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Changes in Metabolic Processes in The Gastric Mucosa in The Pathogenesis of the Formation of Acute Ulcers in Acute Small Intestinal Obstruction

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1. Abstract

1.1. Introduction: Acute small bowel obstruction is a problem of modern surgery. It is not possible to study morphological and functional changes in the walls of the stomach in acute small bowel obstruction on clinical material, performing a biopsy in the dynamics of the development of the disease. Therefore, our work is experimental.

1.2. Methods: 2 intact dogs served as control. In 12 animals (the second group), a strangulation of small bowel obstruction was simulated with a period of 3, 6, 12 and 24 hours. In 12 animals (the third group), obstructive small bowel obstruction was simulated for 3, 6, 12, and 24 hours. The preparations are stained according to Einarson to obtain DNA.

1.3. Results: In the antrum of the stomach, the level of nucleoproteins in the epithelial cells of the mucous membrane after 1 day from the creation of a model of acute 5.2 times, after 2 days - 2.2 times, after 3 days decreased 1.45 times, and after 6 days - 7.28 times when compared with the norm.

In the main cells of the glands after 1 day it increased 2.64 times, after 2 days - 1.44 times, after 3 days - 2 times, and after 6 days - 3 times.

1.4. Conclusions: The most pronounced morphofunctional changes in the gastric mucosa, progressing in the dynamics of the disease, both when modeling acute strangulation and acute obstructive small intestinal obstruction are observed in its antrum, which explains the most frequent localization of acute ulcers in this part of the stomach.

2. Introduction

Improvement of the surgical and anesthetic techniques has significantly expanded the possibilities for performing large surgeries on the abdominal organs, however, an increase in the frequency of postoperative complications is observed [1, 2].

One of the most frequent postoperative intra-abdominal complications, while the least studied, is the development of adhesions in the abdominal cavity [1-3]. The manifestation of adhesive disease can be pain syndrome and dyspeptic disorders of varying severity, which worsen the quality of life for patients [3]. Acute small bowel obstruction (ASBO), which is an acute surgical disease that threatens the lives of patients, can also be a manifestation of adhesive disease [4].

Patients with acute small bowel obstruction make up a significant proportion of all surgical patients [5]. The postoperative mortality of patients with ASBO is from 6.7% to 36.2%, with a total mortality in this pathology from 2.5% to 15.8% [6,7].

Problems in the treatment of ASBO are due to both the severity of the disease itself and the severity of its complications [8, 9]. The success of modern surgery can save patients with diseases that were previously considered prognostic unfavorable, but in some cases, patients who survived after operations and severe purulent complications die from bleeding from acute gastro-duodenal ulcers [10-13], which have been for a long time considered a relatively rare pathology. According to modern literature, among patients with ASBO in the dynamics of the development of the disease and in the postoperative period, after its removal, acute ulcerations of the gastro-duodenal zone (GDZ) are very common (up to 50% of observations) and cause mortality of 35% - 80% of patients [14, 15]. At the same time, many researchers argue that these injuries occur much more often than they are recorded, since in most cases acute erosion and ulcers, not having specific clinical manifestations, remain unrecognized and are detected only at autopsy [16, 17].

The most life-threatening complications of acute gastro-duodenal ulcers are represented by bleeding, perforation and their combination [18]. Especially often acute ulceration of the gastric mucosa is observed in patients of older age groups with comorbidities. Mortality in case of acute course of acute gastro-duodenal ulcers reaches 80% -100% [10-12, 18].

Even with the absence of complications, acute erosions and gastric ulcers significantly aggravate the condition of patients, increase the risk of developing other complications, prolong the time the patient is in the hospital [12,18].

The low effectiveness of preventive and curative measures in this pathology largely depends on the lack of solutions to a number of issues in understanding the pathogenesis of the development of this formidable complication of ASBO [3, 4, 18]. As a result, the therapy carried out is often not pathogenetic and is directed only to the investigative mechanism of pathophysiological disorders.

It is generally accepted that in the basis of the pathogenesis of the formation of acute gastric ulcers lies the imbalance between local aggression factors and protection factors of the gastric mucosa [12,13,18].

The decisive condition for the normal functioning of the entire complex of the protective mechanisms of the gastric mucosa is effective hemocirculation [19]. The protective action of the gastric blood flow is associated with sufficient oxygenation of the mucous membrane, a high level of energy metabolism and reparative processes in it, as well as with neutralization and elimination of hydrogen ions [20]. An increase in the intensity of blood flow increases the metabolic activity of the cells of the epithelial layer and, therefore, their ability to resist destabilization of the protective barrier [20].

According to modern concepts of the microcirculation system, hemodynamics at the micro level naturally obeys the metabolic needs of tissues, depends on homeostasis and affects it [21]. According to most researchers, metabolic disorders are the result of hemodynamic disorders, they are often caused and then maintained by tissue hypoxia [22]. At the same time, a number of experimenters believe that tissue metabolism is disturbed in the early stage of shock even before the onset of circulatory disorders [23].

Patterns of changes in metabolic processes in the gastric mucosa at the cellular level in the dynamics of the development of the disease in various types of acute small bowel obstruction have not been sufficiently studied. At the same time, it is not possible to study the morphofunctional changes in the walls of the stomach during acute small intestinal obstruction on clinical material, performing a biopsy in the dynamics of the disease. Thus, the need for an experimental analysis of the nature and scale of morphofunctional changes in the walls of the stomach during different time periods of the development of the pathological process follows from the clinic's requests.

3. Materials and Methods

The acute adhesive intestinal obstruction most commonly encountered in clinical practice combines in the development mechanism both elements of strangulation and obturation in varying degrees of severity, therefore the experimental modeling of these two types of acute small bowel obstruction has become the basis of our work.

The object of the study of our work were dogs. Choosing them as experimental animals is due to the fact that the structure and functions of the digestive tract, the main sources of blood circulation and blood outflow pathways, the structure of the arterial and venous beds and, consequently, the hemomicrocirculatory bed of the gastrointestinal tract in dogs and humans are similar [24]. A sufficiently high position in the phylogenetic range of dogs and humans causes the same type of reaction. In addition, most of the previous work on the study of the anatomy and physiology of the digestive system in normal conditions and in modeling the diseases used to compare the results obtained was also carried out on dogs.

Our study was performed on 33 adult mongrel dogs of both sexes weighing 17-20 kg. All scientific experiments were conducted in accordance with the guidelines [25-27], guidelines for the care and use of laboratory animals of the National Institute of Health (National Institute of Health - NIH, Bethesda, USA) and the "Rules for working with experimental animals", approved by the Ethics Committee for Federal State Institution "Main Military Clinical Hospital named after Academician NN Burdenko" of the Ministry of Defense of the Russian Federation and the local ethics committee of the First MGMU named I.M. Sechenov.

On 2 intact dogs that served as the first control, the study of the morphology of the gastric wall was performed. In animals of the second group (12 animals), the simulation of strangulation small bowel obstruction was performed for the observation period of 3, 6, 12 and 24 hours. In 12 animals of the third group, low obstructive small bowel obstruction was performed for the observation period of 1, 2, 3, and 6 days. The fourth, control group consisted of 7 animals in which the study of the morphology of the stomach wall after

laparotomy was performed without intervention on the vessels and abdominal organs after 3, 6, 12 and 24 hours, as well as after 2, 3 and 6 days. Comparison of the results of the study in the second and third groups with the fourth group allows to identify changes in the gastric mucosa, caused precisely by acute small bowel obstruction, but which are not the consequences of laparotomy in modeling the disease.

The choice of the observation period is based on the features of the clinical manifestations of acute small bowel obstruction. The manifestation of the clinical symptoms of acute strangulation small bowel obstruction occurs almost immediately after the formation of strangulation, since the mesentery of the small intestine, which contains blood vessels and a large number of nerve stem formations and endings, is involved in the pathological process.

Obturation of the lumen of the small intestine does not occur instantaneously: some time after reducing the diameter of the lumen of the small intestine, the passage of intestinal contents through the intestine is possible (in clinical practice this condition is sometimes called "partial small intestinal obstruction"), and the mesentery of the small intestine with obstructive small bowel obstruction is not involved in the pathological process. When the decrease in the lumen of the intestine reaches a certain critical level, a spasm of its walls occurs with the subsequent manifestation of the clinical symptoms of acute intestinal obstruction (Figure A,B).

During reproduction in the experiment of strangulation small bowel obstruction, after treating the skin, under anesthesia with a midline incision, the peritoneal cavity was opened, and a ligature of nylon string No. 5 was applied to the small intestinal loop 15 cm long at a distance of 80 cm from the ileocecal junction (Figure 1).

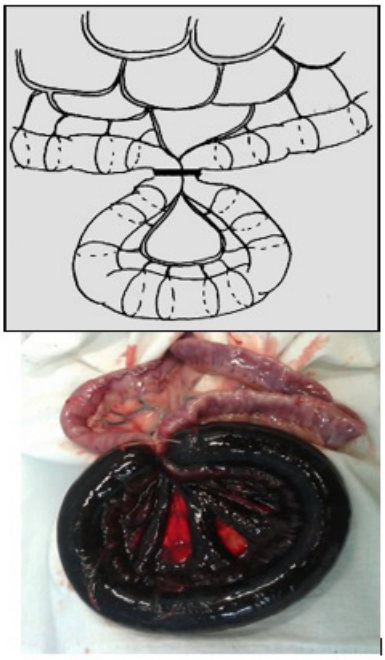

Figure A: Model of acute strangulation small bowel obstruction (scheme and intraoperative macroscopic picture).

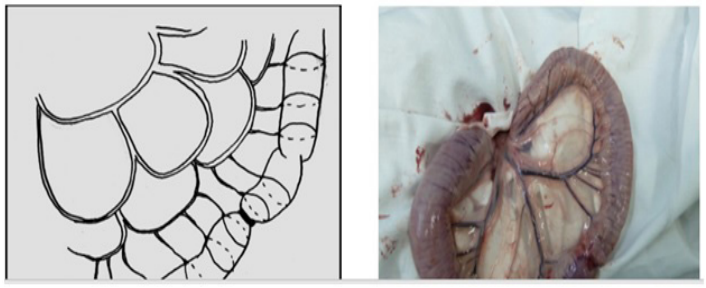

Figure B: Model of acute low obstructive small bowel obstruction (scheme and intraoperative macroscopic picture).

Low obstructive small bowel obstruction (Figure 2) was modeled by applying a capron ligature to the small intestine 80 cm proximal to the ileocecal junction.

The methods for studying the morphology of the stomach walls under the conditions of the norm and after the modeling of small bowel obstruction were used the same. Qualitative histochemical methods of research are based on the use of reactions by which chemicals are detected in cells of tissues and organs. Modern histochemical methods detect amino acids in cells, proteins, nucleic acids, carbohydrates, lipids, vitamins, minerals and other substances, determine the activity of various enzymes, for example, in the Krebs cycle. Identification of these substances is based on the specificity of the reactions between the chemical reagent and the substrate, which is part of the cellular and tissue structures, and on the selection of chemical reaction products in the form of colored precipitation.

To increase the specificity of reactions, (Figure 3) we used the method of enzymatic control. To study the metabolic processes in the epithelium cells and glands of the gastric mucosa, to detect DNA and RNA, halocyanine - chromic alum was used, staining nucleic acids in a persistent blue-violet color - a method for detecting total nucleic acids by Einarson [28].

In addition to information about nucleoprotein metabolism in the cell, the reaction with halocyanin-chromic alum made it possible to assess the morphological changes in the cellular composition of the mucous glands. Coloring was performed on paraffin sections after the material was fixed in Carnoy's fluid [29-31].

A quantitative assessment of the results of cytochemical reactions we, as in a significant number of previously published studies, were carried out by means of point photometry of cells and / or their structures (for example, nuclei) [32-34]. The choice of measurement points was based on the statistical requirements of reliable sufficiency of data in order to assess histochemical changes in the organs and tissues studied. The Background Photocurrent (BP) and the photocurrent from the object (PO) were determined separately, as well as the "dark" photocurrent-an instrument error (DP). Further determination of changes in the activity of metabolic processes was carried out on the basis of changes in the amount of products of specific cytochemical reactions, the calculation of which was made according

to the formula of the Bouguer – Lambert – Ber law. The content of the studied substances is proportional to the amount of products of the cytochemical reaction (C) [35] (Figure 4). The larger the reaction product, the greater the absorption of the initial stream of light emitted by the source (background photocurrent), the smaller the value of the photocurrent from the object. According to the Bouguer-Ber law: I = Io \ times 10 ^ {\ circ} –bCx or PO = BP \ times 10 ^ {\ circ}- bCx, where b is a proportionality coefficient that does not depend on C, x is the slice thickness, hence: \ frac {PO} {BP} = 10 ^ {\ circ} - bCx = => \ lg \ frac {PO} {BP} = -bCx bCx = - \ lg \ frac {PO} {BP}, s considering the error of the device, bCx = - \ lg \ frac {PO - DP} {BP - DP}. Assuming that the coefficient b is the same for all slices containing groups of cytochemical reactions, and the slice thickness "x" is the same for all slices, we can assume that the product bCx, hereinafter referred to as A, is proportional to the amount of substance and can serve as its characteristic, direction of change A can characterize the direction of changes in metabolic processes. It is necessary to stipulate that the slice thickness does not significantly affect the measurement error of the activity of the studied exchange parameter, because with a change in "x" the "C" number of reaction products changes and, accordingly, the photocurrents (the right side of the equation). Thus, A = - \ lg \ frac {PO DP} {BP-DP} in units of optical density. The measurement results are subject to statistical processing using linear statistics methods and using correlation and nonlinear regression analysis (Figure 5).

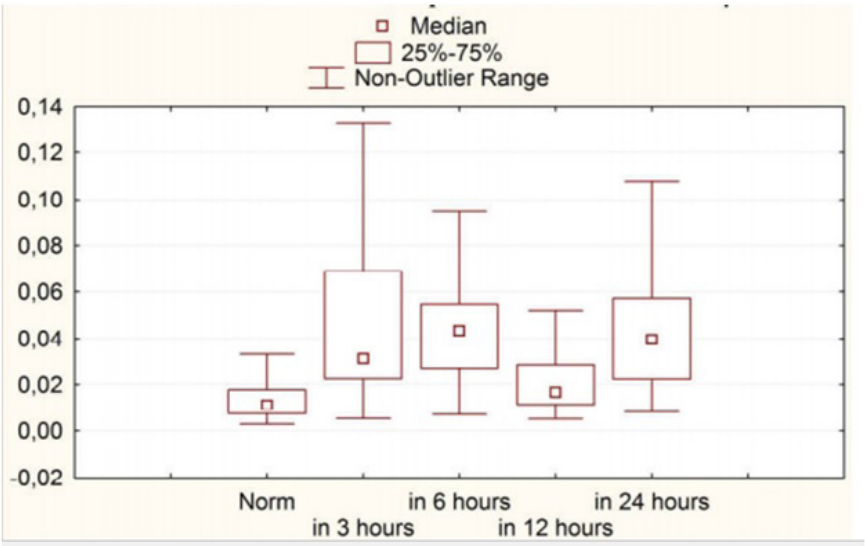

Figure 1: Strangulation intestinal obstruction. Area of interlobular arteries per unit area of 600x103 μm2.

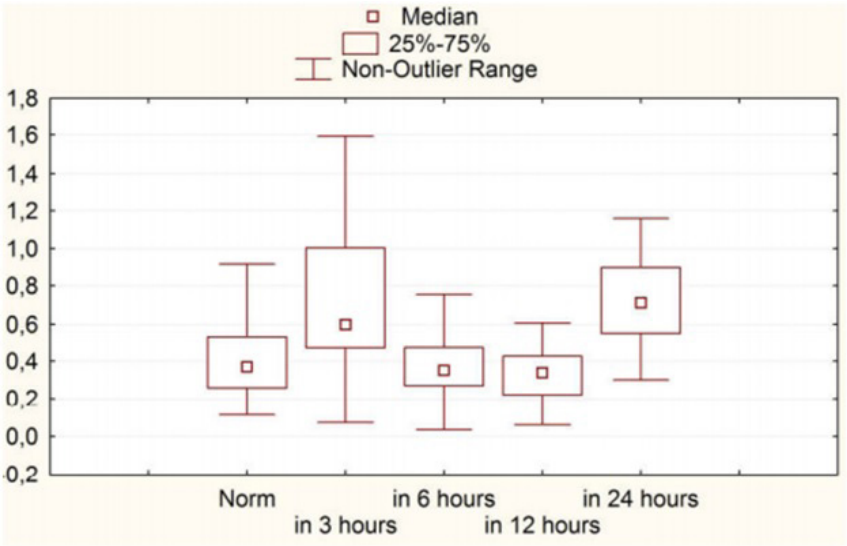

Figure 2: Strangulation intestinal obstruction. Area of interlobular veins per unit area of 600x103 μm2.

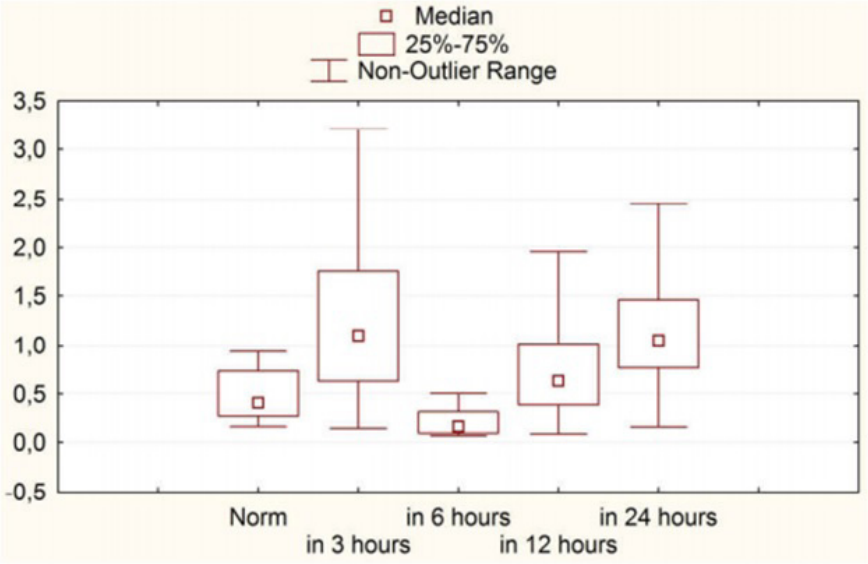

Figure 3: Strangulation intestinal obstruction. Area of the central veins per unit area of 600x103 μm2.

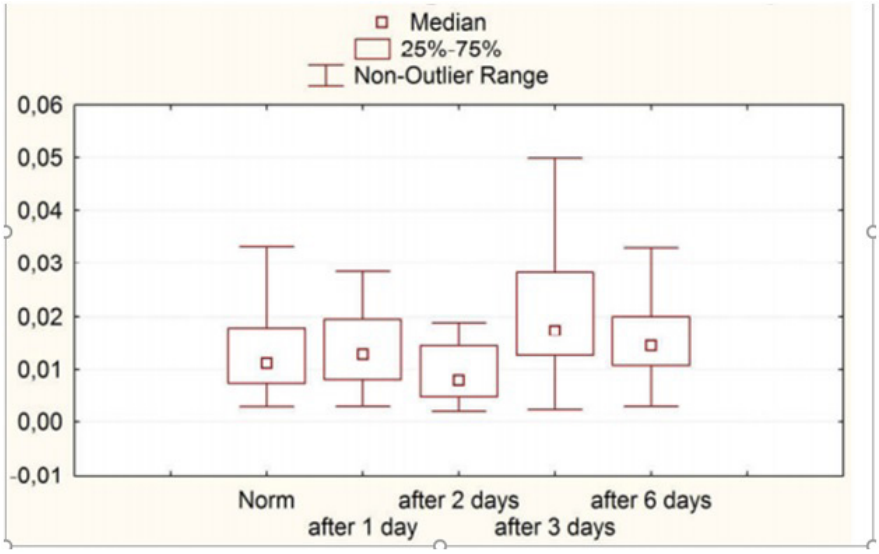

Figure 4: Obturating intestinal obstruction. Area of the central veins per unit area of 600x103 μm2.

An alternative, more modern and promising, in our opinion, approach to quantify the results in this area of research is the method we used additionally using digital equipment. Given the high specificity of the reactions between the chemical reagent and the substrate under study, which is part of the cellular and tissue structures, the selection of products of cytochemical reactions in the form of colored precipitation is also highly specific. Based on this, we believe that the quantitative assessment of the content of reaction products in the objects of study is reliable, using the original method [36], which includes computer programs that allow one to estimate the number of area units of the object of study occupied by the cytochemical reaction products. We believe that the number of area units of the object of study occupied by the products of the cytochemical reaction is the proportion of pigments resulting from the cytochemical reaction in the original pure color after conversion to black and white tones of various degrees of saturation. Since the proportion of pigments in the unit area of the studied objects characterizes the number of products of the cytochemical reaction in the same area, it is obvious that the area occupied by the product of the cytochemical reaction on the area of the histological section in the objects of study is proportional to the amount of substrate that entered the reaction, i.e. characterizes the amount of a chemical in the cells of tissues and organs, as well as in the structural components of the cells of these tissues and organs. Thus, by measuring the area of a specific color range corresponding to the color range of the used

histochemical marker, it is possible to obtain a relative quantitative characteristic of the chemical substrate, and, following these changes in the dynamics of development of processes in tissues and organs, reliably determine the direction of these changes. To measure the area, you can use any morphometric program that allows the segmentation of the object. In our research, the program "Image-Pro Plus" was used. Photographing of the microscopic slides was carried out on an "Axioplan 2 Imaging" microscope equipped with an "AxioCam HRc" digital camera with a resolution of 2788 × 2040 pc. with an increase of 640. In the first stage, the image in the program "Adobe Photoshop" was converted to black and white mode. Then a frame was created - a square with sides of 55 × 55 μm, which can be transferred to any photo. With the help of this frame, the areas of interest were highlighted in the manual mode. In the next step, using the Count / Size function, the corresponding color range is selected in the "Image-Pro Plus" program and the number of pixels of a given color in a given area is calculated. Knowing the area of the measured area (55 × 55 μm), it is possible, by calculating the area of one pixel, to obtain the area of the colored substrate in μm2. This method of morphometry of products of cytochemical reactions allows you to perform a study not only for certain cellular structures, but also for tissue formations, for example, to compare the level of metabolic processes in a unit area of the epithelium, the muscular membrane of an organ, etc. The choice of measurement points is based on the statistical requirements of reliable sufficiency of data in order to assess histochemical changes in the organs and tissues studied. The obvious advantage of this method is the possibility of analyzing small groups of cells detected in situ in preparations, as well as the availability of the method of mathematical modeling of the direction of metabolic processes and the objective comparability of the research results of different authors when choosing the same specified research parameters (Figure 6).

The last group of methods was a statistical analysis of the data obtained.

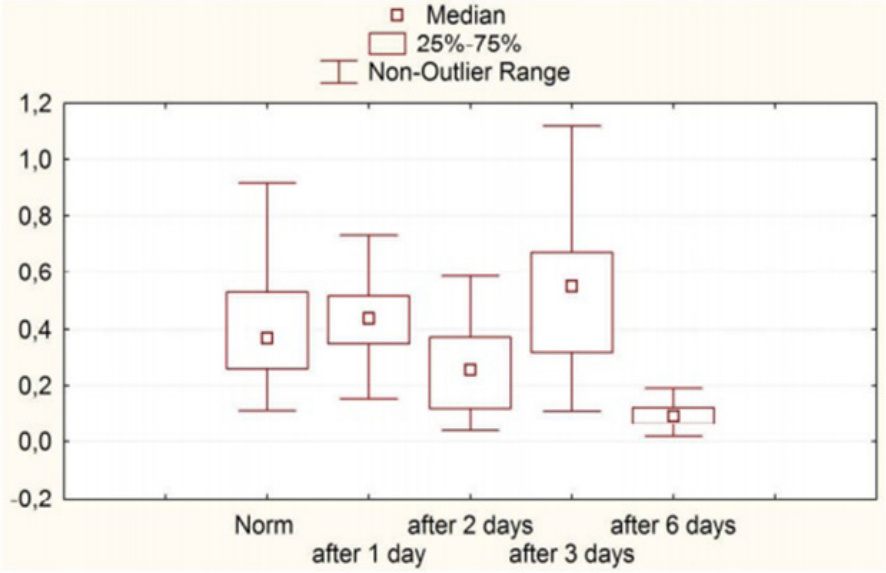

Figure 5: Obturating intestinal obstruction. Area of interlobular veins per unit area of 600x103 μm2.

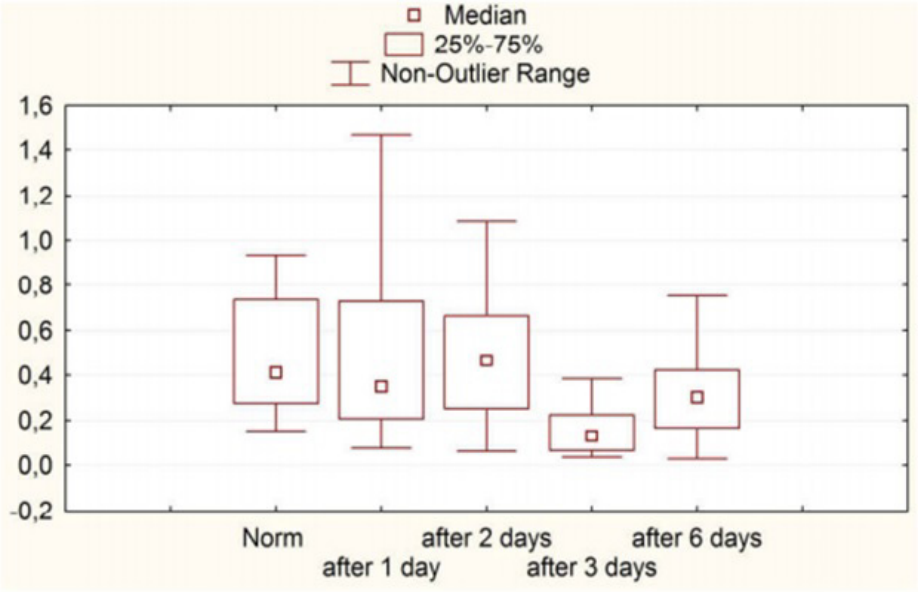

Figure 6: Obturating intestinal obstruction. Area of the central veins per unit area of 600x103 μm2.

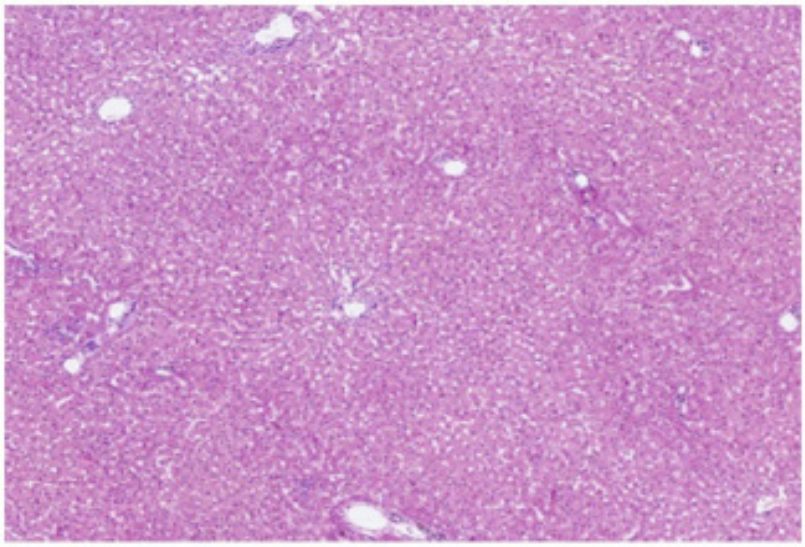

Figure 7: Histological preparation of the dog's liver. Norm. Hematoxylin and eosin stain. Magnification x100.

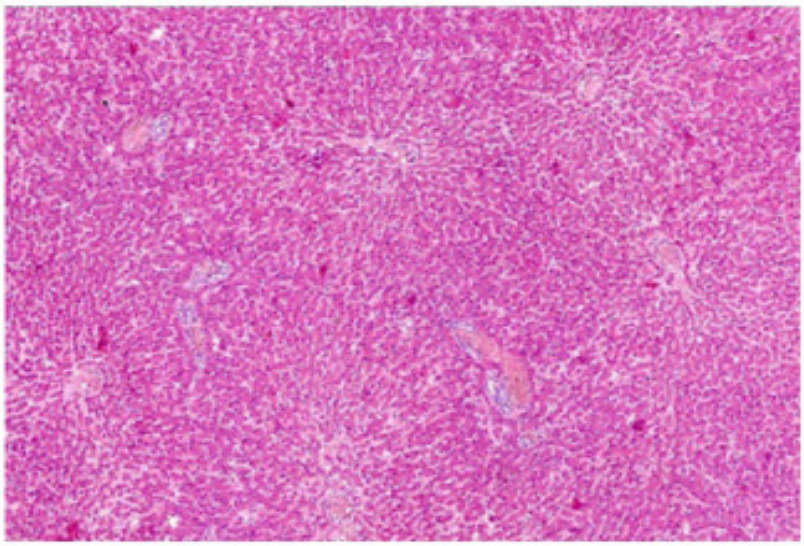

Figure 8: 24 hours of experimental strangulation small bowel obstruction. Pronounced plethora of the central and interlobular veins. Swelling of the stroma. Hematoxylin and eosin stain. X100 magnification

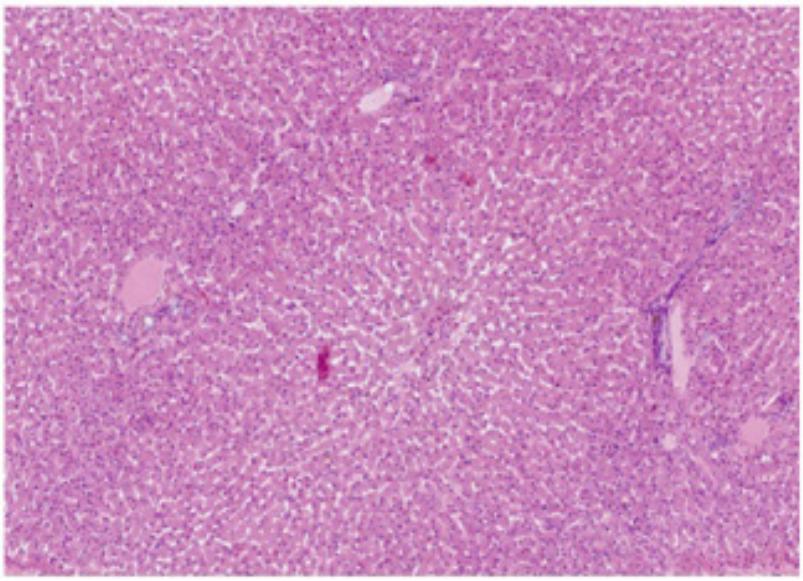

Figure 9: 3 days of experimental low obstructive small bowel obstruction. Pronounced plethora of interlobular veins. Swelling of the stroma. Hematoxylin and eosin stain. Magnification x100.

4. Results

After modeling on dogs an acute strangulation small bowel obstruction by creating a twist of the small intestine loop in its middle section with complete blockage of the blood flow and passage of intestinal contents, a thromboischemic type of hemomicrocirculatory disorders in the gastric mucosa is observed. Changes in the vascular plexuses and HMCB of the mucous membrane and submucosa of the stomach in acute strangulation small bowel obstruction are accompanied by a discharge of the lamina propria and submucosa of the mucous membrane, which is most pronounced in the antrum of the stomach, which is a factor contributing to the subsequent compression of the vessels of the HMCB and the progressive disruption of the peritoneal mucosa and progressive perturbations of the peritoneal gastric mucosa.

The decrease in the intensity of capillary blood flow reduces the metabolic activity of the epithelial layer cells and their ability to resist destabilization of the protective barrier. In acute strangulation small bowel obstruction, even in the early stages of the experiment, we identified changes in mucosal epitheliocytes, most pronounced in the antrum of the stomach, manifested in a decrease in the level of nucleoproteins (Table 1-3), which characterize the level of metabolic processes according to the time of the experiment after 6 hours - 2.94 times, after 12 hours - 2.96 times and after 24 hours - 2.85 times. The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands of the mucous membrane of the antrum is reduced according to the time of the experiment after 3 hours - 1.91 times, after 6 hours - 5.9 times, after 12 hours - 12.75 and after 24 hours - 6.43 times. The level of nucleoproteins in the nuclei of the main cells of the mucous glands of the mucosa decreases in accordance with the time of the experiment after 3 hours - by 1.38 times, after 6 hours - by 4.41 times, after 12 hours - by 2.12 and after 24 hours - by 3.82 times. The dependence of changes in the level of nucleoproteins in the epithelial cells of the mucous membrane, in the nuclei of the main cells of the glands, as well as in the nuclei of the cervical part and the bottom of the glands of the mucous membrane from the timing of the experiment (time of development of the disease) is linear in all parts of the stomach, $p = 0.001$.

Table 1: Changes in metabolic processes in the mucous membrane of the fundus of the stomach in acute strangulation small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	1860930,00 ±23390,07	1180369,23 ±7782,01	396460,00 ±5322,66	372791,11 ±2944,94	1022800,00 ±12625,56
	The level of nucleoproteins in the nuclei of gland cells (main cell)	693525,65 ±7088,02	1720555,66 ±15156,96	2714361,84 ±11363,90	1957403,28 ±15673,78	1425894,91 ±11010,38
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	404960,00 ±5836,78	610704,00 ±5172,48	470010,00 ±3526,13	590148,57 ±3521,44	390926,67 ±2921,04

Table 2: Changes in metabolic processes in the mucous membrane of the body of the stomach in acute strangulation small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	190710,00 ±3188,49	219560,00 ±3363,81	28977,78 ±2656,65	320755,00 ±1618,20	125660,00 ±1752,75
	The level of nucleoproteins in the nuclei of gland cells (main cell)	283086,28 ±7478,09	822860,10 ±20620,08	446662,79 ±10166,49	2246261,69 ±19628,22	523421,23 ±10244,32
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	305056,00 ±2483,34	111910,00 ±1941,85	244056,00 ±2562,99	275960,00 ±5442,75	154234,00 ±3425,62

Table 3: Changes in metabolic processes in the mucous membrane of the antral stomach in acute strangulation small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	495253,33 ±5201,99	568160,00 ±8889,21	168320,00 ±3692,86	166846,67 ±1861,70	173384,00 ±5106,24
	The level of nucleoproteins in the nuclei of gland cells (main cell)	776404,56 ±9878,63	559276,18 ±26674,5	175780,65 ±4445,69	364691,72 ±6677,19	203036,40 ±8501,55
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	470466,67 ±4352,23	245100,00 ±2933,54	79733,33 ±2487,81	36880,00 ±2432,91	73146,67 ±2733,98

In acute obstructive small intestinal obstruction, a thrombohemorrhagic type of hemomicrocirculatory disorders is observed in the submucosa of the gastric mucosa, progressing in the course of the disease. Starting from the initial observation period (1 day), they were manifested by a pronounced dilation of the capillaries and venules, aneurysmal protrusion and thickening of their walls. The hemomicrocirculatory vessels in the submucosal base of the stomach are full-blooded, with a multitude of erythrocyte aggregates and microthrombi completely occluding the lumen. In perivascular tissues there is a pronounced swelling and hemorrhage in the form of dissemination of erythrocytes in the thickness of the mucous membrane, the formation of inter-and subepithelial hematomas. The arteriole diameters are enlarged, which is apparently due to their paralytic vasodilation, with a significant portion of the vessels obstructed by thrombotic masses.

At the same time, the changes in the level of metabolic processes goes in different directions in the different sections of the stomach (Table 4-6). Thus, according to the time of the experiment in the field of the stomach floor, the level of nucleoproteins in the epithelial cells of the mucous membrane after 1 day from creating a model of acute low obstructive obstruction was not statistically significantly changed, and after 2 days decreased by 1.4 times, after 3 days decreased by 1.74 times, and after 6 days - 1.35 times when compared with the norm. The level of nucleoproteins in the main cells of the glands of the mucous membrane of the stomach floor after 1 day from creating a model of acute obstructive obstruction has increased 1.53 times, after 2 days - 2.84 times, after 3 days - 2.32 times, and after 6 days - 1.09 times when compared with the norm. The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands of the gastric mucosa after 1 day from creating a model of acute obstructive small intestinal obstruction increased 1.1 times, and after 3 days and 6 days, respectively, 1.27 times, and 1.29 times when compared with normal values.

In the area of the body of the stomach, the level of nucleoproteins in the epithelial cells of the mucous membrane after 1 day from the creation of a model of acute obstructive obstruction decreased 1.9 times, after 2 days - 1.47 times, after 3 days decreased 2.2 times and after 6 days 1.68 times when compared with normal values. The level of nucleoproteins in the main cells of the glands of the mucous membrane of the stomach floor after 1 day from creating a model of acute obstructive obstruction has increased by 2.64 times, after 2 days - by 1.44 times, after 3 days - by 2 times, and after 6 days - 3 times when compared with normal values.

The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands of the gastric mucosa after 1 day from creating a model of acute obstructive small intestinal obstruction decreased 1.72 times, after 2 days - 2.84 times, after 3 days - 2.65 times and after 6 days - 2.27 times when compared with normal values.

In the antrum of the stomach, the level of nucleoproteins in the epithelial cells of the mucous membrane after 1 day from the creation of a model of acute obstructive obstruction decreased 5.2 times, after 2 days - 2.2 times, after 3 days decreased 1.45 times, and after 6 days - 7.28 times when compared with the norm.

The level of nucleoproteins in the main cells of the glands of the mucous membrane of the antrum of the stomach after 1 day from creating a model of acute obstructive obstruction increased 2.64 times, after 2 days - 1.44 times, after 3 days - 2 times, and after 6 days - 3 times when compared with the norm.

The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands of the mucous membrane of the antrum of the stomach after 1 day from creating a model of acute obstructive small intestinal obstruction decreased 3.35 times, after 2 days - 1.72 times, after 3 days - 2.38 times and after 6 days - 3.1 times when compared with the norm.

Table 4: Changes in metabolic processes in the mucous membrane of the fundus of the stomach in acute obstructive small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	1860930,00 ±23390,07	186170,00 ±13342,66	1331493,33 ±10756,17	1067920,00 ±9180,28	1375120,00 ±18198,70
	The level of nucleoproteins in the nuclei of gland cells (main cell)	693525,65 ±7088,02	1060700,60 ±16884,77	1969455,79 ±27142,76	1606591,33 ±15183,76	752907,27 ±11094,82
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	404960,00 ±5836,78	444560,00 ±7879,66	389224,00 ±2567,07	513421,12 ±2362,32	523834,67 ±3583,02

Table 5: Changes in metabolic processes in the mucous membrane of the body of the stomach in acute obstructive small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	190710,00 ±3188,49	100560,00 ±2402,61	129573,33 ±2092,05	86418,46 ±1520,62	113760,00 ±1985,72
	The level of nucleoproteins in the nuclei of gland cells (main cell)	283086,28 ±7478,09	746792,07 ±5129,71	408064,95 ±6752,44	565538,70 ±6758,87	853528,04 ±9320,08
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	305056,00 ±2483,34	177697,78 ±2863,53	107240,00 ±11316,49	11520,00 ±2749,63	134320,00 ±8574,98

Table 6: Changes in metabolic processes in the mucous membrane of the antral stomach in acute obstructive small bowel obstruction

The investigated parameters		Norm	Experiment			
			3h	6h	12h	24h
The level of nucleoproteins - by optical density in the cells of the mucous membrane	The level of nucleoproteins - by optical density in the cells of the mucous membrane	495253,33 ±5201,99	95160,00 ±3785,7	224232,00 ±2861,68	341768,00 ±4830,09	67991,11 ±1930,75
	The level of nucleoproteins in the nuclei of gland cells (main cell)	776404,56 ±9878,63	255303,34 ±5110,02	954915,23 ±22316,37	229891,50 ±6970,30	758792,33 ±12027,82
	The level of nucleoproteins in the nuclei of cells of the cervical part and the bottom of the glands	470466,67 ±4352,23	140453,33 ±3779,68	274286,67 ±1613,76	498000,00 ±5753,43	151466,67 ±2906,39

5. Discussion

Changes in the vascular plexuses and HMCB of the mucous membrane and submucosa of the stomach in acute small intestinal obstruction are accompanied by edema of the lamina propria and submucosa of the mucous membrane, which is a factor contributing to the subsequent compression of the vessels of the hemomicrocirculatory bed and the progressive violation of tissue perfusion.

Reducing the intensity of blood flow reduces the metabolic activity of the epithelial layer cells and their ability to resist destabilization of the protective barrier.

Metabolic processes in the glands of the mucous membrane, including the cervical part of them, which is the cambial germ zone, are significantly inhibited, which causes a decrease in the reparative capabilities of the gastric mucosa. A pronounced decrease in the reparative capabilities of the gastric mucosa and the development of protective factors, such as the production of mucus, regeneration of the epithelium, etc., thereby increases the sensitivity of the mucous membrane to the acid-peptic factor. However, metabolic activity in the main cells of the gland bottom and the level of nucleoproteins in the nuclei of the main cells quickly return to normal levels, which confirms the opinion of V.T. Ivashkina (1981) and V.M. Uspensky (1986) about intensive anaerobic glycolysis and oxidation fatty acids in the energy processes of these cells and contributes to the discordance of the production of protective and aggressive factors [37]. Thus, the multi directionality of the ischemic factor on the cells of the glands of the stomach is the basis of the pathogenesis of acute ulcers.

The most pronounced morphofunctional changes in the gastric mucosa, progressing in the dynamics of the disease, both when modeling acute strangulation and acute obstructive small intestinal obstruction are observed in its antrum, which explains the most frequent localization of acute ulcers in this part of the stomach [12,13,16,19], coincides with the data of other researchers.

The elucidation of the main stages of the formation of morphofunctional changes, as well as the morphometric parameters of the restructuring of the structures of the gastric mucosa, ensuring its protection against aggressive acid-peptic effects, expands ideas about the adaptation mechanisms of the digestive system, which is of theoretical and practical importance for theoretical and practical medicine.

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