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STRUCTURE OF THE SMALL INTESTINE MUCOSA AFTER ACUTE HEMORRHAGIC SHOCK AND REPERFUSION OF THE ISCHEMIC LIMB

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Abstract. The functional system of digestion and absorption, integrated with the immune system of the small intestinal mucosa, regulating the homeostasis of the internal environment of the body in the norm, is disrupted 1 hour after acute hemorrhagic shock, reperfusion of the ischemic limb of rabbits. The structures of enterocytes and microvilli, glycocalyx and supraepithelial layer of mucus are damaged. Their disintegration and inclusion of sIgA in their composition causes the translocation of microorganisms into the small intestinal mucosa. Correction with the antihypoxant succinasol effectively prevents ischemic damage to the intestine and the translocation of microorganisms and their toxins.

Keywords: small intestine, structure, enterocytes, epithelium, hemorrhagic shock, reperfusion.

INTRODUCTION

It is known that the mucous membrane of the small intestine, located on the border of the external and internal environments of the body, due to the presence of a huge number of microorganisms and their antigens, the intake of qualitatively and quantitatively unpredictable nutrients, has formed a perfect and adaptable functional system that ensures homeostasis. Thanks to it, under physiological conditions, digestion and absorption of nutrients are optimally carried out and regulated, the interaction and penetration of microorganisms and their antigens are prevented *1-4,14+. However, with some somatic diseases, shock, traumatic surgical interventions, the barrier-protective and homeostatic properties of the mucous membrane of the small intestine, the integration of

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its immune and digestive-absorption functions are disrupted *1,2,10,12,14+.

According to numerous studies, the mucous membrane of the small intestine, like the entire digestive tract, was located at the interface between the external and internal environments, experiencing the constant influence of substances of various chemical natures, developing and forming structures whose functions are to break down, form barriers, and regulate the homeostasis of the internal environment of the body [1].

MATERIALS AND METHODS

Acute hemorrhagic shock was produced in 76 chinchilla rabbits weighing 2.6±0.2 kg that had been fasted for 15 hours using a modified Wigger method [2]. Experimental procedure: animals were fixed to a machine, and the inguinal region was anesthetized locally with 0.5% novocaine solution. After surgical isolation of the right femoral artery, it was cannulated with a system of siliconized tubes filled with saline. Blood was released (2.4±0.1% of the animal's body weight) in fractions, every 15 minutes, according to the following schedule: 0.4; 0.3; 0.2; 0.1 parts of the total volume. Hemorrhagic shock is calculated from the moment the arterial pressure drops to 40 mm Hg. After reaching this level below the cannulation site of the femoral artery, a clamp was applied to it.

If the sequential physicochemical degradation of various nutrients is carried out due to the integration of the digestive organs into the functional system [2], then the barrier-protective immunity of the mucous membrane system, its integration with the functional one is the subject of intensive research. At birth of mammals, the structures and functions of the small intestine are relatively well developed [3]. However, the peripheral organs of the immune system, in particular the small intestine, are in their infancy. B-lymphocytes are characterized by "non-response" to antigens of food and microbial origin [4]. Given the biological feasibility of autonomous development of both digestion and immune dynamics of the change from natural milk nutrition to defective one, there is a need to study the mechanisms of their integration as the most optimal way to regulate homeostasis, to optimize the adaptation of the functional system of both the organ and the organ as a whole.

According to the purpose of the study, the mucous membrane of the jejunum and ileum, small intestine of white outbred rats at the age of 1, 3, 7, 14, 21 (natural breastfeeding) and 90 (definitive feeding) days after birth was examined using light and electron microscopy. Under the microscope MBS-9, the number of plaques was stereoscopically counted in the dynamics of age and along the small intestine; the number of lymphatic nodules in them, linear parameters, and relationships between stromal and immune cells were determined morphologically (light and electron microscopy).

RESULTS AND DISCUSSION

One hour after hemorrhagic shock and restoration of blood flow in the ischemic

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limb, the mesentery and intestine look paler than in animals of group 1. The vessels of the mesentery, going from its root to the intestine, are collapsed. The small intestine is slightly swollen, in some areas it contains gases and chyme with mucus. Light-optically, no visible damage to the villi and crypts is noted in the jejunum and ileum. Only a large part of the goblet cells and Paneth cells are almost devoid of secretion, the supraepithelial layer of mucus is unevenly thickened, the capillaries of the stroma of the villi are spasmodic. Electron microscopically, the supraepithelial layer is polymorphic, has a fibrillar structure and includes, in addition to extruded cells, microorganisms. The water-electrolyte layer, glycocalyx and microvilli on the surface of the limbic enterocytes of the villi do not have visible changes. The cytoplasm of the absorptive cells is heterogeneous: some are compacted, others are clear. In the former, the microvilli have a typical structure and have many endocytic vesicles between the bases. In their supranuclear cytoplasm, the Golgi complex is hypertrophied, the mitochondria are extended lengthwise with a moderately dense matrix and a number of cristae. In cleared enterocytes, the microvilli are in a state of partial or complete vesiculation, the number of ribosomes and polysomes is reduced, the mitochondrial matrix is clear, and the cristae are reduced. At their base or between enterocytes with a similar ultrastructure above the level of the basal membrane, as a rule, lymphocytes are determined, less often other leukocytes. If in rabbits of the 1st group interepithelial lymphocytes are single, then after 1 hour of shock and reperfusion of the ischemic limb, their number increases between enterocytes; neutrophils, eosinophils, macrophages, and rarely mast cells are also determined.

High rates of enterocyte renewal in the crypt-villus system require a constant blood supply, and with it, nutrients and energy. Oxygen is required for optimal utilization and provision of intensive processes in the small intestinal mucosa. If the nutrient and oxygen supply is disrupted, for example, due to acute hemorrhagic shock and reperfusion of the ischemic limb, the digestive-absorptive and immune functions of the small intestinal mucosa disintegrate. Despite the absence of a factor that has a direct effect on the small intestinal mucosa, shock and reperfusion, as can be seen from our data, damage the supraepithelial layer of mucus and other barriers integrating with it. As a result, there is a direct interaction of intestinal microorganisms with the glycocalyx and plasma membrane of the microvilli of enterocytes, their translocation into the cytoplasm and stroma of the villi of the small intestine.

In 3-month-old sexually mature rats with normal histological, light-optical and electron-microscopic intestinal microflora, the afferent link of the ISSO consists of 5–6 lymphatic nodules, dome-shaped protruding into the small intestine and lined with a single layer of prismatic epithelium, infiltrative, and numerous lymphocytes. Structurally and functionally, the lymphatic nodule has an embryonic (germinal) center, follicular (B-lymphocytes; Bl), parafollicular (T-lymphocytes; Tl) zones, and a dome (Tl and Tb). The

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surface of the dome is formed by M-single neuroreceptor [2] and numerous meta-epithelial T-lymphocytes. According to the literature, M cells transport antigens from the intestine by receptor-mediated endocytosis to interepithelially located antigen-binding T cells [1], which regularly migrate to the dome zone of the lymph nodes of plaques. In the latter, interacting with macrophages, they stimulate T and B blasts. If G. V. Pinegin, M. M. Karsova [3] consider high functional activity and weak ability to synthesize proinflammatory cytokines to be a characteristic feature of macrophages, then in the dome zone their activity is determined by the properties of the digested antigen. On this basis, the differentiation of stimulated T and B blasts is regulated in the dome zone.

The lymph node zones have a characteristic cell composition in the plaques along the small intestine, and it does not differ significantly when compared with the data of other authors [4]. If in 3-month-old rats the number of Peyer's patches along the small intestine varies from 17 to 28 (on average 24.5±1.8), then in one-day-old rats they are barely detectable, in particular in the duodenum and ileum. They represent a diffuse accumulation of lymphocytes with the proper plate of the mucous membrane. In the dynamics of age (1, 3, 7, 14, 21 and 90 days after birth) the number of Peyer's patches constantly increases. After 2 weeks, when the animals switch to mixed feeding, their number increases to 10.5 ± 1.4 and the germinal zone appears for the first time, where blast and lymphatic dividing lymphoblasts are concentrated. Macrophages are single, contain a moderate number of polymorphic liposomes in the cytoplasm. After the animals switch to final feeding, the number of Peyer's patches along the small intestine becomes the same as in rats. In addition, all the characteristic afferent link of the ISSO, structural and functional zones, and epithelium, which is infiltrated by T-lymphocytes, are clearly formed.

CONCLUSION

1. Structural and functional damage to the supraepithelial layer of mucus, the mucous membrane of the small intestine in acute hemorrhagic shock and reperfusion causes direct interaction of microorganisms with the microvilli of enterocytes, their translocation into the absorptive cells and stroma of the villi, phagocytosis and digestion by macrophages, activation of immunocytes and other connective tissue cells.

2. Succinasol effectively prevents structural and functional damage to the mucous membrane of the small intestine and, as a consequence, the interaction of intestinal microorganisms with the glycocalyx and microvilli, their translocation into the internal environment.

Thus, in the small intestinal mucosa in early postnatal ontogenesis, highly adapted digestive-absorptive and immune systems are simultaneously formed, closely integrating with each other. By the time of transition to definitive nutrition, several stages of digestion are formed, interconnected with SJgA, due to which homeostasis of the internal environment of the body is ensured, protection of antigens contained in food and

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microorganisms. The third, water-electrolyte level is located as a thin strip between the NESS and the glycocalyx of enterocytes lining the surface of the small intestinal mucosa. It is balanced in electrolyte composition, pH, sterile, contains only enteric enzymes, a high concentration of SJgA [3]. The fourth level of regulation of homeostasis of the internal environment should be considered the glycocalyx and plasma membrane of the microvilli of enterocytes of the villi.

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