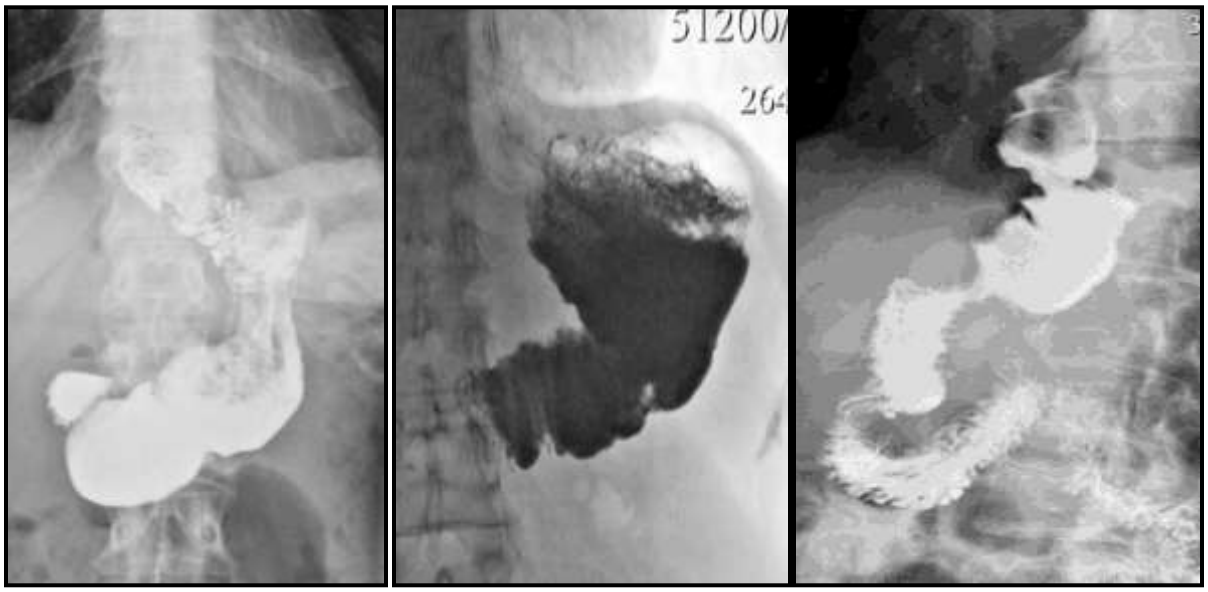
patients (25.0%) and severe – in 3 patients (12.5%). Acid reflux, manifesting as heartburn, was registered in 11 patients (22.9%) due to non-adherence to diet recommendations.

In the long-term period there were no specific surgical complications (such as strictures of the interposed jejunal flap, its anastomotic strictures, twisted obstruction or atony and etc.). 2 patients (4.6%) had revision surgery due to incisional ventral hernia and small bowel obstruction caused intestinal adhesions. X-rays imaging demonstrated gastric emptying in portions from the intestinal flap to distal parts of the digestive tract and normal bowel transit in case of the patients with preserved duodenal passage (**Figure 5**).



а) б) в)

Figure 5: X-rays Imaging in the Long-term outcome: a) After Proximal Gastrectomy with Merendino Procedure; б) after distal Gastrectomy with Jejunal flap; в) Total Resection of Gastric Stump and Colon Graft

The long-term outcome was evaluated in the modified Visick score taking into account patient's well-being, assessment of nutritional status and the presence of gastrointestinal disorders. The results are presented in Table 4.

Table 4: Long-term Outcome of Revision Surgery

Result	**Number of patients**	
	N	**%**
Good	26	59.1
Satisfactory	13	29.5
Unsatisfactory	5	11.4
TOTAL	**44**	**100.0**

The group with 'good' clinical result includes patients without local recurrence or distant metastasis, although experienced periodic typical dyspeptic symptoms due to non-adherence to diet recommendations. During the long-term period, these patients gained weight and increased appetite.

The outcome was considered as 'satisfactory' in those patients who, though to a lesser extent, showed signs of gastrointestinal disorders on the long-term follow-up. Treatment outcome was also recognized as satisfactory when

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patient's cause of death was not associated with the revision surgery and its consequences. Clinical outcome was supposed unsatisfactory when the patient's condition after redo surgery remained at the same level as before surgery. The severity of clinical manifestations in these patients was unchanged following revision surgery. The situation without reconstruction (patients continued to be fed via a stoma) was also rated as an unsatisfactory outcome.

The systematization and the choice of redo surgery for the reconstruction of the digestive tract are defined by the integrated concept of physiological restoration of the alimentary tract continuity which includes the following principles:

1. One-stage operation and completeness – performing the resection and reconstructive stages during single operation with the compulsory restoration of good oral nutrition, without using of preventive stoma and feeding tube (stoma);
2. Preserved duodenal passage - physiological restoration of the alimentary tract continuity by incorporating duodenum into digestion;
3. Reconstruction by the interposition pedicled jejunal flap or colon graft – substitution of the whole stomach or its part using a segment of the jejunum pr colon onto pedicle;
4. The rational use of visceral organs – meticulous surgical technique avoiding unnecessary resection of the fragments of the digestive tract that could be used for stomach replacement.

At the same time, the disease itself and the option of the previous surgical procedure require an individual approach, which is tactically implemented via "rational standardization". The idea of standard allows creating a design of reconstruction according to the developed principles, the idea of rationality allows selecting of the necessary surgical technique based on the features of the previous operation and the patient's condition. The principle "minimum sufficiency" is the performing of the reconstruction (surgical technique or maneuver) by the easiest and the least traumatic surgical method.

IV. DISCUSSION

According to the A.A. Busalov's opinion who named the emerging disorders after gastric operations in 1966 as an "unhappy" section of the surgery bearing in mind the severity of postgastrectomy syndromes and the difficulties of their treatment [10].

Despite the long history of gastric surgery, the literature barely contains the detailed analysis of the long-term results of revision surgery; there is no systematization in the choice of reconstruction [11]. In some experimental studies [12,13,14] various types of reconstruction, which were developed and tested in practice, affect only certain types of pathogenesis of post-gastrectomy disorders. The absence of a single approach to this complicated and atypical section of surgery is explained by the traumatic disorder of revision operations, significant technical difficulties of their implementation and high rate of postoperative complications [15].

Nowadays in a new direction of technological progress, the main surgical task is the improvement of the surgical techniques and the creation of favorable conditions for the compensation of digestion for improving the quality of life in long-term period.

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It is believed that the reconstructive surgery with the gastric replacement and the restoration of the duodenal passage is the most consistent with the normal physiology for the reason that it creates the conditions for the normal bowel transit of food to the small intestine in portions and prevents reflux-esophagitis. It is evidenced by results of revision surgery which demonstrated a complete absence or significant reduction of the post-gastrectomy syndromes.

V. CONCLUSION

The formulated principles of the physiological reconstruction of the digestive tract have a feature of universality and form the methodological basis for primary and revision gastric surgery. The practical realization of these principles is a complicated surgical and technical challenge that requires surgical multivalency in regards to the gastric and esophageal surgery. This condition allows choosing the most rational option of reconstruction in a crucial situation to achieve the best functional result. At the same time the success of revision surgery is not guaranteed, therefore the idea of improving primary gastric surgery is more beneficial.

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