



Article

Impact of physical factors on morphological features in patients with duodenal ulcer

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Abstract: The study was conducted on 57 patients with intestinal dysbacteriosis. Among them, there were 22 women and 27 men. The age of the patients ranged from 18 to 65 years. All patients were diagnosed with dysbacteriosis. Verification of peptic ulcer disease was established endoscopically, the presence of *Helicobacter pylori* by enzyme immunoassays, dysbiosis of the large intestine by microbiological research methods. Patients were divided into 3 groups: 23 patients who received therapy with sinusoidal modulated waves, 19 patients who received therapy with transcranial electrical stimulation, and 15 patients who received therapy with sinusoidal modulated waves to the area of the duodenal triangle and transcranial electrical stimulation. The control group consisted of patients (20 patients) who received standard eradication therapy according to the recommendations of the Maastricht V/Florence Consensus on the treatment of *Helicobacter* infection. The obtained data allow us to state that the inclusion of physical factors in the eradication therapy scheme leads to a more pronounced positive change in the cellular composition of the duodenal mucosa, which may indicate a decrease in the activity of inflammatory and immunoinflammatory processes. It has also been proven that therapy with sinusoidally modulated waves and transcranial electrical stimulation in combination significantly exceeds the similar direction of the effects of standard eradication therapy schemes in their morphological effectiveness. It can be assumed that more positive dynamics in relation to the elimination of *Helicobacter pylori* infection is associated with a decrease in the density of neutrophilic and plasmacytic infiltration at the edges of ulcerative defects of the duodenal bulb.

Keyword: *N. pylori*, duodenal ulcer, dysbiosis, physiotherapy.

Introduction

Morphological changes in the colon related to acid-dependent diseases, particularly colonic dysbiosis, have been widely studied [4,5,7]. However, most research relies on biopsy samples, which restrict the ability to fully assess the progression and extent of structural changes across all layers of the intestinal wall. This limitation makes it difficult to gain a comprehensive understanding of the development and dynamics of colonic pathology in such conditions.

Colonic dysbiosis, an imbalance in the gut microbiota, is frequently associated with various gastrointestinal disorders and has implications for intestinal health. Despite numerous studies exploring the impact of physical and therapeutic factors on the colon, the specific effects of *Ganoderma lucidum*, a fungus known for its medicinal properties, remain unexamined in this context.

Existing literature emphasizes that antibiotics used in eradication therapy exert direct cytotoxic effects, compromising the epithelial barrier's integrity, facilitating microflora translocation, and inducing inflammatory processes that can lead to erosions and ulcers [1,6,11]. These disturbances are accompanied by the activation of phagocytizing macrophages within the mucous membrane of the colon and other immune-related structures such as lymph nodes, the liver, and the spleen [10,13]. While there is documentation of morphological changes in the colon of patients with duodenal ulcers (DUs) and related dysbiosis, these studies predominantly describe alterations in the mucosal layer [3,9]. Consequently, information on the morphological changes in the deeper layers of the colon wall remains limited and fragmented.

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This study aims to address these knowledge gaps by examining the morphological changes in the mucous membrane at the edges of duodenal ulcers, particularly in relation to *Helicobacter pylori* infection, and by evaluating the impact of combined physical therapy treatments on these changes.

Materials and Methods

This study included 57 patients diagnosed with intestinal dysbiosis (ID) and duodenal ulcers (DUs)[4, 7]. The patient cohort comprised 22 women and 27 men, aged between 18 and 65 years. The patients were divided into three experimental groups and one control group:

- Group 1 (n=23): Received centimeter wave (CMW) therapy directed at the duodenal triangle area.
- Group 2 (n=19): Received transcranial electrical stimulation (TES) therapy.
- Group 3 (n=15): Received a combination of CMW therapy for the duodenal triangle area and TES therapy.
- Control Group (n=20): Underwent standard eradication therapy as recommended by the Maas-tricht V/Florence consensus (2017) for *Helicobacter pylori* infection. This regimen included:
 - Proton pump inhibitors (PPIs) administered twice daily for 14 days.
 - Two antibiotics administered twice daily for 14 days.
 - Bismuth tripotassium dicitrate (120 mg) taken four times daily.
 - A probiotic preparation administered at the recommended daily dose for 14 days.

Histological Analysis: Endoscopic examination and biopsy sampling were performed on 51 patients with duodenal ulcers to assess the histological structure of the mucous membrane at the ulcer edges. Histological samples were evaluated according to the modern classification of chronic gastritis by M. Dixon (2006) and the guidelines provided by L.I. Aruina (2008) and V.Yu. Golofeevsky (2004).

Microscopic Examination: Histological analysis focused on:

- The condition of the epithelial lining, including the height and structure of the villi and crypts, with emphasis on enterocytes and goblet cells.
- The presence of cellular dystrophy, atrophy, and foci of gastric metaplasia.
- Assessment of the Brunner glands.

Stromal Analysis: The stroma was evaluated for the severity of neutrophilic, eosinophilic, lymphocytic, and plasmacytic infiltration, both qualitatively and semi-quantitatively (analyzing 10 fields of view)[14]. These parameters are essential for understanding immune regulation, epithelial regeneration, and immune defense mechanisms, which contribute to the formation of acute and chronic inflammation.

Results:

The study examined morphological changes in patients with peptic ulcers localized in the duodenal bulb, revealing prominent dystrophy of villi enterocytes, a decrease in the number of goblet cells within both the villi and crypts, reduced villi height, and areas of gastric villus metaplasia.

A relationship between morphological changes and *Helicobacter pylori* infection was identified. Moderate to severe epithelial dystrophy was significantly more common in patients with *H. pylori* infection, present in 44.7% of cases. In patients without *H. pylori* infection, epithelial dystrophy was noted in only eight cases, with minimal severity. Despite these findings, the difference in the frequency of villous dystrophy and atrophy at the edges of duodenal bulb ulcers between the patient groups did not reach statistical significance.

These observations confirmed that dystrophy and atrophy of the duodenal bulb mucosa are typical morphological features of duodenal ulcers, particularly at their edges. However, no substantial link between these changes and *H. pylori* infection was evident. Gastric metaplasia in villi enterocytes was identified in 38 out of 59 patients. The incidence of *H. pylori* infection in patients with gastric metaplasia showed only a non-significant trend towards being higher compared to those without metaplasia. This suggests that gastric metaplasia may be a compensatory morphological response in the context of inflammation and dystrophy of the bulbar mucosa in patients with duodenal ulcers.

The assessment of the stroma of the mucous membrane at the ulcer edges and morphometric analysis provided further insight into inflammatory changes before and after treatment (Table 1, Table 2).

Table 1. Morphometric characteristics of the stroma of the mucous membrane of the edges of ulcers of the duodenal bulb before treatment

	1 group n=20	2 group n=23	3 group n=19	4 group n=15
Neutrophil infiltration	322±112	487±98	401±89	326±89
Lymphocytic infiltration	3697±115	2997±157	3025±412	2689±501
Plasma cell infiltration	3266±254	3122±239	2798±405	4123±304

Note: - < 0,05;

Table 2. Morphometric characteristics of the stroma of the mucous membrane of the edges ulcers of the duodenal bulb after treatment

	1 group n=20	2 group n=23	3 group n=19	4 group n=15
Neutrophil infiltration	212±62	177±53*	115±15**	110±18**
Lymphocytic infiltration	800±92**	904±69*	225±25**	189±92**
Plasma cell infiltration	2266±250	1922*237	1898±405	1723±214*

Note: * - < 0,05; ** - < 0,001.

The data indicated that eradication therapy, irrespective of the treatment regimen, resulted in significant improvements in morphometric parameters, reducing the inflammatory process in the ulcer edges. The most notable changes included a reduction in the density of neutrophilic and lymphocytic infiltration across all patient groups.

Specifically, the inclusion of physical therapies (CMW therapy and TES) led to more pronounced positive changes in the cellular composition of the duodenal mucosa. The density of neutrophilic infiltration significantly decreased from 401±89 and 326±89 to 115±15 and 110±18 in the 3rd and 4th groups, respectively ($p < 0.001$). Similarly, lymphocytic infiltration density decreased from 3025±412 and 2689±501 to 225±25 and 189±92 in the 3rd and 4th groups, respectively ($p < 0.001$). These findings indicate a marked reduction in the activity of inflammatory and immune-inflammatory processes. Furthermore, the inclusion of TES in the treatment regimen significantly reduced plasmacytic infiltration in the 4th group, from 4123±304 to 1723±214 ($p < 0.05$).

The reduction in the density of inflammatory infiltration was closely associated with improvements in microcirculation, such as the resolution of vasodilation, sludge formation, leukopedesis, and erythrocytopedesis, as well as reduced stromal edema. Notably, these changes were almost completely resolved in the 3rd and 4th groups during the control histological examination.

Conclusions

The study demonstrated that therapy regimens incorporating physical factors, specifically CMW therapy applied to the duodenal triangle and TES therapy, were more effective in promoting morphological recovery of the duodenal mucosa compared to standard eradication therapy alone. These combined treatment approaches resulted in significant reductions in neutrophilic, lymphocytic, and plasmacytic infiltration, indicating decreased inflammatory and immune-inflammatory activity. Additionally, improvements in microcirculation and reduced stromal edema were observed, supporting enhanced tissue repair and healing.

The findings suggest that the higher efficacy of regimens involving physical therapy may be linked to their potential role in more effectively supporting the immune response and facilitating

the elimination of *Helicobacter pylori* infection. This highlights the potential for incorporating CMW and TES therapies into standard treatment protocols for patients with duodenal ulcers and *H. pylori*-associated dysbiosis, offering a promising adjunct to conventional eradication therapy. Further research is recommended to explore the underlying mechanisms and long-term benefits of these physiotherapy-inclusive regimens.

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