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КЛИНИКО-ФУНКЦИОНАЛЬНАЯ ХАРАКТЕРИСТИКА ХРОНИЧЕСКОЙ ДУОДЕНАЛЬНОЙ НЕДОСТАТОЧНОСТИ

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The Clinical and Functional Characteristics of Chronic Duodenal Insufficiency

Резюме

Цель: изучение клинического течения и особенностей нарушений моторно-эвакуаторной функции желудочно-кишечного тракта при хронической дуоденальной недостаточности. **Материалы и методы.** В исследование включено 40 пациентов с хронической дуоденальной недостаточностью (ХДН): 18 (48,2%) женщин, 22 (51,8%) мужчин, средний возраст 37,1±13,8 лет. Группа контроля состояла из 30 здоровых лиц: 10 (33,3%) женщин, 20 (66,7%) мужчин, средний возраст 40,5±13,47 лет. В обследовании пациентов использованы анамнестические и физикальные данные, результаты биохимических, рентгенологических и эндоскопических исследований, внутриполостной манометрии, электрогастроэнтерографии. Оценивали параметры, отражающие психоэмоциональное состояние и вегетативный статус. **Результаты.** У 19 (46,8%) пациентов с ХДН болевой синдром возникал после приема пищи, наиболее часто локализуясь в правом подреберье у 11 (29,0%) и в эпигастральной области у 18 (44,9%) больных. Пациенты с ХДН предъявляли те или иные диспепсические жалобы, которых не наблюдалось в контрольной группе: 22 (57%) отмечали отрыжку горечью, 31 (77,6%) — чувство горечи во рту, 21 (53%) — изжогу, метеоризм — 25 (53,3%) и кашицеобразный стул — 28 (71%). У пациентов с ХДН по сравнению с контрольной группой наблюдались снижение содержания общего белка (62,24±0,17 и 72,3±0,21 г/л, p=0,0002), триглицеридов (0,42±0,0021 и 1,5±0,04 ммоль/л, p=0,022), жирорастворимых витамина B12 (188,0±0,21 и 328,6±18,9 пг/мл, p=0,0048), 25-OH витамина Д (26,87±0,12 и 64,7±1,25 нг/мл, p=0,018). При ХДН по сравнению с контролем выявлено существенное повышение гастрина (29,7 [25,7;32,5] и 19,2 [18,8;20,1] пмоль/л, p=0,0004) и кортизола (471,8±1,09 и 365,3±2,6 нмоль/л, p=0,0001). Уровень инсулина был существенно ниже показателей контрольной группы: (2,89 [2,5;3,0] и 3,8 [2,2;4,5] мкмоль/л, p=0,006). По данным гастроэнтероманитора в постпрандиальном периоде установлено нарушение пропульсивной моторики во всех отделах пищеварительной трубки, что доказывает снижение коэффициента ритмичности (K-ritm) двенадцатиперстной кишки, тощей и подвздошной кишки натощак в 1,5 раза в обе фазы исследования (p=0,000). Коэффициент отношения интрадуоденального давления к интрагастральному при ХДН составил 1,26 [1,19;1,32], что значительно ниже значений в контрольной группе (1,7 [1,0;2,4], p=0,00037) и свидетельствует о нарушении замыкательной функции привратника. Шкала тревоги Ч.Д. Спилбергера (адаптация Ю.Л. Ханина) показала повышение по сравнению с контрольной группой уровней ситуативной (57 [54;60] и 47,0 [45;50] баллов, p=0,0021) и личностной тревожности (25,1 [22,6;27,4] и 21,9 [19,5;23,9] баллов, p=0,003) у пациентов с ХДН. **Заключение.** В связи с неманифестированным течением и отсутствием специфических симптомов хронической дуоденальной недостаточности, в обследовании пациентов для постановки диагноза необходимо использовать помимо клинических данных, рентгенологические, эндоскопические, манометрические и электрофизиологические исследования.

Ключевые слова: *хроническая дуоденальная недостаточность, дуоденогастральный рефлюкс, электрическая активность желудка, электрическая активность двенадцатиперстной кишки, электрическая активность тонкой кишки, замыкательная функция привратника*

Конфликт интересов

Авторы заявляют, что данная работа, её тема, предмет и содержание не затрагивают конкурирующих интересов

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Abstract

Purpose: to study the clinical course and features of violations of the motor-evacuation function of the gastrointestinal tract in chronic duodenal insufficiency. **Materials and methods**. The study included 40 patients with chronic duodenal insufficiency (CDI): 18 (48.2%) women, 22 (51.8%) men, mean age 37.1 ± 13.8 years. The control group consisted of 30 healthy individuals: 10 (33.3%) women, 20 (66.7%) men, mean age 40.5 ± 13.47 years. In the examination of patients, anamnestic and physical data, the results of biochemical, X-ray and endoscopic studies, intracavitary manometry, and electrogastroenterography were used. Parameters reflecting psycho-emotional state and vegetative status were evaluated. Results. In 19 (46.8%) patients with CDI, the pain syndrome occurred after eating, most often localized in the right hypochondrium in 11 (29.0%) and in the epigastric region in 18 (44.9%) patients. Patients with CDF presented some dyspeptic complaints that were not observed in the control group: 22 (57%) noted belching with bitterness, 31 (77.6%) — a feeling of bitterness in the mouth, 21 (53%) — heartburn, flatulence — 25 (53.3%) and mushy stools — 28 (71%). In patients with CDI, compared with the control group, there was a decrease in the content of total protein (62.24 ± 0.17 and 72.3 ± 0.21 g / l, p = 0.0002), triglycerides (0.42 ± 0.0021 and 1.5 ± 0.04 mmol / L, p = 0.022), fat-soluble vitamin B12 (188.0 ± 0.21 and 328.6 ± 18.9 pg / ml, p = 0.0048), 25-OH vitamin D (26.87 ± 0.12 and 64.7 ± 1.25 ng / ml, p = 0.018). With CDI, compared with control, a significant increase in gastrin (29.7 [25.7; 32.5] and 19.2 [18.8; 20.1] pmol / L, p = 0.0004) and cortisol (471, 8 ± 1.09 and 365.3 ± 2.6 nmol / L, p = 0.0001). The insulin level was significantly lower than the values of the control group: (2.89 [2.5; 3.0] and 3.8 [2.2; 4.5] μmol / L, p = 0.006). According to the gastroenteromanitor in the postprandial period, impaired propulsive motility in all parts of the digestive tube was established, which proves a decrease in the rhythm coefficient (K-ritm) of the duodenum, jejunum and ileum on an empty stomach by 1.5 times in both phases of the study (p = 0.000). The ratio of intraduodenal pressure to intragastric pressure in chronic heart failure was 1.26 [1.19; 1.32], which is significantly lower than the values in the control group (1.7 [1.0; 2.4], p = 0.0004) and indicates a violation of the closure function of the gatekeeper. Alarm scale RH. Spielberger (adaptation of Yu.L. Khanin) showed an increase in comparison with the control group in the levels of situational (57 [54; 60] and 47.0 [45; 50] points, p = 0.0021) and personal anxiety (25.1 [22.6; 27.4] and 21.9 [19.5; 23.9] points, p = 0.003) in patients with CDI. **Conclusion**. In connection with the non-manifest course and the absence of specific symptoms of chronic duodenal insufficiency, in the examination of patients for the diagnosis, it is necessary to use, in addition to clinical data, X-ray, endoscopic, manometric and electrophysiological studies.

Key words: *chronic duodenal insufficiency, duodenogastric reflux, electrical activity of the stomach, electrical activity of the duodenum, electrical activity of the small intestine, pyloric closure function*

Conflict of interests

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ANS — autonomic nervous system, CAR — coefficient of adaptation reserves, CDI — chronic duodenal insufficiency, CRG — cardiac rhythmography, DD — duodenum, GIM — gastrointestinal monitor, GIT — gastrointestinal tract, PA — personal anxiety, SA — situational anxiety, TI — tension index

The duodenum is located at the critical crossing between the stomach and small intestines, liver and pancreas, which determines its importance in the synchronization of digestive organs. Despite the long history of studying duodenal diseases, the problem remains relevant in modern gastroenterology. The significance of disorders in this segment of the gastrointestinal tract (GIT) is also determined by the absence of a decrease in the incidence of gastric, biliary and pancreatic diseases over the past decade, which is also due to duodenal diseases [1].

Clinical observations show that patients with a duodenal disorder develop a complex set of symptoms, including morphological inflammatory changes in the duodenal mucosa (duodenitis), impaired gastrointestinal motor function and duodenal hormonal insufficiency. In most cases, duodenal diseases are chronic and lead to chronic duodenal insufficiency (CDI).

Considering the range of problems, in 2018, we proposed the term «chronic duodenal insufficiency», which is rarely used in modern clinical practice [2]. Firstly, this is due to limited diagnostic approaches in clinical settings that allow to study the functional state of the duodenum. Secondly, CDI course is often subclinical due to comorbidities of GIT organs. Thirdly, general symptoms in patients with CDI often prevail over local symptoms due to impaired hormone-producing function of the duodenum [3].

The **objective of this work** is to study the clinical course and features of motor-evacuation disorders of the gastrointestinal tract in cases of CDI.

Materials and methods

This study included 40 patients diagnosed with chronic duodenal insufficiency (CDI): 18 (48.2%) women, 22 (51.8%) men, mean age 37.1 ± 13.8 years. The control group included 30 healthy individuals: 10 (33.3%) women, 20 (66.7%) men, mean age 40.5 ± 13.47 years. Comparability in the two groups was determined by age ($p = 0.104$) and by gender ($\chi^2 = 2.59$, $p = 0.114$). This was an open-label cohort study. Inclusion criteria: signs of CDI according to fibrogastroduodenoscopy (FGD) results and voluntary informed consent of patients to participate in this study. Exclusion criteria: diabetes mellitus, age under 18 and over 65, thyroid diseases, pregnancy and lactation, cancer and autoimmune diseases, chronic viral hepatitis, liver cirrhosis. This study was performed in two stages.

For CDI determination, medical history data and physical findings, results of X-ray and endoscopic examinations, intracavitary manometry were used [4]. Endoscopic criteria for CDI [5]: bile in stomach in fasting state, persistent duodenogastric reflux, dilated duodenum, pyloric sphincter incompetence, yellow-green color of mucous lake, yellowish gastric mucus, congestion of gastric contents, large amount of bile in the duodenum, antral gastritis, reflux esophagitis, erythematous gastropathy, and hyperplasia of gastric folds.

Total serum protein was analyzed using the biuret method with the "Total Protein Agat" reagent kit (manufactured by Agat-Med LLC, Russia). Vitamin B12 concentration was determined by enzyme-linked immunosorbent assay in blood serum using the «Ridascreen@Fast Vitamin B12» reagent kit (manufactured by Stylab Company LLC, Russia). Serum alpha-amylase activity was determined using the amyloclastic method (according to Karavey) using the «Alpha-Amylase Agat» reagent kit (manufactured by Agat-Med LLC, Russia). Serum transferrin level was analyzed by enzyme immunoassay using the «ADVIA Chemistry Transferrin Reagents» reagent kit (manufactured by Siemens Healthcare Diagnostics, Germany). The level of triglycerides in blood serum was analyzed by enzyme immunoassay using the «Triglycerides — UTS» reagent kit (manufactured by Ailiton LLC, Russia). The determination of 25-OH vitamin D was carried out by enzyme immunoassay using the "25-OH Vitamin D" kit (manufactured by Techsystems CJSC, Russia) [6].

Gastrin, insulin, and cortisol levels in peripheral blood were determined by electrochemiluminescence-based analysis. To determine cortisol level, we used a reagent-kit manufactured by Vector-BEST (Russia), reference number — X-3964, range of measured values declared by the manufacturer — 0–1200 nmol/l; for insulin — a reagent kit manufactured by DRG Instruments GmbH (Germany), reference number EIA2935, range of measured values declared by the manufacturer — 0.75–300 μmol/l; for gastrin — a reagent kit manufactured by Biohit (Finland), reference number 601035, range of measured values declared by the manufacturer — 0–52.3 pmol/l [7].

A histological examination of a biopsy specimen obtained during fibrogastroduodenoscopy (FGD) from the gastroduodenal zone was performed.

To determine the closing function of the pylorus, the ratio of intraduodenal to intragastric pressure was used, which was studied using the open-tip catheter manometry technique with Waldman's device [8].

The GEM-01 Gastroskan-GEM (Istok-Sistema, Fryazino) gastrointestinal monitor was used to assess the motor function of the gastrointestinal tract (GIT). The following parameters were evaluated: Pi, Pi/Ps(%), Pi/P(i+1), and C rhythm, where Pi is the electrical activity of each GIT organ; Pi/Ps is the percentage of the ratio of the frequency spectrum to the total spectrum; Pi/P(i+1) is the ratio of the electrical activity of the upper organ to the lower organ; and C rhythm is rhythm coefficient, which is the ratio of the length of the spectral envelope of the examined part to the width of its spectral section. These studied parameters were determined in fasting state and in postprandial period [9].

The Eysenck Personality Questionnaire (EPQ) was used to assess the type of personality. A score of up to 10 points indicates introversion, from 15 to 24 points — extroversion, from 11 to 14 points — ambiversion [10]. High average values (more than 16 points) on the neuroticism scale indicate high emotional instability. Personal (PA) and situational anxiety (SA) were determined using the Spielberger State-Trait Anxiety Inventory (adapted by Yu. L. Khanin). SA is an indicator of the intensity of feelings that arise in response to the current situation, PA is a person's tendency to perceive a wide range of situations as threatening. Interpretation of results: up to 30 points is a low level of anxiety, 31–44 points — moderate, 45 or more — high.

Heart rate variability analysis with the Varicard 2.51 (Yupacom Company, Russia) device was performed to study the functioning of the autonomic nervous system (ANS). The following parameters were used: Mo (mode) is the most common duration of R-R intervals; AMo (mode amplitude) is the number of cardio intervals that fall within the mode range as a percentage; ΔX of the variational range is the maximum amplitude of fluctuations in the values of cardiac intervals; TI (tension index) reflects the degree of heart rhythm control centralization. Vegetative reactivity (VR) is a reaction of the ANS to external and internal stimuli, which was determined

by the following formula: TI2/TI1, where TI1 is clinostatic position, TI2 is orthostatic position, first episode (minute 1) [11].

In cases of normal vegetative reactivity, the TI2/TI1 value is in the range from 0.7 to 1.5; with hypersympathicotonic — more than 0.5; with asympaticotonic — less than 0.7 [11]. The coefficient of adaptation reserves (CAR) was calculated using the TI3/TI2 formula, where TI3 is the orthostatic position from minute 5. Normal CAR is in the range from 0.33 to 3; insufficient — with CAR under 0.33; excessive — with CAR over 3 [12].

Statistical processing of the obtained data was carried out using Excel® 2016, IBM SPSS v. 17.0. The Kolmogorov-Smirnov test was used to check whether sign distribution was within normal. When deviating from the normal distribution, quantitative signs were expressed as the median and interquartile range (25th percentile — 75th percentile) — Me [IQR]]; when corresponding to the law of normal distribution — as the mean value with standard deviation (M ± σ). The following was used to assess intergroup difference depending on the nature of distribution: Mann-Whitney test (U), Student's t-test, Pearson's chi-square test (χ^2) to compare qualitative parameters. Differences were considered statistically significant at $p < 0.05$.

Patients were examined on the basis of voluntary informed consent, in accordance with order No. 390n of the Ministry of Health and Social Development of the Russian Federation of April 23, 2012, in compliance with ethical principles (resolution of the Ethics Committee of 25 June 25, 2013).

Results

The study of the social status of patients with CDI revealed that 30 (75.8%) of the examined individuals were employees with computer-related work, and only 10 (26.1%) of the patients were workers with an active lifestyle. 30 (75.8%) patients with CDI associated their state of health with negative emotional stress.

Concomitant pancreatitis was diagnosed in 30 (75.8%) patients with CDI, chronic acalculous cholecystitis — in 27 (66.8%), postcholecystectomy syndrome — in 25 (63.6%), gastroesophageal reflux disease — in 32 (80.2%).

Nineteen (46.8%) patients with CDI experienced pain after eating, most often localized in the right upper quadrant — in 11 (29.0%) patients, and in the epigastrium — in 18 (44.9%) patients. The painless variant was detected in 5 (12.3%) patients with CDI. Most patients had "aching" pain (32 (80%)).

Patients with CDI had certain complaints of dyspepsia that were not observed in the control group (Table 1): 22 (57%) of them had bitter eructation, 31 (77.6%) — bitter taste in the mouth, 21 (53%) — heartburn, 25 (53.3%) — flatulence, and 28 (71%) — loose stool. Asthenic syndrome was found in 25 (63.3%) patients of the study group ($\chi^2 = 54.8$, $p = 0.00037$), and was manifested by general weakness, irritability, apathy, insomnia.

General examination revealed dry skin with reduced turgor and elasticity in patients with CDI; 30 (74.3%) patients showed signs of roseola rash on the face, 17 (43.7%) — elements of pustular rash, 7 — (17.9%) signs of telangiectasias. On examination, the tongue was covered with white-yellowish fur in 31 (78.9%) patients, with herds of epithelial desquamation — in 7 (18.6%) patients. Most patients (34; 86.1%) had an asthenic body type with a lower body mass index compared with the control group (16.7 ± 0.27 and 24.3 ± 0.42 kg/m^2, $p = 0.025$).

Compared with the control group, patients with CDI showed a lower total protein level (62.24 ± 0.17 and 72.3 ± 0.21 g/l, $p = 0.00021$), which was probably associated with impaired absorption of protein in the duodenum. There was also a decrease in the level of triglycerides (0.42 ± 0.0021 and 1.5 ± 0.04 mmol/l, $p = 0.022$) and increase in amylase level (205.7 ± 12.9 and 126.9 ± 11.3 mmol/l, $p < 0.01$ mmol/l) compared with the control group (126.9 ± 11.3 mmol/l, $p = 0.00018$).

Table 1. *Characteristics of pain and dyspeptic syndromes in patients with CDI*

Parameter	n (%)	χ^2	p
Painless option	5(12,3%)	60,8	0,0022
Pain in the right hypochondrium	11 (29,05)	38,4	0,0017
Pain in the epigastric region	18 (44,9%)	36,3	0,025
Aching nature of pain	32(80%)	18,1	0,0039
Belching bitter	22 (57%)	51,8	0,0013
Feeling bitter in the mouth	31 (77,6%)	66,53	0,00217
Heartburn	21 (53%)	20,2	0,000122
Flatulence	25 (53,3%)	53,3	0,0014
Mushy stool	28 (71%)	60,2	0,0018

Note: CDI — chronic duodenal insufficiency, p — reliability, n — number of patients

A decrease in the levels of fat-soluble vitamin B12 (188.0 ± 0.21 and 328.6 ± 18.9 pg/ml, p = 0.0048) and 25-OH vitamin D (26.87 ± 0.12 and 64.7 ± 1.25 ng/ml, p = 0.018) also indicates duodenal malabsorption in patients with CDI compared with the control group.

The study of iron metabolism revealed a decrease in the transferrin saturation coefficient in patients with CDI compared with the control group (13.2 ± 0.12% and 34.7 ± 0.18%, p = 0.04).

A significant increase in the levels of gastrin (29.7 [25.7; 32.5] and 19.2 [18.8; 20.1] pmol/l, p = 0.0004) and cortisol (471.8 ± 1.09 and 365.3 ± 2.6 nmol/l, p = 0.000147) was also detected in patients with CDI compared with the control group. Insulin level was significantly lower than in the control group: (2.89 [2.5; 3.0] and 3.8 [2.2; 4.5] μmol/l, p = 0.006).

Besides signs of CDI, FGD revealed the following changes in patients: erythematic gastropathy in 37 (93.3%) patients, reflux esophagitis in 27 (66.6%) patients, atrophic gastritis in 17 (42.0%) patients, erosive and ulcerative lesions of the mucosa in 21 (53.3%) patients. According to the histological analysis of the biopsy specimen, patients with CDI developed atrophy in 16 (42.0%) cases, and intestinal metaplasia in 2 (5.6%) cases. All patients had morphological changes of the duodenal mucosa: lymphocytic infiltration, chronic inflammation; 28 (70%) patients had atrophy.

Intracavitary manometry in patients with CDI compared with the control group showed a significant increase in intragastric (119 [114; 126] and 70 [57; 74.8] mm Aq, p = 0.00012) and intraduodenal pressure (168 [165; 172] and 116 [111.9; 124] mm Aq, p = 0.000029). The ratio of intraduodenal to intragastric pressure in patients with CDI was 1.26 [1.19; 1.32], which was significantly lower than in the control group (1.7 [1.0; 2.4], p = 0.00037).

Table 2 presents changes in the myoelectric activity of GIT organs in patients with CDI. The significant increase in gastric Pi/Ps in the postprandial period (46.5 ± 5.8%) was probably due to compensatory hypertrophy of gastric smooth muscles in this group of patients. The increase in the ratio Pi/Pi+1 stomach/duodenum (17.43 ± 2.46) in patients with CDI was caused by the difficult passage of food through the duodenum. An inadequate response of the duodenum to food stimulation, represented by a decrease in the electrical activity of the duodenum (1.7 ± 0.07%), was observed. Normal values of the gastric rhythm coefficient (4.7 ± 2.42) before food stimulation decreased postprandially (3.9 ± 0.11). The low ratio of gastric rhythm was combined with the decrease in this parameter in the duodenum (0.72 ± 0.12 in fasting state; 0.3 ± 0.01 postprandially). There was no similar relationship with the rhythm coefficient in the jejunum.

The range of frequencies typical for the jejunum, ileum and colon revealed no differences in «Pi/Pi+1» and «Pi/Ps» parameters in fasting state between the group of patients with CDI and the control group. However, C rhythm in these parts of the intestine was significantly

Table 2. *Indicators of electrical activity of the gastrointestinal tract in patients with CDI according to (M ± σ)*

Indicators	Zone	Fasting		P	After meal		P
		Patients with CDI (n=40) (M±σ)	Control group (n=30) (M±σ)		Patients with CDI (n=40) (M±σ)	Control group (n=30) (M±σ)	
Pi/Ps (%)	Stomach	13,6 ±0,58	23,6±9,5	**0,000**	46,5±5,8	24,1±1,8	**0,000**
	Duodenum	4,4 ±1,02	2,1±0,68	**0,000**	1,7 ±0,07	2,18±0,17	**0,000**
	Jejunum	3,22±0,12	3,35±0,18	0,958	5,46±0,12	5,1±0,9	0,862
	Ileum	6,54±0,22	8,08±0,15	0,890	17,62±0,42	12,1±1,4	**0,015**
	Colon	69,01±4,14	64,04±3,16	0,622	39,62±2,45	76,2±8,2	**0,000**
Pi/P (i+1)	Relationship Stomach/ Duodenum	6,7 ±0,38	10,4±5,7	**0,000**	17,43 ±2,46	10,2±4,2	**0,000**
	Relationship Duodenum/ Jejunum	0,45±0,01	0,60±0,02	**0,000**	0,40±0,02	0,5±0,06	**0,000**
	Relationship Jejunum/ Ileum	0,46±0,04	0,40±0,01	0,425	0,36±0,08	0,32±0,12	0,874
	Ileum/ Colon	0,109±0,08	0,13±0,04	0,398	0,57±0,09	0,22±0,05	**0,000**
K ritm	tomach	4,7 ±2,42	4,85±2,1	0,883	3,9 ±0,11	4,71±0,18	**0,001**
	Duodenum	0,72 ±0,12	0,9±0,5	**0,013**	0,3±0,01	0,87±0,05	**0,000**
	Тощая Jejunum	2,26±0,51	3,43±0,18	**0,03**	1,519±021	3,26±0,11	**0,003**
	Ileum	3,077±1,39	4,99±0,29	**0,021**	2,44±0,08	5,11±0,21	**0,017**
	Colon	28,03±3,37	22,85±4,17	**0,004**	6,33±1,25	25,18±5,18	**0,000**

Note: signs obey the law of normal distribution (according to the Kolmogorov-Smirnov criterion), presented as M — arithmetic mean, σ — standard deviation), p — the significance of the reliability of differences between the observation group and control groups of patients (according to Student's t-test), n- number of patients.
Duodenal ulcer — duodenum, CDI — chronic duodenal insufficiency. Pi is the electrical activity of each organ of the gastrointestinal tract, Pi / Ps is the ratio of the frequency and total spectrum in percent, Pi / Pi + 1 is the ratio of the electrical activity of the overlying organ to the underlying one, K ritm is the rhythm coefficient, which is the ratio of the length of the envelope of the spectrum of the examined section to the width of the spectral section of this section

different in patients with CDI compared with the control group, which indicates impaired motor and evacuation function of the small intestine and colon in patients with CDI in fasting state. In the postprandial period, there was also impaired propulsive motility in all parts of the gastrointestinal tube, indicating a 1.5-fold decrease in the rhythm coefficient of the duodenum, jejunum and ileum in fasting state in both stages of this study (p = 0.000).

Analysis of the general diagram of the study of the myoelectric activity in the stomach, large intestine and small intestine in three-dimensional mode in patients with CDI showed an increase in signal strength from the stomach in the postprandial period and a decrease in signal strength from the duodenum and colon in comparison with fasting state.

Analysis of psychoemotional disorders revealed a higher level of situational (57 [54; 60] and 47.0 [45; 50] points, p = 0.0021) and personal anxiety (25.1 [22.6; 27.4] and 21.9 [19.5; 23.9] points, p = 0.003) in patients with CDI compared with the control group. Values on the «extraversion-introversion» scale in patients with concomitant CDI were below the control level (8.92 ± 0.29 points), suggesting their introversion tendency.

The study of ANS functioning (Table 3) based on the results of cardiac rhythmography (CRH) in patients with CDI compared with the control group revealed the predominance of the sympathetic division of ANS: Mode amplitude was 94.0% [92.5; 97.5] and 48.3% [45.5; 49.9], respectively, p = 0.00013; variational range (ΔX) was 0.03 [0.018; 0.043] and 0.24 [0.2; 0.3] respectively, p = 0.00022; and TI1 was 1110.4 [1077.5; 1129.3] conventional units and 115.0 [110.0; 121.0] respectively, p = 0.00019. Patients with CDI demonstrated an asympathicotonic

Table 3. *The functioning of the ANS in patients with HTN (Me [IQR])*

Parameters	Patients with CDI (n=40)	Control group (n=30)	p
AMo, %	94,0 [92,5;97,5]	48,3 [45,5;49,9]	0,00013
ΔX (c./s.)	0,03 [0,018;0,043]	0,24 [0,2;0,3]	0,00022
IN1 (con.unit)	1110,4 [1077,5;1129,3]	115,0 [110,0;121,0]	0,00019
IN2 (con. unit)	421,3 [396,5;459,2]	81,1 [80,9;81,2]	0,00054
IN3 (con. unit)	121,7 [107,23;131,4]	61,2 [61,1;61,4]	0,00059
IN2/IN1	0,58 [0,53;0,65]	1,1 [1,05;1,17]	0,024
IN3/IN2	IN3/IN2=0,34[0,2;0,5]	1,32[1,31;1,33]	0,0016

Note: traits do not obey the law of normal distribution (according to the Kolmogorov-Smirnov criterion), presented as Me-median and interquartile range (25th percentile — 75th percentile) — [IQR]., P — significance of differences between the observation group and the control group of patients (according to the Kruskal-Wallis criterion, n is the number of patients, duodenal ulcer, duodenal ulcer, chronic duodenal insufficiency, chronic duodenal insufficiency. range — the maximum amplitude of fluctuations in the values of cardiointervals, IN — stress index, IN2 / IN1 — an indicator of autonomic reactivity, IN1 — wedge position, IN2 — orthoposition the first episode (1st minute), IN3 / IN2- CRA- adaptation reserve coefficient, IN 3- Orthopositional second episode (5th minute)

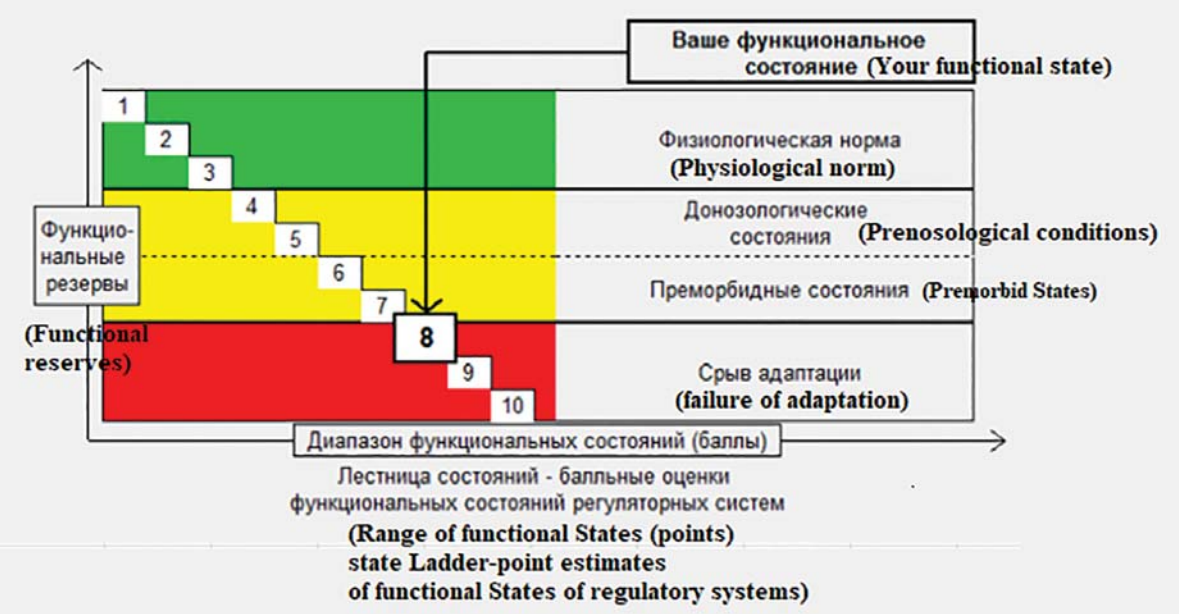

Figure 1. *Scoring of functional states of VNS in CDI*

type of autonomic reactivity in comparison with the control group (TI2/TI1 = 0.58 [0.53; 0.65] and 1.1 [1.05; 1.17] respectively, p = 0.024) and insufficient CAR (TI3/TI2 = 0.34 [0.2; 0.5] and 1.32 [1.31; 1.33] respectively, p = 0.0016). The obtained CRH data in Fig. 1 are presented in the form of a ladder of states and indicate that most patients with CDI (33 (83.5%)) are on the verge of ANS adaptation failure.

Direct correlation analysis demonstrated a moderate direct relationship (r = 0.447, p = 0.007) between Pi/Pi+1 (S/DD) and mode amplitude in patients with CDI, which indicates the regulatory effect of ANS on gastroduodenal motility.

Discussion

Epigastric pain in patients with CDI can be explained by concomitant gastrostasis caused by impaired gastric motor function. Through gastrography, gastric pain was previously attributed to a specific convulsive state of the stomach, characterized by a sharp increase in its tone, with frequent and rapid cramps (clonicotonus) at its peak [13]. This was confirmed during this study. Gastric and duodenal hypertension was observed based on the results of studying electrical activity in fasting state. In the postprandial period, impaired propulsive motility was observed in all parts of the gastrointestinal tract, contributing to pain [14]. The origin of numerous dyspeptic symptoms can be explained not only by the impaired functional state of the duodenum but also by comorbidities of the digestive system.

The secondary lesion of the celiac plexus caused by overexcitation of the sympathetic and parasympathetic divisions of the autonomic nervous system has a certain significance in the development of pain syndrome and its severity in patients with CDI [15].

Most patients have asthenia manifested by increased fatigue, irritability, apathy, sleep disturbance, in the occurrence of which the stagnation of duodenal contents is crucial [16]. The development of generalized symptoms can be interpreted as impaired absorption of vitamins, trace elements and proteins in the duodenum, which was also established in our study.

Many abnormal signs during the experiment after the removal of the duodenum are caused by the loss of the effect of duodenal hormones (gastrin, secretin, cholecystokinin, etc.) [17]. Also, disorders of the intestinal hormonal system have an effect not only within the gastrointestinal tract but also non-digestive (trophic) effect by interacting with pituitary and endocrine hormones[18]. In our study, the increase in gastrin level in patients with CDI was probably associated with the irritating effect of DGR on G cells in the antrum. Cortisol level can change as a result of any stressful effect, impaired body adaptation observed in patients with CDI in the form of increased anxiety level. The decrease in insulin level in patients with CDI compared with the control group may be due to the decrease in n. vagus tone, and the impaired production of the "insular hormone" that induces insulin production [19].

Conclusion

A specific feature of the clinical course of chronic duodenal insufficiency is the predominance of dyspeptic complaints over pain syndrome. The motor and evacuation function of the stomach, duodenum and small intestine is simultaneously impaired during periods of fasting and active digestion. It was found that neurohormonal factors, including the autonomic nervous system, psychoemotional state, and gastrointestinal hormones, are of great importance in regard to the impaired functional state of the duodenum. Due to the silent course and absence of specific symptoms of chronic duodenal insufficiency, X-ray, endoscopic, manometric and electrophysiological studies should be used, in addition to clinical data, in the examination of patients for diagnosis.

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