

GASTROENTEROLOGY



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The results of clinical studies of using Enterosgel in gastroenterology are presented in the collection. Enterosgel has proven itself as an effective agent for the treatment of peptic ulcer disease, inflammatory bowel disease, and diseases of the liver.

We hope that this collection will be useful both for new approaches in treatment and for discussion. The key issues of sorption detoxification using intestinal adsorbents (enterosorption method) in clinical practice addressed in this collection can be relevant to all physicians, regardless of specialty or practice setting.

All the clinical studies were conducted in compliance with the Declaration of Helsinki.

Originals of the research papers have been adapted for translation into English.

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## A Modern View on the Issue of Enterosorption: Choosing the Optimal Drug

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*Reprinted with minor abridgements*

### Abstract

The article provides an overview of the literature on the role of sorption detoxification using intestinal adsorbents (enterosorption method) in the multifaceted treatment of various diseases. The mechanism of action of adsorbents and their therapeutic effects are presented. We emphasized that intestinal adsorbent Enterosgel is a modern, effective, and safe detoxifying agent.

**Keywords:** adsorbent, endogenous intoxication, enterosorption, *H. pylori*, sorption detoxification, toxin

Nowadays, the method of sorption detoxification using intestinal adsorbents/sorbents (enterosorption method) is widely used in the treatment of various diseases. The therapeutic effect of enterosorption is due to the direct and mediated effects of adsorbents. The direct effects are binding and elimination of toxins, toxic metabolites, biologically active substances (neuropeptides, prostaglandins, serotonin, and histamine), pathogenic and opportunistic microorganisms, as well as viruses out of the gastrointestinal (GI) tract. The mediated effects are related with reduction or mitigation of toxic and allergic reactions, prophylaxis of endogenous intoxication, reduction in the metabolic load on the excretory organs that perform detoxification, correction of metabolic processes, restoration of integrity and permeability of the mucosa of the

GI tract, as well as stimulation of intestinal motility. Extensive scientific data regarding sorption materials allows considering their use dependent upon pathogenesis in many diseases, particularly in the conditions of increasing bacterial resistance to antibacterial agents, including specific bacteriophages [3, 8, 9].

The effectiveness of intestinal adsorbents depends on physicochemical properties of the active substance. Porosity plays a crucial role in the process of mass transfer. There can be micropores, mesopores, and macropores in the sorbent. It is known that the nature of porosity influences on adsorption of different substances, thus determining therapeutic effect of the adsorbent. For example, microporous adsorbents are effective in acute poisonings since they have high adsorption capacity; whereas adsorbents

with mesoporous or macroporous structure are effective in the treatment of chronic diseases accompanied by endogenous intoxication. Chemical properties of sorbents play a major role in subdividing them into carbon-based, silicon-containing (including organosilicon and aluminosilicate), natural organic, and composite sorbents. The choice of intestinal adsorbent should be guided by the data on chemical purity of sorbent, level of standardisation, use of high technology in manufacturing, and proven clinical effectiveness [3, 8, 9].

One of the most effective intestinal adsorbents is Enterosgel, which demonstrates therapeutic effect comparable to instrumental methods of detoxification, however has very high safety and tolerability [3, 8, 11]. Enterosgel is used to detoxify the body in allergic reactions, and various diseases accompanied by endogenous/exogenous intoxication, such as infectious diseases, sepsis, diarrhea, intestinal dysbiosis, toxic and viral hepatitis, cholestasis, mushroom and alcohol poisoning, chronic kidney diseases, burns, skin diseases, hepatic and renal failure, diabetes mellitus, autoimmune and oncological diseases, bronchial asthma, and toxicosis during pregnancy [3–5, 7, 14].

The syndrome of endogenous intoxication is observed in various diseases associated with tissue damage, enhanced catabolic processes, impairment of liver and kidney functions, and impaired microcirculation. Intoxication is one of the main pathological syndromes in inflammatory diseases that require intensive care. Endogenous intoxication takes place due to accumulation of four groups of metabolites in the body, such as bacterial endotoxins and exotoxins, tissue

antigens, toxic organic substances, biologically active amines and inflammatory mediators. Bacterial toxins are large hydrophilic proteins having ligands that selectively bind to cell surface receptors of sensitive cells. Some are able to enter cells by endocytosis or through the channels in the lipid bilayer of cells. Pathogenic action of bacterial exotoxins is associated with inhibition of protein synthesis in damaged tissues, whereas the main points of attachment for endotoxins are endothelium of capillaries, blood cells, and autonomic nervous system [3, 8, 9].

Medium-weight molecules (MWM), which are capable to inhibit the functional activity of T lymphocytes and B lymphocytes, phagocytic activity of leucocytes, and tissue respiration processes, play an important role in the development of endogenous intoxication. MWM content in the blood correlates with the severity of the clinical manifestations of intoxication. It is established that the endogenous intoxication as well as metabolic and immune distress are accompanied by disintegration of macrophage-lymphocyte and monooxygenase detoxification chains simultaneously with vascular-platelet hemostasis, resulting in a multiple organ failure. Thus, several factors take part in development of endogenous intoxication, the most important of which are MWM, elevation of serum enzyme activity, bacterial toxins, and reduction in antitoxic resistance of the body [3, 8–10].

The high effectiveness of intestinal adsorbent (enterosorbent) Enterosgel as a detoxifying agent in infectious and inflammatory diseases is associated with its ability to adsorb MWM and pathogenic microorganisms, thereby positively influencing

the cellular and humoral immunity. Enterosgel contributes to enhancing the functional activity of neutrophilic granulocytes to the level of subcompensation [8, 9]. Performing enterosorption using Enterosgel contributes to restoring the functional activity of T lymphocytes and B lymphocytes [8, 9].

The bacterial toxins in purulent diseases and septic complications are capable of suppressing the functional activity of T lymphocytes, which restores only after a certain period and depends upon the severity of disease. Fixation of oligopeptides and MWM onto the surface of T lymphocytes inhibits their functional activity. This is evident from the decrease in lymphocyte blast-transformation reaction (LBTR) in the presence of serum fractions containing nucleotides, MWM, and products of lipid peroxidation (PLP) [3, 8, 9]. One of the reasons behind decrease in LBTR is the action of C-reactive protein (CRP) and other acute phase proteins, which have an inhibitory effect on stimulation by phytohemagglutinin (PHA). Under such conditions, functional activity of B lymphocytes has a tendency to increase indicating a significant activation of humoral immunity in response to the antigenic stimulation. Bacterial lipopolysaccharides (LPS) can act as polyclonal mitogens. Under such conditions, B lymphocytes acquire the capability to produce low-affinity antibodies against its own erythrocytes. Thus, accumulation of toxins of bacterial origin in inflammatory diseases results in the development of secondary immunodeficiency and autoimmune reactions [8, 9].

Including intestinal adsorbent Enterosgel in the multifaceted treatment of various diseases leads to a significant decrease in

plasma concentration of MWM, low molecular weight compounds, and PLP, thereby reducing the toxic load on phagocytic and immune cells. This in turn contributes to maintaining immunological reactivity on the level of subcompensation and to decreasing autosensitization in patients. Reduction of the endogenous intoxication contributes to maintaining functional activity (subcompensation) of natural detoxification factor (toxin-binding capacity of peripheral blood albumin) preventing involvement of globulins in the detoxification processes and retaining their basic functions. It is also established that one of the mediated effects of detoxification using adsorbent Enterosgel is the reduction in serum levels of proinflammatory cytokines, which indicates reduction in the intensity of systemic inflammatory response [2]. By taking into consideration the above-given data, it can be concluded that the use of Enterosgel in enterosorption depends upon pathogenesis and allows to improve significantly the effectiveness of treatment in infectious and inflammatory diseases.

The high effectiveness of enterosorbent Enterosgel has been proven in the multifaceted treatment of various diseases of the digestive system [6, 7, 11]. Gastrointestinal pathology results in disruption of the process of digestion, development of intestinal dysbiosis, and accumulation of intermediate toxic metabolites in the blood, forming the syndrome of endogenous intoxication. This causes further impairment of the functions of the liver, kidneys, cardiovascular system, metabolism, as well as inhibition of hematopoiesis and immunity [6, 7, 11]. The most pronounced manifestations of

endogenous intoxication are observed in chronic disorders and diseases of the digestive system, which are accompanied by severe disturbances in the lipid metabolism. Significant intensification of PLP contributes to damage of cell membranes and accumulation of free radicals, hydroperoxides, aldehydes, and ketones. Therefore, the prophylaxis and treatment of endogenous intoxication and intestinal dysbiosis are of a great importance.

Numerous studies testify the high effectiveness of the use of adsorbent Enterosgel for reduction of endogenous intoxication and intestinal dysbiosis. It is proven that Enterosgel effectively adsorbs toxic metabolites (bilirubin, cholesterol, nitrogenous wastes, etc.) from the intestinal lumen and the blood (through capillary membrane of mucosal villi), while the mineral salts and high molecular weight proteins (immunoglobulins) do not undergo adsorption. Enterosgel also exhibits selectivity towards microorganisms as it actively binds pathogenic and opportunistic microflora though does not inhibit the normal microflora, thus eliminating intestinal dysbiosis [3, 14]. Enterosgel coats mucous membrane of the stomach and intestine thus protecting it from erosions. It is not absorbed into the blood; it does not cause intestinal atony; and it is rapidly excreted. Thus Enterosgel has a good safety profile.

The use of Enterosgel depends upon pathogenesis in enterocolitis, colitis, and diarrhea. Administration of this adsorbent results in rapid improvement of patients' health, positive dynamics of clinical symptoms, and normalisation of intestinal microecocenosis [13, 14].

Intestinal adsorbent Enterosgel is used for the treatment of *H. pylori*-positive peptic ulcer disease (PUD) as an adjuvant. It is proven that the accumulation of MWM and oligopeptides in patients' blood, increased toxicity index, and increased activity of NADP-dependent alcohol dehydrogenase, as well as reduction in the effective albumin concentration and reserve of toxin-binding capacity of albumin are markers of the endogenous intoxication in patients with PUD. This data is of a great practical significance and is used to look for new multifaceted treatment plans for PUD with the inclusion of detoxifying agents. The results of performed studies testify that Enterosgel is an effective adjuvant for the treatment of *H. pylori*-positive PUD. Enterosgel reliably enhances the anti-*Helicobacter* effectiveness of the standard triple therapy. At the same time, the incidence of side effects of anti-*Helicobacter* therapy is reduced and its tolerance is improved [13].

Enterosgel is widely used in the multifaceted treatment of diseases of liver [1, 11]. There are disturbances of metabolic processes in patients with acute and chronic liver impairment of various origins. Such disturbances of metabolic processes are caused by the syndrome of metabolic (endogenous) intoxication. MWM (products of proteolysis) have a toxic effect on cells of the liver, kidney, and brain neurons. Severe course of diseases of the liver leads to accumulation of toxic protein metabolites in the blood, causing the development of toxic encephalopathy and hepatic coma. Therefore, detoxification has a major significance in the treatment of liver diseases [1]. Clinical effectiveness of using Enterosgel in liver diseases is determined

by both the direct and mediated effects. The direct effect is related with detoxifying action against toxic metabolites and bacterial toxins. By binding toxic substances, Enterosgel suppresses the processes of their resorption and recirculation in the body, which reduces the metabolic and toxic load on the liver and accelerates the restoration processes. The mediated effects of Enterosgel are produced by its ability to maintain normal intestinal microbiocenosis, which in turn improves digestion and provides a high metabolic activity of enterocytes [1]. The use of Enterosgel in the multifaceted therapy of diseases of liver accelerates normalisation of biochemical parameters such as levels of bilirubin, transaminases, alkaline phosphatase, cholesterol, lipoproteins, acute phase proteins of inflammation, leucocyte count, ESR, etc. It is accompanied by clinical improvement of patients' health as there is increased appetite, disappearance of weakness and itching, as well as normalisation of stool [7, 11]. Furthermore, the use of intestinal adsorbent Enterosgel in infectious (acute) hepatitis allows shortening the terms of infusion and detoxification therapy, improving the treatment results [1, 6, 7, 11].

The ability of Enterosgel to correct the lipid metabolism by indirectly reducing the levels of cholesterol and lipoproteins in the blood substantiates its inclusion in the multifaceted treatment of cardiovascular diseases, particularly with concomitant diabetes. Optimising the therapy with enterosorbents allows significantly improving the results of treatment and quality of life in patients with ischemic heart disease [4, 5].

Thus, the results of numerous studies testify that intestinal adsorbent Enterosgel

is a modern, effective, and safe detoxifying agent. By possessing selective adsorption properties, Enterosgel binds and removes bacterial toxins, endogenous products of hydrolysis, biologically active substances, pathogenic and opportunistic microorganisms, as well as viruses from the GI tract; and in addition, it adsorbs toxic metabolites from the blood. That in turn leads to reduction in the toxic and metabolic load on the excretory organs that perform detoxification, correction of the metabolic processes, reduction in the intestinal permeability, normalisation of the intestinal microbiocenosis, improvement in the motility of the GI tract, reduction in the inflammatory processes, as well as positive influence on the cellular and humoral immunity. Figuratively speaking, Enterosgel fulfils the function of an additional excretory organ that performs detoxification optimising the work of vital organs and systems. Inclusion of Enterosgel in therapeutic regimens allows significantly reducing the severity of diseases, avoiding dangerous complications (multiple organ dysfunction syndrome) and chronic pathological process.

Thanks to such an all-round positive impact on the patient's body, Enterosgel is included as a basic detoxifying agent in the multifaceted treatment for a number of diseases in adults and children.

The high adsorption capacity of Enterosgel, safety and ease of use, and ability to be combined with other medicinal products allow the doctor individualising the treatment policy, avoiding side effects of the conventional therapy, and achieving high effectiveness of the treatment while reducing its duration.

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## Effectiveness of Enterosorbent Enterosgel in Combined Anti-*Helicobacter* Therapy for Patients with Peptic Ulcer Disease

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### Abstract

The results of an open-label, parallel-group, comparative study of the effectiveness of triple therapy (omeprazole, clarithromycin, and amoxicillin) in combination with intestinal adsorbent (enterosorbent) Enterosgel in patients with peptic ulcer disease (PUD) are presented in this article. It was established that the clinical effect and ulcer healing rate were significantly higher in patients with gastric ulcer that received Enterosgel than in patients of the control group. Using triple therapy combined with Enterosgel led to a significantly higher *H. pylori* eradication rate in patients with duodenal ulcer. It was found out that Enterosgel not only enhances the effectiveness of the eradication therapy but also improves its tolerance by reducing the side effects of antibiotics. Enterosgel can be widely used as an adjuvant in the treatment of *H. pylori*-positive PUD.

**Keywords:** adsorbent, enterosorbent, eradication, *Helicobacter pylori*, peptic ulcer disease

### INTRODUCTION

Peptic ulcer disease (PUD) is characterized by the formation of *Helicobacter pylori* (*H. pylori*)-positive peptic ulcers on the mucous membrane of the stomach and/or duodenum. PUD is a widespread disease that affects 10–15% of the world's adult population [1, 6, 8]. Treatment of PUD with no medications to eradicate *H. pylori* often leads to recurrence (in 60–80% of cases during year) and complications (in 15–20% of patients). Thanks to application of new algorithms of PUD diagnostics and treatment, the nature of the disease course has significantly changed. The basic strategy

of PUD treatment is to eradicate *H. pylori*, which in most cases allows the disease to be completely cured [6, 7, 9]. According to the international consensus, the recommended first-line treatment for *H. pylori* infection is a proton-pump inhibitor (PPI)-based triple therapy [2–9]. The effectiveness (successful eradication rate) of triple therapy is 80–93% in different countries and depends on several factors including duration of the treatment, resistance of *H. pylori* to antibiotics, individual sensitivity of patients to PPIs, compliance of patients, and side effects of the therapy (hepatotoxicity and diarrhea). A promising way to increase the effectiveness of the treatment and reduce the

incidence of side effects is to use additional detoxifying agents including intestinal adsorbents (enterosorbents).

The objective of this study was to assess the effectiveness, safety, and tolerance of triple eradication therapy combined with enterosorbent Enterosgel in the treatment of PUD associated with *H. pylori*.

### MATERIALS AND METHODS

60 patients (37 males and 23 females) aged from 18 to 60 years with *H. pylori*-positive peptic ulcers of the stomach (12 patients) and duodenum (48 patients) were included in this open-label, parallel-group, comparative study. To assess the effectiveness of the eradication therapy combined with enterosorbent Enterosgel, the patients were randomly assigned into two groups.

The experimental group was composed of 30 patients (25 with duodenal ulcer, and 5 patients with gastric ulcer) who received the 7-day triple eradication therapy combined with 10-day administration of Enterosgel. The triple therapy consisted of omeprazole (20 mg 2 times a day), clarithromycin (500 mg 2 times a day), and amoxicillin (1000 mg 2 times a day). Enterosgel was prescribed as 1 tablespoon 3 times a day (45 g/day), 1–2 hours before or after a meal. After finishing the basic course of the treatment, the patients continued to receive omeprazole 20 mg once a day for 2 weeks (with duodenal ulcer) and 3–6 weeks (with gastric ulcer).

The control group consisted of 30 patients (23 patients with duodenal ulcer and 7 patients with gastric ulcer) who received only the 7-day triple therapy and a subsequent omeprazole treatment (20 mg once

a day) for 2 weeks (with duodenal ulcer) and 3–6 weeks (with gastric ulcer).

At initial examination, all patients underwent a physical and laboratory examination (total protein and protein fractions, total bilirubin and its fractions, liver function test, blood glucose level, and stool for occult blood), endoscopy with biopsy, pH-measurement of gastric juice, and abdominal ultrasound. Two methods were used for verifying the diagnosis (histopathology and rapid urease test). Pain and dyspeptic syndrome were observed in all patients with duodenal ulcer (100%) and in 9 out of 12 (75%) patients with gastric ulcer. High acidity of gastric juice was revealed in 79.2% of patients with duodenal ulcer and in 66.6% with gastric ulcer.

On day 7 of treatment, all patients underwent a physical and laboratory examination.

On day 28 after the start of treatment, all patients underwent a physical and laboratory examination, endoscopic assessment. Endoscopy was not performed in patients with duodenal ulcer if no clinical manifestations of disease were observed.

On day 49 after the start of treatment, an endoscopic examination was performed in those patients with gastric ulcer who had no complete healing of ulcers within 28 days.

Comparative effectiveness of treatments in the two groups of patients was assessed in terms of following indicators:

- clinical improvement rate (reduction or disappearance of all clinical manifestations of the disease) on the 7th, 28th and 49th day after the start of treatment (number and percent of patients);

**Table 1.**

Clinical improvement rate on different days after the start of treatment, n (%)

Days	Experimental group (n = 30)		Control group (n = 30)	
	Gastric ulcer (n = 5)	Duodenal ulcer (n = 25)	Gastric ulcer (n = 7)	Duodenal ulcer (n = 23)
7	3 (60)	23 (92)	4 (57.1)	21 (91.3)
28	4 (80) <sup>a</sup>	25 (100)	5 (71.4)	23 (100)
49 (for patients with gastric ulcer)	4 (80)	–	6 (85.7)	–

<sup>a</sup> p < 0.05 vs the control group.

- gastric ulcer healing rate on the 28th and 49th day of the study (number and percent of patients);
- *H. pylori* eradication rate according to the data of <sup>13</sup>C-urea breath test performed in 4 weeks after completion of treatment (number and percent of patients).

Data identified as criteria for the effectiveness and tolerance was assessed according to the offered scale, processed statistically, and compared in both the groups.

The effectiveness of treatment was monitored using <sup>13</sup>C-urea breath test performed in 4 weeks after completion the treatment. Conclusion regarding the effectiveness and tolerance of the triple therapy with/without Enterosgel was made based on the obtained results.

**Table 2.**

The rate of complete healing of gastric ulcers on the 28th and 49th day after the start of treatment, n (%)

Days	Experimental group (n = 5)	Control group (n = 7)
28	3 (60) <sup>a</sup>	3 (42.8)
49	4 (80)	6 (85.7)

<sup>a</sup> p < 0.05 vs the control group.

## RESULTS AND DISCUSSION

All patients completed their treatment without interruption. The dynamics of clinical manifestations of the disease in both groups of patients is presented in Table 1.

As it can be seen from Table 1, there were revealed no differences in the speed of achieving positive dynamics in patients with duodenal ulcer. In patients of the experimental group with gastric ulcer, the clinical effect occurred quicker as the percentage of the patients with reduction or disappearance of clinical manifestations of the disease on day 28 of the treatment was significantly higher than in the control group (80% vs 71.4%, p < 0.05).

Significant difference was observed in the rate of healing of gastric ulcers within

**Table 3.**

*H. pylori* eradication rate according to the results of <sup>13</sup>C-urea breath test performed in 4 weeks after completion of treatment, n (%)

Groups	Gastric ulcer (n = 12)	Duodenal ulcer (n = 48)	Total (n = 60)
Experimental (n = 30)	4 (80) (n = 5)	24 (96) <sup>a</sup> (n = 25)	28 (93.3) <sup>a</sup>
Control (n = 30)	6 (85.7) (n = 7)	19 (82.6) (n = 23)	25 (83.3)
<b>Total</b>	10 (83.3)	43 (89.6)	53 (88.3)

<sup>a</sup> p < 0.05 vs the control group.

28 days of treatment (Table 2). Complete healing of ulcers took place in 3 out of 5 patients of the experimental group (60%) while healing was noted only in 3 out of 7 patients of the control group (42.8%) during the same period (p < 0.05).

Application of basic therapy combined with Enterosgel allowed increasing the effectiveness of the treatment (clinical improvement and endoscopic

healing) in 28 days in patients with gastric ulcer.

Administration of enterosorbent Enterosgel was accompanied by a significantly higher *H. pylori* eradication rate in patients with duodenal ulcer (Table 3).

Comparative analysis of tolerance of the eradication therapy with/without Enterosgel was assessed based on the frequency and intensity of the side effects (Table 4).

**Table 4.**

The rate and type of side effects of therapy on the 7th day of treatment, n (%)

Side effects	Experimental group (n = 30)	Control group (n = 30)
Nausea	7 (23.3)	7 (23.3)
Abdominal bloating	5 (16.6) <sup>a</sup>	8 (26.7)
Diarrhea	5 (16.6) <sup>a</sup>	9 (30)
General weakness	5 (16.6)	4 (13.3)
Dizziness	4 (13.3)	3 (10)
Skin itch	1 (3.3)	1 (3.3)
Unpleasant metallic and bitter taste in the mouth	10 (33.3) <sup>a</sup>	14 (46.6)
Transient elevation of transaminases	1 (3.3) <sup>a</sup>	4 (13.3)

<sup>a</sup> p < 0.05 vs the control group.

No serious side effect was recorded during the treatment. In patients of both the groups, there were observed non-serious side effects associated with the administration of clarithromycin and amoxicillin. The total number of patients with side effects was significantly lower in the group receiving Enterosgel than in the control group (33.3 vs 46.6%,  $p < 0.05$ ). Besides, symptoms such as abdominal bloating (16.6% vs 26.6%,  $p < 0.05$ ), diarrhea (16.5% vs 30%,  $p < 0.05$ ), unpleasant metallic and bitter taste in the mouth (33.3% vs 46.6%,  $p < 0.05$ ), and transient elevation of transaminases (3.3% vs 13.3%,  $p < 0.05$ ) were significantly rare in the experimental group than in the control group. More than one side effect was observed in 9 patients (30%) of the experimental group and in 14 patients (46.6%) of the control group ( $p < 0.05$ ). Excellent and good treatment tolerance was observed in 21 patients (70%) of the experimental group and in 16 patients (53.3%) of the control group ( $p < 0.05$ ). In other patients, the tolerance was assessed as satisfactory.

The safety of treatment was assessed based on the dynamics in complete blood count and biochemical analysis of blood. No significant changes were noted pertaining to the laboratory parameters of blood except transient elevation of transaminases on day 7 of treatment. Transient hypertransaminasemia was observed in 1 patient (3.3%) of the experimental group and in 4 patients (13.3%) of the control group. Its appearance was probably connected with the hepatotoxic effect of the antibiotics.

## CONCLUSIONS

1. Intestinal adsorbent (enterosorbent) Enterosgel is an adjuvant in the treatment of patients with *H. pylori*-positive PUD.
2. Enterosgel enhances the effectiveness of the triple eradication therapy, reliably reduces the rate of side effects of antibiotics, and improves their tolerance.

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# Clinical Effectiveness of Enterosorption in Reduction of Endogenous Intoxication Syndrome in Patients with Nonspecific Ulcerative Colitis

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## Abstract

The role of the sorption detoxification using intestinal adsorbent (enterosorption) in reducing the severity of endogenous intoxication in patients with active ulcerative colitis (UC) was studied. Application of the intestinal adsorbent (enterosorbent) Enterosgel in combination with conventional therapy demonstrated high clinical effectiveness in the treatment of UC aiming to maintain the functioning of natural detoxification systems and reducing risk of severe endogenous intoxication development.

**Keywords:** adsorbent, albumin, endogenous intoxication, enterosorbent, enterosorption, sorption detoxification, ulcerative colitis

## INTRODUCTION

Typically, diseases characterized by increased tissue damage, increased catabolism, liver and renal impairment and reduced microcirculation are accompanied by endogenous intoxication syndrome [4]. Clinical symptoms of endogenous intoxication are quite similar in different diseases. Nevertheless, the course of endogenous intoxication is largely determined by the nature of disease. Intoxication is the main pathological syndrome that requires intensive therapy in virtually all diseases, including ulcerative colitis (UC) [1–4]. Disruption of intestinal epithelial barrier plays an important role in the pathogenesis of UC. It is believed that the defects of mucosa can lead

to increased intestinal permeability for a variety of agents (e.g., undissociated molecules, bacterial antigens), which can then trigger a cascade of inflammatory and immune reactions. In addition to pathological immune responses the damaging effect on tissues is exerted by active oxygen and proteases. The changes in the process of apoptosis were noted as well.

The aims of this study were to examine parameters of endogenous intoxication in patients with UC and to assess effectiveness of the sorption detoxification using intestinal adsorbent (enterosorption method) in combined therapy of UC. It seemed reasonable to use the new generation intestinal adsorbent (enterosorbent) Enterosgel.



## MATERIALS AND METHODS

In total, the study involved 45 persons aged from 30 to 45 years, including 35 patients with active UC and 10 healthy individuals.

To assess the impact of enterosorption on parameters of endogenous intoxication patients with UC ( $n = 35$ ) were divided in two groups.

The experimental group comprised 20 patients with UC who received the conventional therapy combined with enterosorbent Enterosgel during 14 days. Enterosgel was administered as follows: 1 tablespoon (15 g) 3 times a day (45 g/day) 1–2 hours before or after a meal.

The control group comprised 15 patients with UC who received only conventional therapy.

The following parameters were tested in all subjects of the study [1, 5]:

- level of medium-weight molecules (MWM);
- total albumin concentration (TAC);
- effective albumin concentration (EAC);
- toxin-binding capacity of serum albumin and globulins;
- coefficient of intoxication (CI), which is calculated as the ratio of MWM to EAC ( $CI_{MWM/EAC}$ );
- cryoglobulin test;
- ethanol gelation test (EGT).

These parameters in patients with UC were determined before and after treatment.

Statistical data processing was performed on Pentium IV computer using Microsoft Excel 2007 and Stat Soft Statistica v 8.0 softwares. Evaluation of significance of differences between the mean values was performed using Student *t*-test. Differences were considered significant at  $p < 0.05$ .

**Table 1.**

Parameters of endogenous intoxication in patients with UC before and after treatment (mean  $\pm$  SEM)

Parameters	Experimental group ( $n = 20$ )		Control group ( $n = 15$ )		Healthy subjects ( $n = 10$ )
	Before treatment	After treatment	Before treatment	After treatment	
TAC (g/l)	43.40 $\pm$ 2.11	45.20 $\pm$ 3.11	42.70 $\pm$ 2.07	43.70 $\pm$ 2.16	47.50 $\pm$ 0.55
EAC (g/l)	28.33 $\pm$ 1.22 <sup>a</sup>	35.22 $\pm$ 2.12 <sup>a, b</sup>	28.12 $\pm$ 1.57 <sup>a</sup>	33.17 $\pm$ 1.67 <sup>a, b</sup>	40.40 $\pm$ 3.70
MWM (optical density units)	0.67 $\pm$ 0.02 <sup>a</sup>	0.59 $\pm$ 0.05 <sup>a</sup>	0.68 $\pm$ 0.04 <sup>a</sup>	0.65 $\pm$ 0.03 <sup>a</sup>	0.56 $\pm$ 0.06
Hydrophilic fraction of MWM (optical density units)	0.25 $\pm$ 0.07 <sup>a</sup>	0.22 $\pm$ 0.07 <sup>a</sup>	0.25 $\pm$ 0.04 <sup>a</sup>	0.23 $\pm$ 0.05 <sup>a</sup>	1.19 $\pm$ 0.03
Hydrophobic fraction of MWM (optical density units)	0.42 $\pm$ 0.02 <sup>a</sup>	0.37 $\pm$ 0.03 <sup>a</sup>	0.43 $\pm$ 0.02 <sup>a</sup>	0.42 $\pm$ 0.04 <sup>a</sup>	0.37 $\pm$ 0.04
$CI_{MWM/EAC}$	23.63 $\pm$ 1.22	16.75 $\pm$ 0.89	24.18 $\pm$ 1.14	19.69 $\pm$ 1.19	13.86 $\pm$ 1.55

<sup>a</sup>  $p < 0.05$  vs healthy subjects; <sup>b</sup>  $p < 0.05$  vs baseline values.

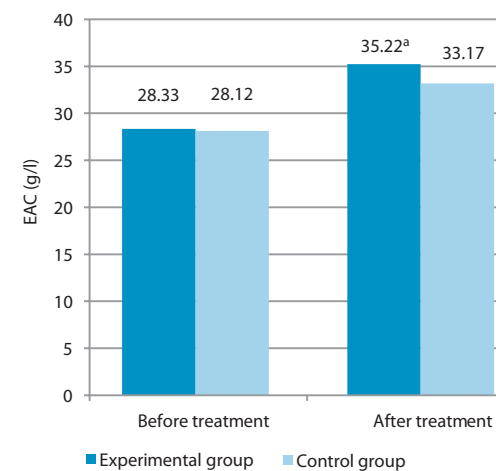
## RESULTS AND DISCUSSION

Comparison of endogenous intoxication parameters in UC patients from both groups before and after treatment is shown in Table 1. TAC was reduced 1.09-fold in all patients with UC compared with the healthy subjects. In our opinion, this is due to decrease in albumin/globulin ratio caused by significant production of autoantibodies in patients with UC. After treatment a tendency of TAC increase compared with baseline data was observed in all patients.

Before treatment EAC values were lower in experimental and control groups comparing to healthy subjects (42.6% and 43% respectively). After treatment, including treatment with enterosorbent Enterosgel, EAC values in patients of the experimental group exceeded baseline values by 24.32%

**Figure 1.**

EAC values in patients with UC before and after treatment



<sup>a</sup>  $p < 0.05$ .

( $p < 0.05$ ), although remained significantly lower than in healthy subjects (Figure 1). Meantime EAC values in patients of the experimental group were higher compared to the control group.

The increased MWM levels were observed throughout the study period in patients of both groups. In patients of the experimental group the level of hydrophobic fraction of MWM was 1.3-fold higher than in healthy subjects ( $p < 0.05$ ). Hydrophobic fraction of MWM in blood plasma is completely in a bound state in the form of complexes with albumin and low density lipoproteins. Namely hydrophobic toxins (hydrophobic products of protein degradation) have most significant toxic properties as they are able to rapidly bind to blood cells membranes and intracellular proteins, altering their structure, increasing permeability of membranes and inhibiting enzymatic activity. This process occurs simultaneously with the underlying significant decrease of toxin-binding capacity of albumin. Hydrophobic toxins exert significant impact on the functional activity of neutrophilic granulocytes and monocytes resulting in decompensation of their functions. Due to inhibition of intracellular bactericidal enzymes activity of neutrophilic granulocytes and monocytes and damaging of phagocytosis processes, these cellular structures subsequently become a source of secondary intoxication at later stages of the disease.

The results of the study showed that the  $CI_{MWM/EAC}$  in patients of the experimental group at the start of the treatment was increased 1.70-fold compared to healthy subjects, indicating a high level of endogenous

intoxication in patients with UC. As a result of the treatment there was a decline of this parameter by 41.07% compared to baseline level (Table 1).

$Cl_{MWM/ECA}$  in patients of the control group after the treatment was 17.55% higher compared to the experimental group, which indicates the severity of endogenous intoxication associated with a decrease in EAC and an increase of MWM level in serum (Table 1).

Prior to treatment the toxin-binding capacity of serum albumin in patients of the control group was 33.8% lower ( $p < 0.05$ ) compared to healthy subjects (Table 2). This indicates a significant decompensation of toxin-binding capacity of albumin and accumulation of tissue destruction' products in the blood serum, which is confirmed by the large number of positive results of

the EGT. Decompensation of detoxification capacity of albumin in patients with inflammatory bowel disease is the cause of globulins' involvement in binding and elimination of toxins. This has resulted in cryoglobulinemia in these patients. Results obtained in the study of toxin-binding capacity of globulins confirm these assumptions, which are reflected in the study of humoral immunity.

Similar trends predetermine severe endogenous intoxication, the main cause of which is inhibition of natural detoxification systems activity. Involvement of globulins in detoxification processes can lead to derangement of their basic functions, namely, participation in regulation of immune response. Use of enterosorption in treatment of patients of the experimental group resulted in maintenance of

**Table 2.**

Values of toxin-binding capacity of serum proteins in patients with UC before and after treatment (mean  $\pm$  SEM)

Parameters	Experimental group (n = 20)		Control group (n = 15)		Healthy subjects (n = 10)
	Before treatment	After treatment	Before treatment	After treatment	
Toxin-binding capacity of albumin ( $\mu\text{g}/\text{mg}$ protein)	0.070 $\pm$ 0.002 <sup>a</sup>	0.085 $\pm$ 0.005 <sup>a,b</sup>	0.071 $\pm$ 0.004 <sup>a</sup>	0.080 $\pm$ 0.003 <sup>a</sup>	0.095 $\pm$ 0.010
Toxin-binding capacity of globulins ( $\mu\text{g}/\text{mg}$ protein)	0.022 $\pm$ 0.001	0.010 $\pm$ 0.002 <sup>b</sup>	0.023 $\pm$ 0.002	0.014 $\pm$ 0.003 <sup>b</sup>	0
Cryoglobulin test positivity (% of positive results)	69.22 $\pm$ 3.47	45.40 $\pm$ 1.34	69.12 $\pm$ 2.67	51.22 $\pm$ 2.45	0
EGT (% of positive results)	71.22 $\pm$ 4.56	47.57 $\pm$ 2.78	71.12 $\pm$ 3.22	51.34 $\pm$ 2.56	0

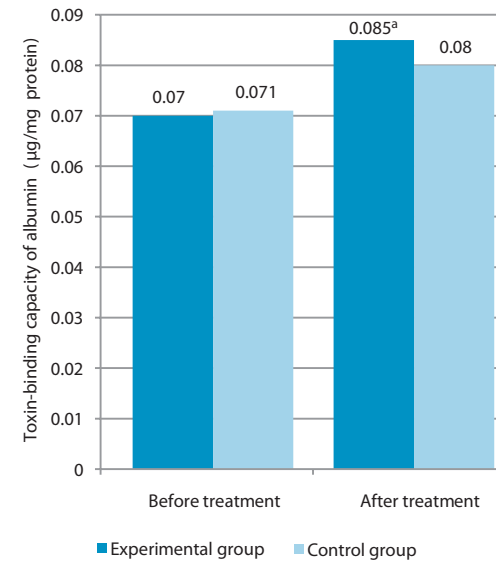
<sup>a</sup>  $p < 0.05$  vs healthy subjects; <sup>b</sup>  $p < 0.05$  vs baseline data.

detoxification functions of serum albumin at the optimum, subcompensated level. Meantime, the increase of values in comparison with the baseline was 21.42% ( $p < 0.05$ ) and reduction of globulins involved in processes of toxins binding was 2.2-fold ( $p < 0.05$ ), which indicates high effectiveness of Enterosgel in treatment of patients with endogenous intoxication (Figure 2). It was also observed that the number of positive results of the EGT decreased by 49.71% and the cryoglobulin test by 52.46% compared to the baseline, indicating a decline in activity of processes associated with accumulation of tissue destruction' products.

During study of values of serum protein toxin-binding capacity in patients of the control group it was found that conventional treatment contributed only to partial recovery of detoxification capacity of albumin, but these means were lower than in the experimental group 1.06-fold (Table 2). Meantime, high activity of globulins in detoxification reactions was maintained. High percent of positive results of the EGT and the cryoglobulin test were also found. However, downward trend in these parameters comparing to baseline values should be noted (Figure 2). Obtained results confirm that after treatment a significant decompensation of function of humoral detoxification system with accumulation of tissue destruction' products is maintained in patients of the control group.

**Figure 2.**

Values of toxin-binding capacity of serum albumin in patients with UC before and after treatment



<sup>a</sup>  $p < 0.05$ .

## CONCLUSIONS

In patients with active UC there is a significant decompensation of toxin-binding capacity of albumin. Meantime, involvement of globulins occurs in processes of toxins elimination, which alter their properties and can cause development of infectious complications in patients with UC.

Use of enterosorbent Enterosgel in combination treatment of patients with UC helps to reduce toxic load on natural detoxification systems and maintain optimal value of toxin-binding capacity of albumin. Meantime, decreased role of serum globulin fraction in detoxification processes maintains their basic functional capacities, thereby reducing the risk of infectious and autoimmune complications in patients with UC.

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**RESEARCH ARTICLE**

## Role of Detoxification Therapy in Maintaining Toxin-binding Capacity of Peripheral Blood Albumin in Patients with Alcoholic Liver Disease

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**Abstract**

This paper justifies the effectiveness of the sorption detoxification using intestinal adsorbent (enterosorption) in the treatment of patients with alcoholic liver disease (ALD) aiming to restore normal functioning of natural detoxification systems. Patients with ALD usually have substantial reduction of toxin-binding capacity of peripheral blood albumin that is a marker of development of endogenous intoxication. The experimental group comprised 132 patients with ALD who received standard therapy along with intestinal adsorbent Enterosgel for 14 days. The control group comprised 50 patients with ALD who received standard therapy alone. In the experimental group, the toxin-binding capacity of albumin was significantly increased compared to baseline values (1.62-fold) on days 10–15 of the study, while in the control group this parameter for the same period showed only a tendency for increase. Use of Enterosgel in the treatment of patients with ALD reduces the concentration of toxic products of tissue destruction, thereby maintaining detoxification capacity of albumin at optimal level even at low values of its concentration in the blood serum.

**Keywords:** adsorbent, albumin, alcoholic liver disease, endogenous intoxication, enterosorbent, enterosorption, sorption detoxification

**INTRODUCTION**

To date, alcohol remains one of the major causes of liver disease. Number of alcohol abusers in the population is increasing, although many of them do not consider themselves alcohol-dependent. Meantime, according to literature, excessive consumption of alcohol is the major etiologic factor of chronic liver injury development in every fourth patient. It should be noted that the number of patients with chronic toxic hepatitis increases with each passing year. At the same time, analysis of statistical data

demonstrates that vast majority of these patients are young people [1, 2].

Concept of alcoholic liver disease (ALD) includes a variety of functional and structural disorders of different severity and caused by systematic consumption of alcoholic beverages. There are following forms of ALD [3, 4]:

- alcoholic fatty liver (alcoholic liver steatosis);
- alcoholic liver fibrosis;
- acute alcoholic hepatitis;
- chronic alcoholic hepatitis;
- alcoholic cirrhosis.

Timely diagnosis of alcoholic hepatitis is of great significance. Detection of objective signs of chronic alcohol intoxication provides an opportunity to clarify etiology of the disease and determine tactics of treatment. Diagnosis of acute alcoholic hepatitis can be set based on patient's history of long-term alcohol abuse, signs of liver injury supported by the results of physical examination and laboratory findings.

The aim of this study was to investigate the effectiveness of sorption detoxification with intestinal adsorbent (enterosorption method) to maintain functioning of natural detoxification systems in patients with ALD.

## MATERIALS AND METHODS

In total the study involved 182 patients aged from 30 to 65 years with ALD in acute exacerbation and 20 healthy individuals of the same age. The ALD diagnosis was established based on the patient's history and evidence of long-term (at least 2 years) and regular alcohol consumption. All patients received standard therapy aiming at detoxification and correction of main parameters of homeostasis. Patients with ALD were randomized into experimental and control groups. Groups were comparable in terms of gender, age and severity of clinical manifestations of ALD.

The experimental group comprised 132 patients with ALD who concomitantly to the standard therapy received intestinal adsorbent (enterosorbent) Enterosgel. Enterosgel has the ability to adsorb toxic substances from the intestinal lumen, as well as to bind and eliminate bacterial endotoxins from the blood through the intestinal wall. Enterosgel was administered orally or through

a nasogastric tube, 1 tablespoon (15 g) 3–4 times a day (45–60 g/day), 1–1.5 hours before or 2 hours after a meal for 14 days.

The control group comprised 50 patients with ALD who received standard therapy alone.

The following parameters were tested in all study participants [4, 5]:

- toxin-binding capacity of serum albumin;
- total albumin concentration (TAC)
- ethanol gelation test (EGT) (as a criterion of the degree of accumulation of tissue destruction products).

All tests in patients with ALD were performed on days 2–3, 6–7 and 10–15 from the date of admission to the hospital and the start of treatment.

## RESULTS AND DISCUSSION

In patients of the control group 1.33-fold reduction of TAC values comparing to healthy subjects was observed on days 2–3 of the treatment ( $p < 0.05$ ) (Table 1). On days 6–7, the same patients showed further reduction of TAC: 1.14-fold ( $p < 0.05$ ) comparing to baseline values and 1.53-fold comparing to healthy subjects ( $p < 0.05$ ). On days 10–15, patients in the control group showed increased TAC comparing to baseline data ( $p < 0.05$ ), however TAC remained reduced 1.18-fold comparing to the values of healthy subjects.

Dynamics of TAC in patients of the control group was observed along with the reduction of toxin-binding capacity of peripheral blood albumin. Meantime, the lowest values of toxin-binding capacity of albumin were observed on days 6–7, which were signifi-

**Table 1.**

Parameters of endogenous intoxication in patients of the control group (mean  $\pm$  SEM)

Parameters	Control group (n = 50)			Healthy subjects (n = 20)
	Study days			
	2–3	6–7	10–15	
TAC (g/l)	35.50 $\pm$ 3.22 <sup>a</sup>	31.03 $\pm$ 3.07 <sup>a</sup>	40.22 $\pm$ 2.15 <sup>a</sup>	47.50 $\pm$ 1.55
Toxin-binding capacity of albumin ( $\mu$ g/mg protein)	0.036 $\pm$ 0.004 <sup>a</sup>	0.031 $\pm$ 0.002 <sup>a</sup>	0.039 $\pm$ 0.005 <sup>a</sup>	0.09 $\pm$ 0.010
EGT (% of positive results)	68	59	48	0

<sup>a</sup> $p < 0.05$  vs healthy subjects.

cantly different from the values observed in healthy subjects ( $p < 0.05$ ) and in comparison with baseline values observed on days 2–3 ( $p < 0.05$ ). On days 10–15, patients in the control group showed only a tendency to increase toxin-binding capacity of albumin comparing to baseline values.

In our opinion, these results confirm that one of the main causes of development of severe endogenous intoxication in patients with ALD is significant inhibition of detoxification capacity of serum albumin with the underlying reduction of TAC. These trends

are associated with the process of accumulation of tissue destruction products in the peripheral blood and can be measured by the EGT. Analysis of the EGT results showed that the maximum number of positive results in patients of the control group (68%) was observed on days 2–3. Reduction of these values in patients of the control group was observed only on days 10–15 (48%).

In patients of the experimental group, 1.33-fold reduction of TAC values in peripheral blood comparing to healthy subjects was observed on days 2–3 ( $p < 0.05$ ) (Table 2).

**Table 2.**

Parameters of endogenous intoxication in patients of the experimental group (mean  $\pm$  SEM)

Parameters	Experimental group (n = 132)			Healthy subjects (n = 20)
	Study days			
	2–3	6–7	10–15	
TAC (g/l)	35.50 $\pm$ 3.05 <sup>a</sup>	31.00 $\pm$ 2.75 <sup>a</sup>	40.81 $\pm$ 2.85 <sup>a</sup>	47.50 $\pm$ 1.55
Toxin-binding capacity of albumin ( $\mu$ g/mg protein)	0.035 $\pm$ 0.007 <sup>a</sup>	0.036 $\pm$ 0.006 <sup>a</sup>	0.057 $\pm$ 0.007 <sup>a</sup>	0.09 $\pm$ 0.010
EGT (% of positive results)	67	55	40	0

<sup>a</sup> $p < 0.05$  vs healthy subjects.



On days 6–7, further reduction of TAC was observed comparing to baseline values. On days 10–15, patients of the experimental group showed increasing TAC comparing to baseline values (1.15-fold) ( $p < 0.05$ ), while TAC remained reduced comparing to the values observed in healthy subjects by 53.22% ( $p < 0.05$ ).

Reduction of toxin-binding capacity of albumin in patients of the experimental group was observed on days 2–3 comparing to the values observed in healthy subjects ( $p < 0.05$ ). This trend continued on days 6–7. Positive dynamics was observed on days 10–15: toxin-binding capacity of albumin increased comparing to baseline values 1.62-fold ( $p < 0.05$ ), but remained lower than values observed in healthy subjects by 57.9% ( $p < 0.05$ ).

Maximum number of positive results of the EGT in the experimental group was observed on days 2–3. On days 6–7, there was some decrease in the number of positive results of the EGT (55%), however maximum reduction in the number of positive results of the EGT was observed on days 10–15 (40%).

## CONCLUSIONS

Patients with ALD demonstrated significant decompensation of toxin-binding capacity of peripheral blood albumin. This process occurs along with the TAC decrease, which is associated with impaired biosynthetic processes in the liver and accumulation of tissue destruction' products in the blood serum.

Results of the study demonstrate effectiveness of enterosorption in restoration of normal functioning of natural detoxification systems in patients with ALD.

The use of intestinal adsorbent Enterosgel in the combination therapy of patients with ALD reduces the concentration of toxic products of tissue destruction, thereby maintaining detoxification capacity of albumin at optimal level even at low values of its concentration in the blood serum. This reduces the risk of severe endogenous intoxication and associated complications of the disease.

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## EXTENDED ABSTRACT

# Peculiarities of Eradication Therapy for Chronic *H. pylori*-associated Gastroduodenitis in Children Living in Ecologically Unfavorable Conditions

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**Keywords:** adsorbent, enterosorbent, eradication, gastroduodenitis, *Helicobacter pylori*

## INTRODUCTION

According to national and foreign authors the *Helicobacter pylori* (*H. pylori*) infection is the most common infection in the world which reaches pandemic scale [1–4]. The course of *H. pylori* infection may vary from asymptomatic infection to development of severe erosive and ulcerative lesions of the upper gastrointestinal (GI) tract [5, 6]. Humans become infected in early childhood and infection often manifests with symptoms of acute gastroenteritis [7].

The detection rate of *H. pylori* among children with recurrent abdominal pain syndrome ranges from 29 to 63.3% [8–10]. Long-term persistence of *H. pylori* in the gastric mucosa results in development of atrophic, apoptotic and metaplastic processes [11, 12]. International Agency for Research on Cancer (IARC) classified *H. pylori* as a Group 1 carcinogen. Therefore,

it is important to diagnose *H. pylori* infection at initial stages of pathological process and timely start adequate antibiotic therapy [13]. However, international *H. pylori* eradication regimens (Maastricht III) are not adapted for children [14–17]. Moreover, the use of the medications of the first- and second-line treatment may aggravate metabolic disorders and create an additional burden on detoxification organs in settings with the negative environmental influences and chronic intoxication with anthropogenic chemicals. It is known that many environmental toxicants possesses cumulative and immunopathological effects. Peculiarities of etiology and pathogenesis of chronic gastroduodenitis (CGD) associated with *H. pylori*, encourage finding new approaches to the selection of eradication therapy programme.

The purpose of the study was to evaluate the effectiveness of various regimens of triple therapy, including intestinal adsorbent



polymethylsiloxane polyhydrate (Enterosgel) for eradication of *H. pylori* in children with CGD, living in ecologically unfavorable areas.

## MATERIALS AND METHODS

46 children aged from 7 to 16 years with CGD associated with *H. pylori* were enrolled in the study. The diagnosis was confirmed with rapid urease test, urea breath test and histopathology of the gastric antrum mucosa. All patients were from large settlements with developed multidisciplinary industrial sector. Patients ( $n = 46$ ) were randomized into three groups depending on the choice of medication and its dosage.

Patients in the group 1 ( $n = 15$ ) received triple therapy for *H. pylori* eradication: lansoprazole (60 mg/day), clarithromycin (500 mg/day for children under 12 years of age and 1000 mg/day for children over 12 years) and nifuroxazide suspension (800 mg/day).

Patients in the group 2 ( $n = 16$ ) received triple therapy with the same medications as patients in the group 1. However, the dose of nifuroxazide was reduced to 400 mg/day.

Patients in the group 3 ( $n = 15$ ) received lansoprazole, clarithromycin and metronidazole in recommended doses according to age.

All patients received intestinal adsorbent (enterosorbent) Enterosgel: 1 tablespoon (15 g) once a day 1–2 hours before a meal together with triple eradication therapy. Enterosgel has the ability to bind in the GI tract toxic substances of different origin and pathogens and eliminate them from the body. Enterosgel also provides coating and cytoprotective effects.

Duration of the treatment course was 7 days. At the enrolment and on day 14 of the study, all patients underwent laboratory testing (blood chemistry, determination of toxicants concentration in the blood, determination of acetaldehyde and acetone concentrations in the gastric juice) and upper GI endoscopy. Therapeutic effectiveness was assessed by degree of *H. pylori* eradication that was verified by negative urea breath test 4–5 weeks after the end of treatment.

## RESULTS AND DISCUSSION

All patients with *H. pylori*-positive CGD showed increased level of toxic organic compounds (methanol, formaldehyde, etc.) and heavy metals (manganese, chromium, lead, nickel) in the blood, increased concentrations of acetaldehyde and acetone in the gastric juice. Histopathologic changes in the mucosa of the stomach and duodenum (polymorphocellular infiltration with predominance of macrophages and fibroblasts, lymphoid hyperplasia, sclerosis and collagenosis in the stroma) significantly dependent on the concentration of toxic substances in the blood ( $p < 0.05$ ).

On day 3 of the treatment, patients of the group 1 showed statistically significant positive dynamics of clinical symptoms: relief of pain and hyperacidity syndromes, normalization of stool. On day 14 of observation, all patients of the group 1 (100%) showed epithelialization of ulcer defects, erosive lesions, reduction of hyperemia and edema or swelling of mucosa. Upon completion of eradication therapy all laboratory parameters observed in children of the group 1 returned to normal, in contrast to

the group 2 and group 3. At the same time they showed a significant increase in the level of the secretory IgA in gastric contents ( $p < 0.001$ ), indicating restoration of protective functions of the gastric mucosa. In addition, patients from the group 1 showed decreased levels of manganese, nickel, chromium, lead and formaldehyde ( $p < 0.05$ – $0.01$ ). In the group 2 and group 3 on day 14 of observation were determined persistent clinical and endoscopic signs of CGD, increased level of malondialdehyde in gastric juice secretion and decreased IgA.

The *H. pylori* eradication rate in children of the group 1 was 87.5%, while in group 2 and group 3 eradication rates were achieved in 47.1% and 63.3% respectively.

## CONCLUSIONS

For patients living in areas of environmental concern with high risk of industrial toxicants accumulation in the body, it is advisable to carry out *H. pylori* eradication therapy with medications with least toxic and resorptive effect.

Use of nifuroxazide suspension in daily dose 800 mg in combination with intestinal adsorbent Enterosgel was more efficient and safer than use of therapeutic regimen with metronidazole.

According to international standards of efficient eradication therapy (87%) it is recommended to use 7-day triple therapy with lansoprazole (60 mg/day), clarithromycin (500 mg/day for children under 12 years of age and 1000 mg/day for children over 12 years) and nifuroxazide suspension (800 mg/day). Use of nitrofurans does not contradict to the modern international standards (Maastricht III-2005) [18].

In the territories of large settlements with developed multidisciplinary industry the eradication therapy should be carried out in combination with Enterosgel (1 tablespoon once a day 1–2 hours before meals, preferably before breakfast).

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## EXTENDED ABSTRACT

### Endogenous Intoxication in Inflammatory Bowel Disease in Children: Substantiation of Detoxification Therapy Using Enterosorption Method

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**Keywords:** adsorbent, Crohn's disease, endogenous intoxication, enterosorbent, enterosorption, inflammatory bowel disease, sorption detoxification, ulcerative colitis

#### INTRODUCTION

Diagnosis and treatment of inflammatory bowel disease (IBD) in children is a serious problem in modern gastroenterology due to the clinical forms of the disease that are severe and resistant to the conventional therapy, as well as high frequency of disability. In recent years, IBD in children is characterised by a very early onset of the disease, increased duration and severity of the inflammatory bowel lesions, and a much higher incidence of extraintestinal manifestations [1, 2].

Improving the effectiveness of modern treatment of IBD is impossible without taking into account of endogenous intoxication in disease pathogenesis and its correction. The appearance of endogenous intoxication in children with IBD is caused by systemic autoimmune inflammatory process, as well as increased intestinal per-

meability, degree of which depends on the extent, depth, and nature of intestinal lesions [3].

The damaging effect of endogenous toxins on cellular structures leads to even more severe immunological and metabolic imbalance that creates conditions maintaining the inflammatory process in intestinal mucosa. According to the majority of authors, low- and medium-molecular-weight substances (LMMWS) weighing up to 10,000 Da are universal markers of endogenous intoxication [4]. Clinical manifestations of endogenous intoxication in IBD are non-specific, varied, and include lethargy, anorexia, dyspepsia and trophic disorders.

The aim of this study was to investigate endogenous intoxication as one of the pathogenetic mechanisms of IBD in children, and substantiation of sorption detoxification using intestinal adsorbents (enterosorption method).

## MATERIALS AND METHODS

A total of 65 children aged from 5 to 17 years have been under clinical observation. Group 1 included 25 children with IBD, whereas group 2 (control group) consisted of 40 children with chronic constipation.

Degree of endogenous intoxication was assessed based on LMMWS concentration in erythrocytes, plasma, and urine by the method of M. Ya. Malakhova *et al.* (spectrogram of the supernatant in the wavelengths range of 238–298 nm) [5].

## RESULTS AND DISCUSSION

Endogenous intoxication was detected in all patients of group 1. Plasma LMMWS concentration was 1.5-fold higher in the patients with IBD than in the children with constipation. Measurement of urine LMMWS concentration allowed evaluating the detoxification capabilities of the body. In the children of group 1, the urine LMMWS concentration was significantly higher than that in the children of group 2. Simultaneous determination of oligopeptides (OP) giving a positive Lowry reaction allowed quantitatively evaluating the proteolytic activity in blood. Significant increase in OP levels was noted in the patients of group 1.

Coefficient of intoxication (CI) is an integral indicator of endogenous intoxication and is calculated using the following formula:

$$CI = LMMWS_{plasma} \times OP_{plasma} + LMMWS_{erythrocytes} \times OP_{erythrocytes}$$

CI was significantly much higher in children of group 1 ( $p = 0.05$ ). Predominant accumulation of LMMWS in plasma was

noted in patients with IBD due to the decrease in sorption capacity of erythrocytes ( $p = 0.05$ ).

Confirmation of endogenous intoxication in children with IBD serves as a basis for performing detoxification therapy in conjunction with standard therapy. The non-invasive method of sorption detoxification using intestinal adsorbents (enterosorption) is considered preferable. Therapeutic action of enterosorption is caused by the direct and mediated effects [6]. Direct effects are related to the physical and chemical mechanisms (adsorption, absorption, ion exchange and complex formation) taking place on the active surface of various porous systems while adsorbent passes through the intestinal lumen. Mediated effects are control and prevention of allergic inflammation and intoxication, reduction in the metabolic load on the organs of excretion and detoxification, correction of metabolic processes and immune status of sick child, restoration of integrity and permeability of the intestinal mucosa, improvement in the functional status of the intestine (reduction of flatulence, and improvement of microcirculation).

The data of comparative studies of modern intestinal adsorbents indicate that the medication of choice for children with IBD is Enterosgel (organosilicon adsorbent). Enterosgel effectively binds toxic substances of different origin without reducing the absorption of vitamins, microelements, and calcium. Thanks to its gel-like consistency, Enterosgel has exhibits obducing and cytoprotective effects, promoting the healing of ulcers and erosions. Enterosgel has a high level of safety; and it can be used for a long

period without causing colonic atony or flatulence. Enterosgel suspension is easily diluted with water; and it is prescribed orally 1–2 teaspoons 1–2 hours before or after a meal, 3 times a day (15–30 g/day) for children aged 1–5 years and 2–3 teaspoons 3 times a day (30–45 g/day) for children over 5 years of age. The duration of the treatment course is 2–3 weeks. There are no restrictions on the number of repeated courses.

## CONCLUSIONS

IBD in children is accompanied by the development of endogenous intoxication, manifestation of which is conditioned by the severity of the process and dependent on the nature of intestinal lesion.

Enterosorption is an effective and safe method of sorption detoxification in the combination treatment of IBD in children, since it reduces the toxic load on the detoxification system of the body and the risk of developing infectious and autoimmune complications.

Enterosgel is the adsorbent of choice since it has high effectiveness and safety in

young children, significant cytoprotective effect, convenient pharmaceutical form, and can be used in a long-term repeated course.

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## Use of Enterosorbent Enterosgel in Combination Treatment of Intestinal Dysbiosis in Children with Burn Disease

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**Keywords:** adsorbent, burn injury, intestinal dysbiosis, endogenous intoxication, enterosorbent, enterosorption, probiotic, sorption detoxification

### INTRODUCTION

According to modern concepts, the syndrome of endogenous intoxication plays an important role in the pathogenesis of burn disease. The main source of intoxication is a burn wound, however there are several publications demonstrating involvement of the bowel in formation of this syndrome. Application of the sorption detoxification using intestinal adsorbents (enterosorption method) is very important in reduction of endogenous intoxication and preparation of internal environment of the bowel for the use of probiotics [1]. Intestinal adsorbent (enterosorbent) Enterosgel binds pathogenic microorganisms and products of their metabolism/lysis in the intestinal lumen without depressing saprophytic microflora (the genus of *Lactobacillus*, *Bifidobacterium*, etc.) [2].

The aim of this study was to examine clinical effectiveness of intestinal adsorbent Enterosgel administration for reduction of endogenous intoxication in children with burn disease, as well as Enterosgel use in combination with *Lactobacillus acidophilus* (*L. acidophilus*) in treatment of intestinal dysbiosis in these patients.

### MATERIALS AND METHODS

In total the study involved 68 children aged from 1 to 7 years with burn injury and 20 healthy children. Patients were divided in 3 groups. Group 1 comprised patients who received standard therapy in combination with Enterosgel. Group 2 comprised patients who received standard therapy in combination with Enterosgel and probiotic *L. acidophilus*. Group 3 (control group) comprised patients who received only standard therapy. Enterosgel was administered orally starting on the second day after injury for

14 days in the following doses: children under 5 years 1–2 teaspoons (5–10 g) 3 times a day, children older than 5 years 2–3 teaspoons (10–15 g) 3 times a day.

All subjects of this study underwent testing for composition of intestinal microflora (inoculation of the stool samples), toxin-binding capacity of serum albumin, total cytolytic activity of autologous serum and functional activity of neutrophilic granulocytes and monocytes (nitro blue tetrazolium (NBT) test).

### RESULTS AND DISCUSSION

On days 3–4 after burn injury, all children showed a disproportion of intestinal microflora content with anaerobic bacterial overgrowth up to complete absence of *Lactobacillus* and *Bifidobacterium*. Increase in number of opportunistic microorganisms and occurrence of fermentation-deficient *E. coli* were observed in 88.2% patients. *Klebsiella*, *Enterobacter*, *Proteus vulgaris* and *Proteus mirabilis*, *Citrobacter*, *Staphylococcus aureus* and yeast-like fungi of the genus *Candida albicans* were detected in stool samples. These microorganisms showed growth as a monoculture and as in microbial associations.

In the group 2 (standard therapy + Enterosgel + *L. acidophilus*) the proportion of patients excreted lactobacilli was 40% on days 9–11 of treatment and 60% on days 19–21 of treatment. Excretion of associations of microorganisms was not observed, while proportion of patients, excreted opportunistic microorganisms, was only 40% (versus 82–85% in the control

group). Normalization of anaerobic resident microflora was observed on days 9–11 in patients of the group 2: the number of lactobacilli was within normal range in 80% of patients and the number of bifidobacteria was within normal range in 60% of patients. Meantime, there was no increase in fermentation-deficient *E. coli*.

Increase of toxin-binding capacity of albumin, decrease of cytolytic activity of autologous serum, decrease of toxins effects on the cells of phagocytic and immune systems were observed in groups 1 and group 2.

### CONCLUSIONS

On days 3–4, children with burn injury develop severe intestinal dysbiosis. Use of intestinal adsorbent Enterosgel in combination with probiotic *L. acidophilus* for treatment of children with burn disease resulted in 20–40% correction of resident anaerobic microflora and 40–60% correction of aerobic and facultative anaerobic microflora. At the same time the antagonism to a variety of intestinal pathogens and viruses was restored.

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## Enterosgel® in Gastroenterology: Posology and Method of Administration

**Enterosgel® (polymethylsiloxane polyhydrate) Oral Suspension** is an innovative intestinal adsorbent (enterosorbent), developed for binding toxins, harmful substances, pathogens and allergens in the gastrointestinal tract and their elimination from the body.<sup>1,2</sup>

Standard dosage and administration of Enterosgel® for the treatment of diseases of the digestive system					
Age group	Single dose	Frequency	Daily dose	Duration of treatment	Method of administration <sup>b</sup>
Adults and adolescents (≥ 14 years)	15 g (1 sachet or 1 tablespoon)	3 times a day	45 g	10–14 days	Oral administration at 1–2 hours before or after a meal  When Enterosgel® is taken it is recommended to wash down the single dose with sufficient quantity of water or dilute it in half a glass of water prior to administration  For children under 1 year the single dose is taken before feeding  For children under 1 year the single dose may be mixed with milk, infant formula, juice or a semi-liquid baby food (in the ratio 1:3) before administration
Children aged 5 to < 14 years	10–15 g (2–3 teaspoons)	3 times a day	30–45 g	No restrictions on repeat of courses of Enterosgel® application	
Children aged 1 to < 5 years	5–10 g (1–2 teaspoons)	3 times a day	15–30 g		
Children <sup>a</sup> < 1 year	1.7 g (1/3 teaspoon)	Up to 6 times a day	Up to 10 g		

<sup>a</sup> The safety and efficacy of Enterosgel® have been established for children, including infants.

<sup>b</sup> An adequate water intake is recommended over the course of Enterosgel® application, i.e. not less than 1.5–2 litres of liquids per day. For children aged < 6 years daily intake of liquids should not be less than 0.5 litres.

<sup>1</sup> The information contained herein is granted based on the Patient Information Leaflet (revised January 2013).

<sup>2</sup> Enterosgel® has been approved as a medicinal product (A07B: Intestinal adsorbents) in CIS and as a Class IIa medical device in the countries of EU.

## Dosage and Administration of Enterosgel® for the Treatment of Acute Diarrhea

Enterosgel® can be used as monotherapy (in mild diarrhea without clinical signs of invasive diarrhea) or combined with antimicrobial agents, oral rehydration therapy, probiotics and prebiotics.

Dosage and administration of Enterosgel® for the treatment of acute diarrhea				
Age group	Starting dose	Following dose	Frequency	Duration of treatment
Adults and adolescents (≥ 14 years)	30 g (2 sachets or 2 tablespoons)	15 g (1 sachet or 1 tablespoon)	After each subsequent loose stool	3–5 days  Once the diarrhea has stopped, it is recommended to continue Enterosgel® treatment for 5 days using the standard dosage and administration
Children aged 5 to < 14 years	20–30 g (4–6 teaspoons)	10–15 g (2–3 teaspoons)		
Children aged 1 to < 5 years	10–20 g (2–4 teaspoons)	5–10 g (1–2 teaspoons)		
Children < 1 year	3.4 g (2/3 teaspoon)	1.7 g (1/3 teaspoon)		



