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Research Article

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Intestinal Lavage in the Complex Treatment for Corrosive Poisoning

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BACKGROUND The high incidence of various complications and the persistent mortality remain relevant to the search for new approaches in the treatment of victims with poisoning by corrosive substances.

OBJECTIVE To increase the effectiveness of the therapeutic complex in case of corrosive poisoning by adding intestinal lavage.

MATERIAL AND METHODS We examined 73 patients (34.3% of women and 65.7% of men) with acute oral poisoning by acetic acid (35.6% of the total number of patients) and alkali — NaOH (64.4%) aged from 27 to 65 years (43 (33.0; 56.0) years). Endoscopic examination before the start of treatment in all the patients revealed 2–3rd degree chemical burns of the mucous membrane of the mouth, pharynx, esophagus and stomach. The treatment of 38 patients (study group) included intestinal lavage using an enteral solution in a volume of 4.5 liters in the first 6 hours after taking the poison. The comparison group consisted of 35 patients who received standard therapy. The groups were identical in age, sex, type and severity of poisoning.

RESULTS Patients who received intestinal lavage showed a clear positive dynamics of the process of cleansing the affected areas of the mucous membrane of the esophagus and stomach from necrotic masses and the appearance of granulations already on the 5th day. In the comparison group, by this time there were no signs of healing of local defects in the mucous membrane of the esophagus and stomach.

CONCLUSION The inclusion of intestinal lavage in the treatment complex helps reduce the regeneration time of the mucous membrane of the gastrointestinal tract in case of damage and inflammation caused by poisoning by corrosive substances, a decrease in the incidence of extraintestinal complications, in particular pneumonia (by 17.1%), which is reflected in a decrease in mortality (by 5.7%) and a decrease in the duration of hospitalization by 2.1 times.

Keywords: oral poisoning by corrosive substances, chemical burns of the esophagus and stomach, intestinal lavage, accelerated regeneration of damaged tissues

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AP — acute poisoning
CP — corrosive poisoning
CS – corrosive substances
EDTA — ethylenediaminetetraacetic acid
EGDS — esophagogastroduodenoscopy
ES — enteral solution
GIT — gastrointestinal tract
ICU — intensive care unit
IL — intestinal lavage

INTRODUCTION

In the structure of acute poisoning (AP), injuries caused by corrosive substances (CS) in Russia have a fairly high proportion (12–14%) [1]. According to the Scientific and Practical Toxicological Center of the Federal Medical and Biological Agency of Russia, from 12 to 16% of AP are caused by CS. Corrosive poisoning (CP) takes III–IV place in the structure of causes of hospitalizations (up to 7% of the total flow of patients with acute chemical poisoning). The rate of hospitalization of patients with acute chemical poisoning in hospitals of the federal districts of Russia in 2008 was 148.6 per 100 thousand population; in the structure of AP by nosological forms, CP was 6.21% [2].

One of the most common types of household exogenous intoxication with CS are AP by acids and alkalis. According to specialized centers for the treatment of poisoning in Russia (2008–2011), CP accounted for up to 7.4% of hospitalized patients, of which 69.6% of cases were due to vinegar essence. Most often these substances enter the body orally, but poisoning through the respiratory system and skin is also possible [1, 2].

In the structure of causes of deaths in acute chemical poisoning, cauterizing substances (acids and alkalis) accounted for 3.1%. At the same time, CP is characterized by high mortality, especially poisoning by acetic acid (acetic essence), which in 2005 and 2006 averaged 11.7% and 14.6%, respectively, reaching 30.6% in a number of hospitals [2].

CP has an irritating, necrotizing and melting effect at the point of contact with tissues. In addition to local manifestations in the form of a chemical burn of varying area and depth, which is accompanied by pain, poisons of this group, as a result of absorption, also have a general toxic effect on the body in the form of various disorders of homeostasis, including the development of exotoxic shock; and in case of poisoning by acetic acid, intravascular hemolysis can occur, aggravating hypoxemia, lipid peroxidation, disorders of the hemostatic system and microcirculation [1, 3]. Arrosive bleeding is possible at the site of the chemical burn [1, 2]. In the pathogenesis of burn disease associated with CP, a certain role is played by endotoxicosis syndrome associated with intestinal translocation, which, in an unfavorable course, can cause multiple organ failure if anti-shock and detoxification measures, as well as correction of homeostasis disorders, are not taken

in a timely manner [2, 4]. It is also important that poisoning by radioactive substances is characterized by severe medical, social and economic consequences (costly treatment, long-term disability, disablement, high mortality) [2].

The high incidence of various types of complications (exotoxic shock, arrosive bleeding, hemolysis, reflux esophagitis, perforation or stricture of the esophagus and stomach), and high mortality rate make the search for new approaches in the treatment of CP victims an urgent task [1, 5, 6].

In recent decades, the method of detoxification and correction of homeostatic imbalance - intestinal lavage (IL) - has been successfully used for various nosological forms of AP (hypnotics, psychotropic, cardiotoxic drugs, organophosphorus insecticides, salts of heavy metals, alcohol surrogates, etc.) [7]. However, despite its effectiveness and safety, this method has not yet been used for CP. This is explained by specialists' concerns related to the development of complications (bleeding, increased pain, etc.). These concerns have long held back the use of IL for this pathology. However, along with this, in the early period of CP (the first 6 hours), gastric lavage is indicated, which, in accordance with the federal clinical recommendations, is a mandatory, safe and non-contraindicated manipulation [2]. In addition, it is known from literary sources that in the early period of poisoning only the so-called early primary arrosive bleeding can occur, which is characterized by the fact that it occurs against the background of blood hypercoagulation, and therefore stops on its own [1, 2, 3]. These facts were a theoretical premise and a basis to consider it safe to conduct IL in the early stages of CP. According to our idea, the main mechanism for increasing the effectiveness of the therapeutic complex that includes IL for CP should be sanitation of the gastrointestinal tract (GIT), including the removal of hemolyzed blood and burn tissue degradation products in order to reduce their resorption and the severity of enterogenous intoxication.

Aim: to evaluate the effectiveness of IL using enteral solution (ES) followed by the administration of the same solution with the addition of glucose as a nutraceutical in the complex treatment of patients in the early stages of CP.

Objectives

1. Study the effect of IL and subsequent nutraceutical support using ES on the process of tissue cleansing and healing in areas of chemical burns due to poisoning by corrosive substances.

2. Assess the effectiveness of IL as a means of preventing complications of CP.

3. Compare the results of complex treatment of patients using ES in the form of IL and nutraceutical support and the standard approach to CP according to clinical indicators.

MATERIAL AND METHODS

An open, prospective, randomized study was conducted at the Department of Acute Poisonings and Somatopsychiatric Disorders of the N.V. Sklifosovsky Research Institute for Emergency Medicine in the period of 2017–2021, for which preliminary approval was received from the Biomedical Ethics Committee (extract from protocol No. 5-16 of November 21, 2016). The selection of patients was carried out in accordance with the inclusion criteria (age up to 65 years, period from corrosive substance ingestion of no more than 6 hours before admission to the hospital, the presence of a chemical burn of the mucous membrane of the mouth, pharynx, esophagus of the 2nd–3rd degree and stomach of the 2nd–3rd degree according to the classification of S.V. Volkov et al.) (2005) [8]. Diagnosis of the chemical burn and subsequent monitoring of the condition of the mucous membrane of the upper GIT was made using endoscopic examination - esophagogastroduodenoscopy (EGDS).

We examined 73 patients (34.3% females and 65.7% males) with severe acute oral poisoning by acetic acid (35.6% of the total number of patients), and alkali sodium bicarbonate (64.4%), who were treated in the intensive care unit (ICU). The median age of the patients was 43 (33.0; 56.0) years. The patients were divided into two groups: the Comparison Group (35 patients), who received standard therapy, and the Study Group (38 patients), whose treatment complex included IL using ES in a volume of 4.5 l upon admission to the hospital.

Table 1 presents the characteristics of the observation groups by age, gender and severity of GIT damage due to CP.

Table 1

General characteristics of observation groups with corrosive poisoning

Parameters	Study Group (n=38)	Comparison Group (n=35)
Age, years Me (Q1; Q3)	47 (34.0; 57.5)	42 (32.5; 54.5)
Males, n (%)	24 (63.1)	24 (68.6)
Females, n (%)	14 (36.9)	11 (31.4)
Degree of chemical burn of the gastrointestinal tract: Esophagus Stomach	 2–3 2–3	 2–3 2–3

Note: * — differences in indicators between the groups are statistically significant (p<0.05)

Table 1 shows that the groups were comparable in age, gender and severity of gastrointestinal damage due to CP.

The ES used for IL contains sodium phosphate, sodium chloride, sodium acetate, potassium chloride, citric acid, disodium salt of ethylenediaminetetraacetic acid, as well as calcium chloride and magnesium sulfate, drinking purified water. ES is prepared from a set of commercially produced mineral acid concentrate. To do this, the concentrate is dissolved in a given volume of water according to the manufacturer's instructions. The osmolarity of the solution is 290–310 mOsm/l (depending on the volume of water used to dissolve the salts), pH≈5.8 [7].

The patients of the Study Group underwent IL using ES in the first hours of chemical trauma after the prescription of painkillers and antispasmodics and gastric lavage. For this purpose, every 5 minutes they were given 200 ml of ES to drink, the temperature of which was 18–22oC. After 1.5–2 hours, the patients developed diarrhea. The GIT was washed until light translucent water appeared from the rectum (it could be yellowish), after which the patient stopped drinking the solution. Over the next 30–40 minutes, bowel movements continued, then spontaneously stopped. The total volume of the solution ranged from 3 to 4.5 liters. The IL procedure lasted an average of 3 hours. The patients tolerated it satisfactorily; there were neither reactions nor complications. In subsequent days, as nutritional support, patients were given the same solution orally in portions of 200 ml in a total volume of 3–4 liters per day. In cases where the patients, due to the severity of their condition, were initially unable to take ES on their own, it was administered through a nasogastric tube. The study points were as follows: before the start of treatment (designated as "day 1"), after 5 days of stay in the ICU, and also before discharge from the specialized hospital. At the stages of the examination, the severity of the patients' condition, nature and severity of local changes, period of appearance of epithelization of damaged tissues, incidence of complications, length of stay in the ICU, total period of hospitalization in the AP department and mortality were assessed.

Statistical processing of the material was performed using the IBM SPSS Statistics 27.0 program. The normality of data distribution was assessed using the Shapiro–Wilk test (n≤50). Due to the fact that the distribution of characteristics differed from normal, the median (Me), 25th and 75th percentiles – Me (Q1; Q3) were determined. Comparison of quantitative data between the groups was performed using the Mann–Whitney U test. Pearson's χ^2 test was used to compare qualitative data between the groups. The level of statistically significant differences in the characteristics was accepted as p<0.05.

RESULTS

Table 2 shows the treatment outcomes of patients with CP in the Study Group and the Comparison Group.

Table 2

Clinical indicators of the treatment outcome of patients with poisoning by corrosive substances

Indicators	Study Group (n=38)	Comparison Group (n=35)
Epithelization in foci of destruction on the 5th day, n (%)	30 (79.0)	5 (14.3)*
Scarring with deformation, n (%)	3 (8.3)	4 (11.4)
Secondary bleeding, n (%)	1 (2.6)	5 (14.3)
Pneumonia, n (%)	0	6 (17.1)*
Vein thrombosis of the lower extremities, n (%)	0	3 (8.6)
Pulmonary embolism, n (%)	0	1 (2.9)
Delirium, n (%)	0	4 (11.4)
Length of stay in the ICU, days	4.0 (4.0; 6.0)	6.0 (5.0; 9.0)*
Total length of hospitalization, days	7.0 (5.0; 11.0)	15.0 (11.0; 20.0)*
Mortality, n (%)	0	2 (5.7)

Note: * — differences in indicators between the groups are statistically significant (p<0.05)

It follows from Table 2, that during the control endoscopy performed on the 5th day of the patients' treatment, signs of epithelization were recorded at the sites of chemical burns in 79% of patients in the Study Group, and in 14.3% of patients in the Comparison Group. This difference was statistically significant ($p<0.05$). Along with this, the incidence of subsequent scarring with signs of stenosis of the hollow organs (esophagus and stomach) in the patients of the Study Group was detected by 27.2% less often than in the Comparison Group. Secondary bleeding (early or late), which often causes death in this pathology, occurred 5.5 times less often in the Study Group than in the Comparison Group. Pneumonia as a complication of poisoning in the Comparison Group was observed in 17.1% of patients, and it was not registered in a single case in the Study Group. 8.6% of patients in the Comparison Group, despite anticoagulant therapy, developed thrombosis of the veins of the lower extremities, and one of them had a pulmonary embolism. There were no such complications in the Study Group. Intoxication delirium developed in 4 patients (11.4%) of the Comparison Group, while no disorders of consciousness were observed in the Study Group.

In the Comparison Group, 2 patients (5.7%) died, and in the Study Group all patients survived, while the average length of stay in the ICU compared to the Comparison Group was reduced by 1.5, and the total length of hospitalization by 2.1 times.

Characteristics of clinical observations from the Study and Comparison Groups can serve as an illustration of the effect of IL in poisoning by acetic acid.

Clinical example No. 1 (from the Study Group)

Patient D., 35 years old. Acetic acid poisoning (ICD 10: T54.9). He was admitted to the N.V. Sklifosovsky Research Institute for Emergency Medicine on January 18, 2017. Upon admission, after anesthesia, an emergency diagnostic esophagogastroduodenoscopy (EGDS) was performed, during which widespread ulcerative burn esophagitis was revealed: the mucous membrane of the esophagus was markedly swollen, whitish, with ulcerative defects of irregular shape, without clear contours. The detected changes in the mucous membrane, presented in Fig. 1, corresponded to the 3rd degree chemical burn of the esophagus.

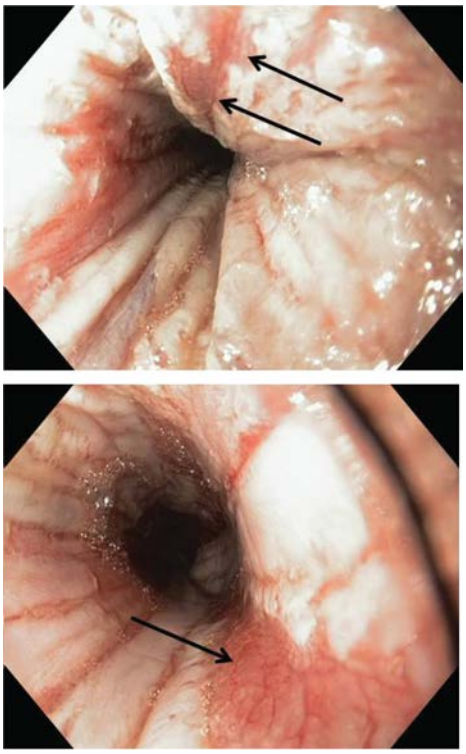

Fig. 1. 3rd degree chemical burn of the esophagus. 1st day (ulcerative defects are indicated by a single arrow)

The gastric mucosa is clearly hyperemic, edematous, with linear ulcerative defects located along the tops of the folds of the greater curvature of the stomach. Hydrochloric acid hematin was determined at the bottom of the ulcerative defects (Fig. 2).

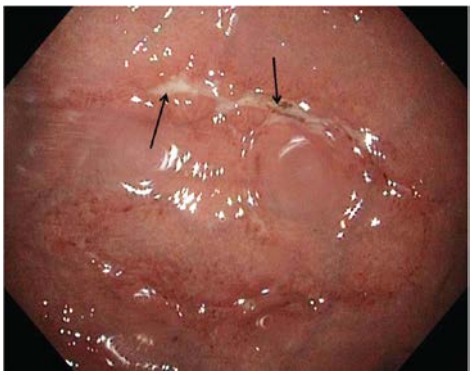

Fig. 2. 3rd degree chemical burn of the stomach. 1st day (ulcers indicated by arrows)

In addition to the standard therapy complex, in the first hours of hospital stay, the patient underwent IL according to the method presented above in a volume of 4.5 l of ES.

Over the next 5 days, as a nutritional correction, the patient was prescribed the same solution, but with glucose, orally in portions of 200 ml in a total volume of 3 liters per day. There were no complications or side effects; the solution was tolerated well. The patient's condition was improving. On the 5th day of treatment, the patient underwent a repeat EGDS. The endoscopic picture was characterized by a significant decrease in swelling of the esophageal mucosa, ulcerative defects acquired clearer, smooth contours, and areas of epithelization of the esophageal mucosa were revealed (Fig. 3).

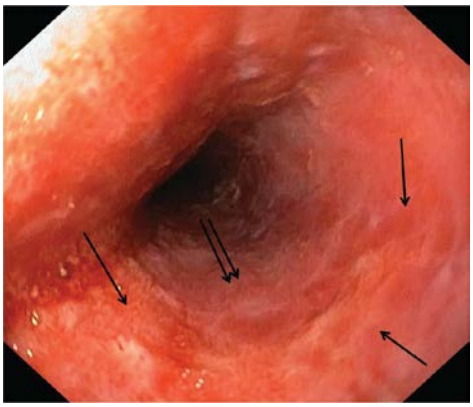

Fig. 3. 3rd degree chemical burn of the esophagus. 5th day (ulcerative defects are indicated by a single arrow, areas of epithelialization — by a double arrow)

By the 5th day, linear ulcerative defects of the body of the stomach were completely healed and epithelialized (Fig. 4).

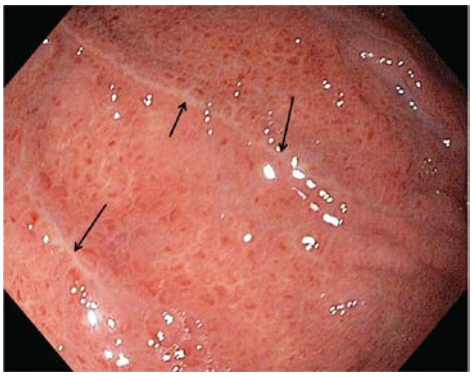

Fig. 4. Linear gastric scars (indicated by arrows). 5th day

On the 9th day after the injury, complete scarring and epithelization of the ulcerative defects of the esophagus were noted with barely noticeable circular flat scars that did not narrow or deform the lumen of the esophagus (Fig. 5).

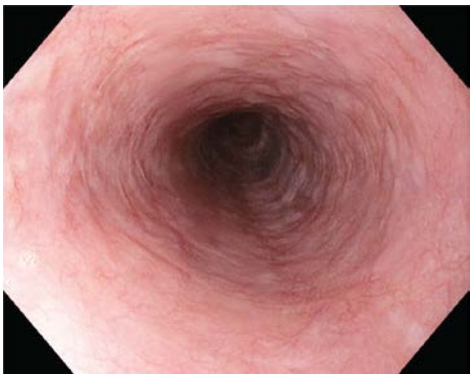

Fig. 5. 3rd degree chemical burn of the esophagus. 9th day. Complete scarring and epithelization of ulcerative defects

The course of the disease was smooth, without complications, and ended in recovery. The patient was discharged from the specialized hospital on the 11th day.

Clinical example No. 2 (from the Comparison Group)

Patient J., 27 years old. Acetic acid poisoning (ICD10: T54.9). He was admitted to the N.V. Sklifosovsky Research Institute for Emergency Medicine on July 23, 2017. Upon admission, after anesthesia, an emergency diagnostic EGDS was performed, during which widespread ulcerative burn esophagitis was revealed, the endoscopic picture of which is presented in Figure 6: the mucous membrane of the esophagus is markedly swollen, whitish, with ulcerative defects of irregular shape, without clear contours, which corresponded to the 3rd degree chemical burn.

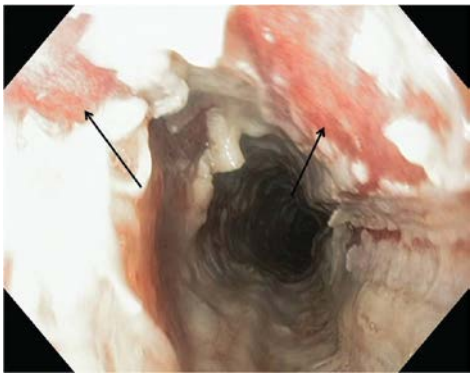

Fig. 6. 3rd degree chemical burn of the esophagus. 1st day. Arrows indicate ulcerative defects

On the brightly hyperemic mucous membrane of the cardiac part of the stomach, ulcerative defects with hematin in the bottom and spontaneous bleeding that arose during air insufflation of the stomach were determined (Fig. 7).

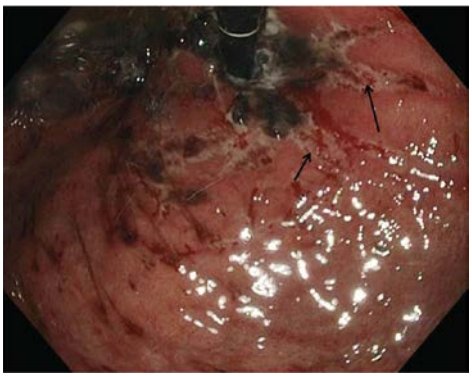

Fig. 7. 3rd degree chemical burn of the stomach. 1st day. Arrows indicate ulcers of the cardial part of the stomach

On the 8th day after the injury, the standard course of the grade 3 chemical burn of the esophagus was noted. Diagnostic EGDS revealed circular drainage deposits of dense light fibrin on the walls of the esophagus (Fig. 8).

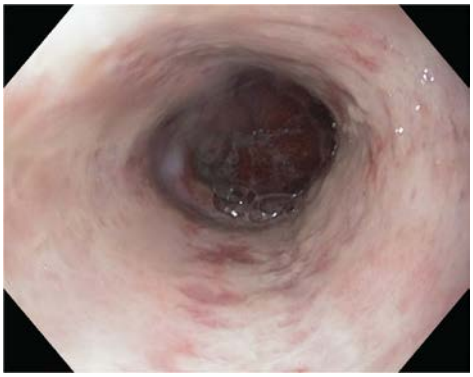

Fig. 8. 3rd degree chemical burn of the esophagus. 5th day. Circular dense light fibrin on the walls of the esophagus

In the cardiac part of the stomach, ulcerative defects covered with light fibrin were identified (Fig. 9).

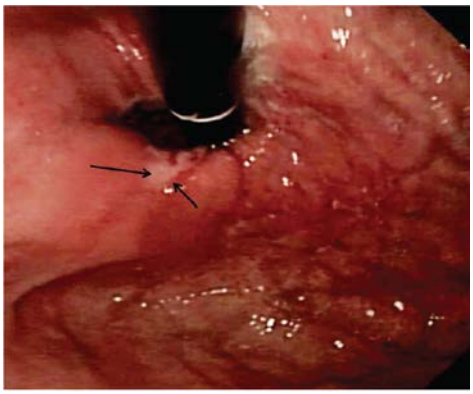

Fig. 9. 3rd degree chemical burn of the stomach. 8th day. Ulcers are indicated by arrows

EGDS on the 17th day after injury: the walls of the esophagus were completely cleared of fibrin. Areas of epithelization of the mucous membrane of the esophagus and moderate circular scar-granulation deformation of the lumen of the thoracic esophagus without visible epithelization were visualized (Fig. 10).

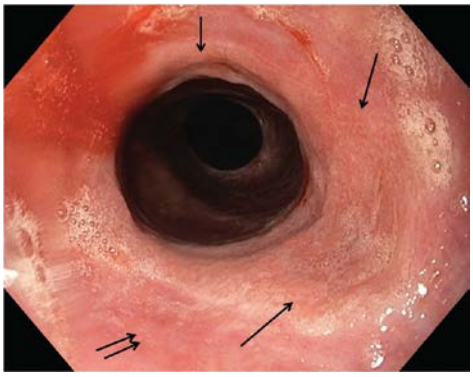

Fig. 10. 3rd degree chemical burn of the esophagus. 17th day. Moderate cicatricial granulation deformity of the thoracic esophagus. Areas of epithelization — double arrows. Non-epithelialized granulation scar tissue — single arrows

The endoscopic picture of ulcers in the cardiac part of the stomach on the 17th day after injury corresponded to the picture on the 8th day; the ulcers were still covered with light fibrin. The patient was discharged from the hospital on the 20th day under the supervision of a gastroenterologist at his place of residence.

1 month after the chemical burn, the patient began to notice dysphagia which consisted of impaired passage of large food fragments. Diagnostic EGDS revealed a short post-burn scar stricture of the thoracic esophagus (Fig. 11).

Fig. 11. Short epithelialized scar post-burn stricture of the thoracic esophagus

A comparative description of the presented clinical examples showed that, with initially similar indicators of the severity of acetic acid injury, the course of the disease in the patient who received IL followed by nutraceutical support with glucose-containing ES proceeded smoothly, without complications. Epithelization in the areas of chemical burn of the esophageal mucosa appeared on the 5th day. In the patient who received standard treatment, epithelization in the areas of chemical burn of the esophageal mucosa appeared only on the 17th day, and the defects in the gastric mucosa were not yet cleared of fibrin by this time. 1 month after the chemical burn, the course of the disease was complicated by the post-burn cicatricial stricture of the thoracic esophagus.

THE DISCUSSION OF THE RESULTS

The mechanisms of the positive effect of the new approach in the complex therapy for CP remain to be researched. Currently, the observed therapeutic effects can be explained hypothetically, from the standpoint of accumulated knowledge on the use of ES in other nosological forms of AP [9]. The improvement in clinical indicators in the group of patients with CP who received IL using ES, and subsequent fractional intake of this solution enriched with glucose is probably associated with both the local effect of ES, a GIT cleansing factor preventing the development of enterogenous endotoxemia, and its resorptive effect expressed in the correction of homeostasis disorders [9]. The positive local impact of ES may be associated with the fact that it washes away fragments of necrotic masses, thereby facilitating the rapid cleansing of chemical burn sites. This prevents or reduces the intensity of local inflammation and promotes early epithelization of the mucous membranes.

Unlike patients receiving standard treatment which presupposes rest for the digestive organs (hunger) on the first day, patients who received IL actively drink liquid during the first day and in the following days, that is, they make swallowing movements. Early functional load, especially of the upper part of the digestive tube, probably contributes to the prevention of post-burn strictures.

An important link in the complex of therapeutic measures is the fact of cleansing the GIT with the help of IL. Removal of its natural as well as pathological contents from the intestinal cavity (particles of necrotic tissue, inflammatory products and hemolyzed blood) creates the prerequisite for reducing the flow of pathological agents into the systemic bloodstream through the intestinal wall, which permeability increases during CP [4]. In turn, sanitization of the GIT and a decrease in the volume of intestinal translocation help reduce the risk of developing systemic inflammatory reaction and its consequences. This can explain the decrease in the incidence of extraintestinal complications of the infectious nature, intoxication psychosis, etc. [10].

The systemic effect of ES, manifested as a result of its absorption, consists in the correction of homeostasis disorders: water-electrolyte, acid-base, hemo-rheological and hemocirculatory ones [9]. Local and systemic effects of ES, aimed at cleansing lesions, improving microcirculation and supply of tissues with oxygen, energy and plastic substrates, obviously contribute to earlier healing of foci of destruction in CP.

Correction of homeostatic imbalances at the early stage of CP, namely the state of hypercoagulation, is the prevention of vein thrombosis, and in the subsequent period - the prevention of fibrinolysis and secondary bleeding.

Thus, the positive clinical effects from the use of ES in the form of IL and nutraceuticals are explainable from the perspective of their already known therapeutic mechanisms: detoxification (in this case, endotoxemia), correction of homeostatic and functional disorders [7].

CONCLUSION

The first experience of using an enteral solution in the form of intestinal lavage and as an element of early enteral nutrition in case of poisoning by corrosive substances was gained. The present study showed that sanitation of the gastrointestinal tract using intestinal lavage in case of poisoning by corrosive substances improves the results of complex therapy, namely, promotes early cleansing and epithelization of mucous membranes in areas of chemical burns with a tendency to reduce the incidence of tissue scarring which subsequently leads to deformation of the affected hollow organs, as well as the risk of secondary bleeding by 5.5 times, and other complications characteristic of poisoning by corrosive substances, such as pneumonia, thrombosis of the veins of the lower extremities, intoxication delirium, what, in turn, had an impact on reducing mortality. Prevention of

the development of these complications and accelerated repair in the areas of tissue destruction also influenced the reduction in length of stay in the specialized hospital by 2.1 times.

FINDINGS

1. The inclusion of intestinal lavage in the complex treatment for poisoning by corrosive substances helps accelerate the epithelization of ulcerative defects in the mucous membrane of the esophagus and stomach: on the 5th day, epithelization was observed in the foci of destruction in 79% of cases versus 14.3% in the Comparison Group. Differences in indicators between the groups are statistically significant ($p<0.05$).

2. The use of intestinal lavage in case of poisoning by corrosive substances allows reducing the incidence of complications: scarring by 3.1%, secondary bleeding by 5.5 times. The development of pneumonia in the Comparison Group was noted in 17.1% of patients, thrombosis of the veins of the lower extremities in 8.6% of patients, pulmonary embolism in 1 case, and intoxication delirium in 4 cases. These complications were not recorded in the Study Group. Differences between the groups in the incidence of pneumonia are statistically significant ($p<0.05$).

3. The use of intestinal lavage in the complex treatment for poisoning by corrosive substances leads to a reduction in the duration of treatment in the intensive care unit by 1.5 times, the length of hospital stay by 2.1 times, and a decrease in mortality (5.7% in the Comparison Group, no deaths in the Study Group). Differences in indicators between the groups by length of hospitalization are statistically significant ($p<0.05$).

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