

Serotonin blood level study, anxiety-depressive states indicators and patients life quality after laparoscopic treatment of gastroesophageal reflux disease

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Nowadays effective treatment of gastroesophageal reflux disease (GERD) remains a difficult and still unsolved problem. The use of various antisecretory drugs in combination with surgical treatment does not allow to achieve a long lasting improvement of the quality of life and reliable prevention of complications. In this regard, special attention is paid to study humoral factors influencing the pathogenesis of GERD, data on which will improve the results of therapeutic and surgical treatment. It is promising to study the dynamics of serotonin after laparoscopic treatment of various types of GERD, especially in combination with dyspepsia, anxiety or depressive disorders, as well as the possibility of using drugs that affect the metabolism of this hormone to correct the above mentioned disorders and achieve long lasting recovery after laparoscopic fundoplication.

The aim of the work was to study the dynamics of serotonin in the blood during laparoscopic total fundoplication and analyze the correlation of this hormone with the psychological well-being of patients before and after surgical treatment of GERD.

Materials and methods. Laparoscopic fundoplication by Short Floppy Nissen modification was performed in 35 patients with GERD. There were 26 (74.3 %) women, 9 (25.7 %) men. Age – 55.3 ± 11.3 . The comparison group consisted of 20 healthy volunteers (women – 14 (70.0 %); men – 6 (30.0 %), average age – 56.7 ± 10.6), who did not undergo surgery. The groups were comparable by gender and age. The studies were carried out in venous blood plasma, samples of which were maintained using standard methods and stored in a low-temperature freezer at a temperature of -80°C . Tests for serotonin (Serotonin ELISA, RE59121, IBL) were studied on the immunoenzyme complex ImmunoChem-2100 (USA) of the Department of Clinical Laboratory Diagnostics in the Zaporizhzhia State Medical and Pharmaceutical University. The concentration of the last indicators was expressed in ng/ml. The presence of concomitant anxiety, depression and level of psychological well-being was assessed using the GAD-7, PHQ-9 and SF-36 questionnaires. Statistical assessment of the research results was carried out using the Statistica for Windows 13 software package (StatSoft Inc., No. JPZ8041382130ARCN10-J). Differences were considered statistically significant at $p < 0.05$.

Results. The serotonin level in the blood of practically healthy people was 5.8 ± 1.5 ng/ml. In the main group serotonin values before surgical treatment were 3.1 ± 1.3 ng/ml. After surgical treatment the serotonin level increased to 5.4 ± 1.8 ng/ml and was not statistically different from the level of practically healthy patients. The dynamics of serotonin levels correspond to the dynamics of the patients number with signs of anxiety and depression before and after surgery in the main group, as well as the improvement in the psychological state of patients after surgery compared to preoperative data on the scales of the “psychological component” of SF-36 health questionnaire: Vitality (VT), Social Functioning (SF), Role-Emotional (RE), Mental Health (MH).

Conclusions. Laparoscopic crurorrhaphy and fundoplication in the Short Floppy Nissen modification through the mechanism of serotonin helps to improve the psychological state of patients with GERD in the postoperative period, eliminate anxiety and depression, improve quality of life and achieve a lasting antireflux effect. The obtained dynamics of serotonin levels confirms its participation in the formation of behavioral reactions in GERD, helping to improve the results of surgical treatment.

Ключові слова:

гастроєзофагеальна рефлюксна хвороба, тривога, депресія, якість життя, серотонін.

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Вивчення рівня серотоніну крові, показників тривожно-депресивних станів і якості життя хворих після лапароскопічного лікування гастроєзофагеальної рефлюксної хвороби

Є. І. Гайдаржі

Ефективне лікування гастроєзофагеальної рефлюксної хвороби (ГЕРХ) залишається складним і досі не вирішеним завданням сучасної медицини. Застосування комбінації різних антисекреторних препаратів із хірургічним лікуванням не дає змоги досягти стійкого покращення якості життя та надійної профілактики виникнення ускладнень. Тому особливу увагу приділяють вивченню гуморальних факторів, що впливають на патогенез ГЕРХ. Ці дані сприятимуть покращенню результатів терапевтичного та хірургічного лікування. Перспективним є вивчення динаміки серотоніну при лапароскопічному лікуванні різних варіантів ГЕРХ, особливо у поєднанні з диспепсією, тривожними або депресивними розладами, а також можливість застосування препаратів, що впливають на метаболізм цього гормону, для корекції названих розладів та досягнення стійкого одужання після лапароскопічної фундоплекції.

Мета роботи – вивчити динаміку серотоніну в крові під час лапароскопічної тотальної фундоплекції та проаналізувати кореляцію цього гормону з психологічним самопочуттям пацієнтів до та після хірургічного лікування ГЕРХ.

Матеріали та методи. Лапароскопічну фундоплекцію в модифікації Short Floppy Nissen виконано 35 пацієнтам із ГЕРХ: 26 (74,3 %) жінкам, 9 (25,7 %) чоловікам віком $55,3 \pm 11,3$ року. У групу порівняння залучили 20 здорових волонтерів (14 (70,0 %) жінок, 6 (30,0 %) чоловіків, середній вік – $56,7 \pm 10,6$ року), яким операцію не робили. Групи зіставні за статтю та віком обстежених. Здійснили дослідження в плазмі венозної крові, зразки якої одержали за стандартною

методикою та зберігали у низькотемпературній морозильній камері при температурі -80°C . Рівень серотоніну (Serotonin ELISA, RE59121, IBL) визначили, застосовувавши імуноферментний комплекс ImmunoChem-2100 (США) на базі кафедри клінічної лабораторної діагностики Запорізького державного медико-фармацевтичного університету. Концентрація показників наведена у нг/мл. Наявність супутньої тривоги, депресії та рівня психологічного благополуччя оцінювали з використанням опитувальників GAD-7, PHQ-9 та SF-36. Статистично результати дослідження проаналізували, застосовувавши програмний пакет Statistica for Windows 13 (StatSoft Inc., № JPZ8041382130ARCN10-J). Статистично значущими вважали відмінності при $p < 0,05$.

Результати. Рівень серотоніну в крові практично здорових людей становив $5,8 \pm 1,5$ нг/мл. В основній групі до хірургічного лікування вміст серотоніну становив $3,1 \pm 1,3$ нг/мл. Після хірургічного лікування рівень серотоніну підвищився до $5,4 \pm 1,8$ нг/мл і статистично не відрізнявся від показника практично здорових пацієнтів. Динаміка рівня серотоніну відповідає динаміці кількості пацієнтів з ознаками тривоги та депресії до та після операції в основній групі, а також покращенню психологічного стану хворих після операції порівняно з доопераційними даними за шкалами «Психологічного компонента» здоров'я за опитувальником SF-36: життєва активність (Vitality – VT), соціальне функціонування (Social Functioning – SF), рольове функціонування, зумовлене емоційним станом (Role-Emotional – RE), психічне здоров'я (Mental Health – MH).

Висновки. Лапароскопічна крурорафія та фундоплікація в модифікації Short Floppy Nissen через механізм впливу серотоніну сприяє покращенню психологічного стану пацієнтів з ГЕРХ у післяопераційному періоді, усуненню тривоги та депресії, підвищенню якості життя та досягненню стійкого антирефлюксного ефекту. Визначена динаміка рівня серотоніну підтверджує його участь у формуванні поведінкових реакцій при ГЕРХ, а отже і позитивний вплив на результати хірургічного лікування.

Today, despite the availability of many modern techniques, effective treatment of GERD remains a difficult and still unsolved problem [1]. The variety of pathological disorders in this disease, including functional ones, negates the development of a “gold standard” of treatment that allows achieving a long lasting positive result in all patients [2]. The use of various combinations of conventional drugs (PPIs, prokinetics, antacids, etc.) is not enough, and combination with surgical treatment has not yet allowed to achieve a long lasting improvement in the quality of life and reliable prevention of the development of GERD complications (erosions, ulcers, strictures, Barrett's esophagus) [1,2].

In this regard, intensive study of the GERD pathophysiology continues to draw the attention of scientists to the humoral factors that influence the pathogenesis of this disease, and the use of the obtained data to improve the results of both therapeutic and surgical treatment [3,4]. One of the humoral substances of interest is serotonin, which plays a diverse role in the development of various gastrointestinal diseases, including GERD [5,6]. It is promising to study the dynamics of this hormone both during therapeutic and surgical treatment of various variants of GERD in combination with dyspepsia, anxiety or depressive disorders, as well as the possibility of additional drug effects on serotonin receptors to correct the above disorders and achieve stable recovery after surgical treatment [4,5,6].

Aim

To study the dynamics of serotonin in the blood during laparoscopic total fundoplication and analyze the correlation of this hormone with the psychological well-being of patients before and after surgical treatment of GERD.

Materials and methods

During the study laparoscopic total fundoplication in the Short Floppy Nissen modification was performed for 35 patients with GERD. There were 26 (74.3 %) women,

9 (25.7 %) men. Age – 55.3 ± 11.3 . The comparison group consisted of 20 healthy volunteers (women – 14 (70.0 %); men – 6 (30.0 %); average age – 56.7 ± 10.6), who did not undergo surgery. Groups of sick and healthy individuals were comparable by gender and age.

Gastroscopy and 24-hour pH impedance measurements to diagnose GERD were used.

Venous blood was collected before surgical treatment and 2–3 months after surgery in the main group and after excluding the presence of GERD in the comparison group. In our study, we determined the concentration of free serotonin in plasma, for which we were guided by the instructions for determining serotonin (section: detection of serotonin in plasma) [7].

It is known that a significant portion of serotonin is produced by enterochromaffin cells located in the mucosa of the intestine, from where it is released into the lumen of the intestine and further into the portal circulation. Serum serotonin is rapidly transported into platelets through specialized transport proteins on the platelet membrane. Upon their activation, platelets release a substantial amount of serotonin, leading to an increase in the level of 5-HT in the serum. Therefore, the concentration of free serotonin was measured in plasma, which, according to several literary sources, makes it possible to assess the biological effects of serotonin that are not related to the functional activity of platelets [8,9].

Venous blood plasma samples obtained according to the standard method and were stored in a low-temperature freezer at a temperature of -80°C . Determination of serotonin (Serotonin ELISA, RE59121, IBL) was carried out on the ImmunoChem-2100 immunoenzymatic complex (USA) of the Department of Clinical Laboratory Diagnostics in Zaporizhzhia State Medical and Pharmaceutical University. The concentration of experimental indicators was expressed in ng/ml [10].

The presence of concomitant anxiety and depression was assessed using the GAD-7 and PHQ-9 scales [11,12]. The level of psychological well-being was assessed using the SF-36 questionnaire [13]. According to the presented valid questionnaires, patients of both groups were sur-

Table 1. Serotonin levels in the groups of studied patients

Parameter, units of measurement	Control group (n = 20)	Basic group (n = 35), GERD	
		Before operation	After operation
Serotonin, ng/ml	5.8 ± 1.5	3.1 ± 1.3*	5.4 ± 1.8**

*: p < 0.05 compared with the control group and with postoperative data; **: p < 0.05 compared with preoperative data; p – value of statistical difference.

Table 2. Distribution of patients with GERD depending on the level of anxiety

Level of anxiety	Control group (n = 20)	Basic group (n = 35), GERD	
		Before operation	After operation
Light	–	7 (20.0 %)	1 (2.9 %)*
Moderate	–	3 (8.6 %)	–
Heavy	–	–	–
Total	–	10 (28.6 %)	1 (2.9 %)*

*: p < 0.05 compared with preoperative data; p: value of statistical difference.

Table 3. Analysis of depression manifestations before and after surgery using the PHQ-9 scale

Severity of depression	Control group (n = 20)	Basic group (n = 35), GERD	
		Before operation	After operation
Minimal manifestations of depression	–	13 (37.1 %)	5 (14.3 %)
Mild depression	–	4 (11.4 %)	1 (2.9 %)
Moderate depression	–	–	–
Severe depression	–	–	–
Total	–	17 (48.5)	6 (17.2 %)*

*: p < 0.05 compared with preoperative data; p: value of statistical difference.

veyed before and after surgical treatment during venous blood sampling to determine serotonin levels. The level of mental well-being, degree of anxiety and depression were determined using the point scale presented in the above-mentioned literary sources.

The selection of patients for the study was carried out by a complete random method using the following inclusion/exclusion criteria. The criteria for inclusion in the study were confirmed GERD, consent to surgical treatment and the absence of general contraindications to surgery. Exclusion criteria – absence of GERD, refusal of operative treatment, absence of acute surgical pathology or other chronic diseases of the gastrointestinal tract in the exacerbation stage. The comparison group was formed from practically healthy patients in whom the presence of GERD was excluded, who met the inclusion / exclusion criteria and gave their consent to participate in the study.

Statistical evaluation of the research results was carried out using the Statistica for Windows 13 software package (StatSoft Inc., No. JPZ8041382130ARCN10-J). The obtained results, obeying the law of normal distribution, are presented in the form of the arithmetic mean and the mean square deviation $M \pm s$. Results that do not obey the law of normal distribution were described by the median and interquartile range: between the 25th and 75th percentiles. The data were presented in the form of x (x ; x). Differences and relationships between groups were assessed using non-parametric methods of the Mann–Whitney, Wilcoxon, and Spearman tests, as well as using the “Second significance criteria” submodule in the “Basic Statistics and Tables” module. Differences at $p < 0.05$ were considered statistically significant.

Results

The analysis of the obtained results showed in the *Table 1*. In the main group serotonin values before surgical treatment is statistically lower compared to the control group.

After the surgical treatment, the level of serotonin of the studied patients increased and statistically differs from the preoperative values ($p < 0.05$), however, it does not differ from the values obtained in practically healthy individuals ($p = 0.25$).

It should be noted that the concentration of serotonin in the blood plasma of healthy individuals that we obtained corresponded to the 97.5 % percentile value specified in the instructions for determining serotonin [7].

The distribution of patients by anxiety level in the main group before and after surgical treatment is presented in *Table 2*.

As can be seen from *Table 2*, there is a statistically significant decrease in the number of patients with anxiety disorder after surgery.

When analyzing the presence of depressive disorders in the main group, there was also a statistically significant decrease in the number of patients with depressive disorders after surgery (*Table 3*).

In the main group of patients there were no patients with moderate or severe depression both before and after surgery, and the number of patients with mild depression and with minimal manifestations of depression after surgery decreased significantly.

Mean scores on the GAD-7 Anxiety Scale and PHQ-9 Depression Scale are presented in *Table 4*.

The average indicators of anxiety and depression in the main group after surgery differ statistically from

Table 4. Indicators of the GAD-7 and PHQ-9 scales in the main group before and after surgical treatment

Anxiety, depression	Control group (n = 20)	Basic group (n = 35), GERD	
		Before operation	After operation
Anxiety, points	1.0 (0.0; 1.0)	3.0 (1.0; 6.0)	0.0 (0.0; 2.0)*
Depression, points	0 (0.0; 1.0)	4.0 (2.0; 7.0)	1.0 (0.0; 3.0)*

*: $p < 0.05$ compared with preoperative data; p : value of statistical difference.

Table 5. Correlation values r and the level of statistical significance P between serotonin and indicators of anxiety and depression in the main group

Anxiety and Depression Scales	Basic group (n = 35), GERD		
	Correlation rate with serotonin		Before operation
	p	r	
Serotonin, ng/ml	–	–	3.1 ± 1.3
GAD-7	0.048	-0.24	3.0 (1.0; 6.0)
PHQ-9	0.067	-0.22	4.0 (2.0; 7.0)

Table 6. Assessment of psychological quality of life using the SF-36 scale in patients of the main group before and after surgical treatment

SF-36 Scale (psychological well-being)	Control group (n = 20)	Basic group (n = 35), GERD	
		Before operation	After operation
VT (Vitality)	72.6 ± 4.4	65.0 (45.0; 70.0)	75.0 (60.0; 85.0)*
SF (Social Functioning)	88.1 ± 7.6	75.0 (50.0; 87.5)	87.5 (75.0; 87.5)*
RE (Role-Emotional)	88.3 ± 16.3	66.7 (0.0; 100.0)	100.0 (33.3; 100.0)*
MH (Mental Health)	76.8 ± 4.42	60.0 (44.0; 72.0)	80.0 (68.0; 84.0)*

*: $p < 0.05$ compared with preoperative data; p : value of statistical difference.

Table 7. Correlation between the level of serotonin and the values of the SF-36 scales, reflecting the level of “psychological” well-being

SF-36 Scales (psychological well-being)	Basic group (n = 35), GERD		
	Correlation rate with serotonin		Before operation
	p	r	
Serotonin, ng/ml	–	–	3.1 ± 1.3
MH (Mental Health)	0.156	+0.170	65.0 (45.0; 70.0)
RE (Role-Emotional)	0.304	+0.125	75.0 (50.0; 87.5)
VT (Vitality)	0.392	+0.100	66.7 (0.0; 100.0)
SF (Social Functioning)	0.626	-0.060	60.0 (44.0; 72.0)

preoperative values and do not differ from the group of healthy volunteers.

Correlation analysis between the dynamics of serotonin levels before and after surgical treatment with indicators of anxiety disorder and depression showed the presence of a statistically significant negative correlation with anxiety indicators (Fig. 1).

A detailed analysis of the correlation values between the dynamics of serotonin levels with indicators of generalized anxiety disorder and depression, indicating the level of statistical significance p is presented in Table 5.

As can be seen from Table 5, there is a statistically significant correlation between serotonin levels and anxiety scores ($p = 0.048$), and a correlation between serotonin levels and depression scores approaching statistical significance ($p = 0.067$).

Assessing the “psychological component” of health in the main group using the SF-36 questionnaire, there was a significant improvement in the condition after surgery compared to preoperative data on the following scales: Vitality (VT), Social Functioning (SF), Role functioning, due to emotional state (Role-Emotional – RE), Mental Health (MH) (Table 6).

The indicators of “psychological well-being” on the SF-36 scales are statistically different from the preoperative values in the main group and do not differ from the values in the group of healthy volunteers, which is clearly presented in Fig. 2.

Detailed analysis of correlation values between the dynamics of serotonin levels with scales reflecting psychological well-being SF-36 (Vitality (VT), Social Functioning (SF), Role functioning, due to emotional state (Role-Emotional – RE), Mental Health (MH)) indicating the level of statistical significance p is presented in Table 7.

The results presented in Table 7 once again indicate a statistically significant correlation between the level of serotonin and the level of anxiety, close to a statistically significant ($p = 0.067$) correlation between the dynamics of serotonin and the depression scale and the absence of a statistically significant correlation between the level of serotonin and the SF-36 scales, reflecting the psychological component of quality of life.

However, the lack of statistical significance does not mean the absence of clinical significance, and may be due to the small number of patients in the study, which requires continued work in this direction.

1

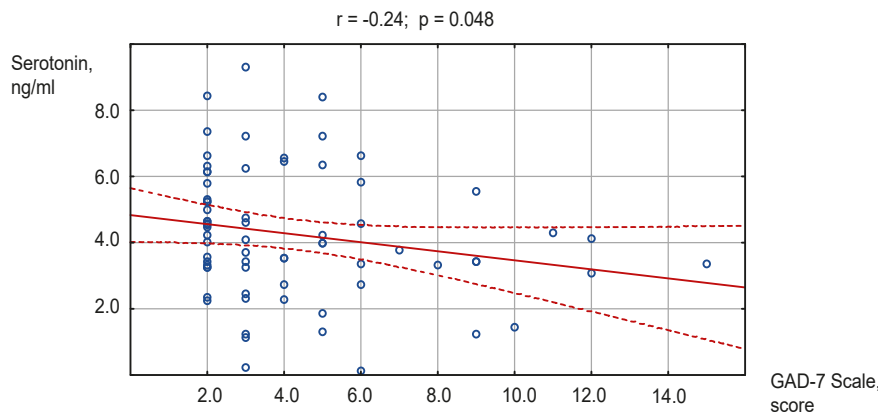


Fig. 1. Correlation between serotonin levels and anxiety levels on the GAD-7 scale before and after surgical treatment in the main group.

2

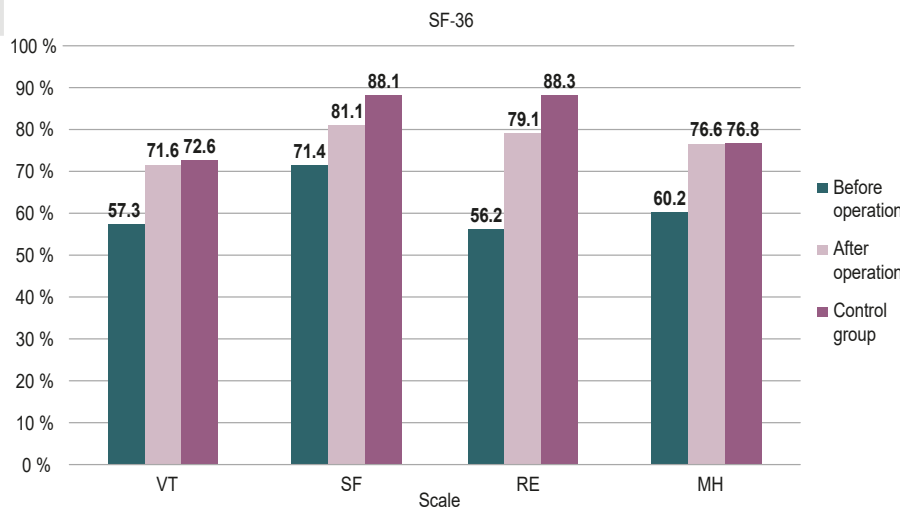


Fig. 2. Dynamics of the quality of life of patients in the control and main groups before and after surgical treatment.

Discussion

Serotonin is an important neurotransmitter not only in the brain, but also in the gastrointestinal tract, having a diverse effect on the functions of the digestive system in close connection with the functioning of the central nervous system. 60–90 % of serotonin is produced in the gastrointestinal tract. Due to the variety of targets of serotonin in the digestive canal, this hormone has a key effect on the regulation of motility and secretion of the gastrointestinal tract, enhancing its peristalsis and secretory activity, influencing the tone of smooth muscles, dilating or constricting blood vessels, regulating various physiological parameters of the body: salt secretion acids, chlorine transport and bicarbonate secretion. At the same time, serotonin is involved in the regulation of memory, sleep, behavioral, emotional and eating reactions, blood pressure control, thermoregulation, and the functioning of the human cardiovascular, endocrine, immune, and respiratory systems [14,15].

Impaired serotonin metabolism plays an important role in the pathogenesis of various gastrointestinal diseases: Crohn's disease, ulcerative colitis, irritable bowel syndrome, gastroesophageal reflux disease.

The relationship between the form of irritable bowel syndrome and the level of serotonin has been shown: a decrease in the content of serotonin and enzymes of its metabolism in the form associated with constipation, and an increase in the diarrheal form. Peaks in the rise in serotonin levels correlate with attacks of dyspepsia, confirming the role of the hormone in the pathogenesis and clinical manifestation of this pathology. A connection was found between serotonin levels and the severity of pain and autonomic disorders. With a decrease in serotonin, the sensitivity of the body's pain system increases [16,17,18,19,20].

Changes in serotonin signaling pathways affect the sensitivity of the esophagus to refluxate, low esophageal sphincter pressure, amplitude and frequency of esophageal peristalsis, which actively involves them in the pathogenesis of GERD [5,6]. In this case, deficiency or inhibition of serotonergic transmission, for example, caused by a decrease in serotonin levels in the brain, is the cause of depressive conditions. Under stress, serotonin consumption increases, which leads to the development of relative and absolute serotonin deficiency. This is accompanied by a violation of behavioral adaptation mechanisms with

the possible development of anxious mental states and depression [19,20].

Patients with GERD have a significantly reduced quality of life, with equally affected physical, psychological and social functioning. Deterioration in quality of life depends on the severity of GERD symptoms and the presence of symptoms of anxiety and depression. Psychological testing reveals anxiety disorders in 35 % of patients with GERD, and anxiety-depressive disorders in 65 %. 36 % of patients with GERD have clinically significant depressive disorders. 47 % of the total number of patients with GERD with depression have masked depression. 64 % of patients with GERD have a high level of personal anxiety, predisposing to the occurrence of anxious and depressive reactions, which are closely correlated with impaired esophageal motility and the high intensity of the GERD clinic [19,20]. Treatment of patients with GERD with the use of antidepressants from the selective serotonin reuptake inhibitors group or serotonin receptor agonists leads to a decrease in the severity of complaints from the esophagus, as well as from the stomach and intestines, a decrease in levels of depression and anxiety, and an improvement in quality of life [3,6].

Our work clearly shows that in patients with GERD who are preparing for surgical treatment, the level of serotonin in the blood is reduced below the control group before surgery, and increases after surgery. At the same time, rates of anxiety and depression also show a similar trend. The scales of the SF-36 questionnaire Vitality (VT), Social Functioning (SF), Role-Emotional (RE), Mental Health (MH) are grouped into the indicator of the "psychological component of health".

Vitality (VT) reflects the feeling of being full of strength and energy. Low scores indicate patient fatigue and decreased vital activity. Social Functioning (SF) determines the degree of limitation of social activity (communication) associated with the patient's condition. Low scores indicate a significant limitation of social contacts, a decrease in the level of communication as a result of illness, emotional state. Role functioning due to emotional state (Role-Emotional – RE) involves assessing the extent to which the emotional state interferes with the performance of work or other daily activities (including large amounts of time, decreased volume of work, decreased quality of work, etc.). Low scores on this scale are interpreted as a limitation in performing daily work due to a deterioration in the emotional state.

Mental Health (MH) characterizes mood, depression, anxiety, general indicator of positive emotions. Low rates indicate the presence of depression, anxiety, and mental ill-being. When assessing the correlation of serotonin with the indicators of these scales, we noted the highest statistical significance with the mental health scale (Mental Health – MH), then role functioning (Role-Emotional – RE), Vital Activity (Vitality – VT) and social functioning (Social Functioning – SF) (Table 7).

In combination with correlation indicators between serotonin levels and anxiety and depression scales, this confirms the important role of serotonin in the regulation of behavioral reactions, the close relationship of GERD with the psycho-emotional state, the need for functional disorders correction in the treatment of GERD, as well as

the positive impact of surgical treatment of GERD on the psychological well-being of patients after operations. An increase in serotonin after surgery helps to increase lower esophageal sphincter pressure, reduce the sensitivity of the esophagus to refluxate, increase the amplitude and frequency of esophageal peristalsis, normalize gastrointestinal motility, which has a positive effect on the effectiveness of surgical treatment of GERD. So, a peculiar pathogenetic "closed" circle is observed: successful operation – disappearance of gastroesophageal reflux – improvement of the patient's physical condition – improvement of the patient's psycho-emotional state – reduction of stress associated with the disease – reduction of the load on the serotonin system to counteract stress – increase in the level of serotonin in the blood – positive effect on the motility of the gastrointestinal tract, sensitivity of the esophagus to reflux, tone of the lower esophageal sphincter, frequency and amplitude of esophageal peristalsis – further improvement of the anti-reflux mechanism – disappearance of pathological reflux – improvement of the patient's physical condition – improvement of the patient's psycho-emotional condition, etc., which is pathogenetic the mechanism of increasing the level of serotonin in the blood of patients during the surgical treatment of GERD.

Thus, treatment of GERD is difficult and is not always successful. At the same time, organic signs of gastrointestinal tract damage (esophagitis, erosions, ulcers, Barrett's esophagus) with GERD are easier to treat than functional disorders. A comprehensive analysis of the serotonin metabolism as a neurotransmitter, hormone and paracrine immunomodulator is a promising area of research in the field of gastroenterology, in particular the pathophysiology of GERD, which can become the basis for the development of a new strategy for correcting the gastroesophageal barrier when GERD is combined with various functional and psychosomatic disorders [20].

Conclusions

1. An increase in serotonin levels and an improvement in quality of life indicators after laparoscopic treatment of GERD in the scope of crurorrhaphy and total fundoplication in the Short Floppy Nissen modification are observed.
2. The closest correlation between serotonin levels is determined with manifestations of anxiety, depression, and mental health, which confirms its participation in the formation of behavioral reactions in GERD, helping to improve the results of surgical treatment by improving the psychological state of patients in the postoperative period, eliminating anxiety, depression and improving quality life.
3. Increasing the level of serotonin in the postoperative period through the mechanisms of a positive effect on the tone of the lower esophageal sphincter, motility of the esophagus and stomach can contribute to a more effective achievement of anti-reflux results in the surgical treatment of GERD and the elimination of concomitant psychosomatic and functional gastrointestinal disorders.
4. The dynamics of the level of serotonin in the blood with GERD raises the question of the determining feasibility of this hormone in order to correct the tactics

of patients postoperative management to achieve a lasting positive result and improve the quality of life, which requires continued work in this direction.

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