CHANGES IN THE ANATOMO-HISTOLOGICAL STRUCTURE OF BLOOD VESSELS AND NERVES OF THE SMALL INTESTINE AFTER RESECTION OF ITS HALF IN AN EXPERIMENT

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Abstract. The article describes an experimental study in cats where a portion of the small intestine was surgically removed. At specified intervals, the vascular-nerve relationships were examined by injecting the intestinal vessels with a chloroform-ether mixture containing finely ground Paris blue dye. Subsequently, the nerve tissue was impregnated with silver nitrate using the Bielschowsky-Gross method. Based on the condition of the neurovascular elements of the small intestine at various time points following resection of half the organ, it is possible to approximately assess the degree of regenerative processes, their plasticity, and the ability to compensate for the function of the removed portion.

Keywords: experiment, cat, Bielschowsky-Gross method, small intestine resection, blood vessels and nerves, morphometric analysis.

ИЗМЕНЕНИЯ АНАТОМО-ГИСТОЛОГИЧЕСКОЙ СТРУКТУРЫ СОСУДОВ И НЕРВОВ ТОНКОЙ КИШКИ ПОСЛЕ РЕЗЕКЦИИ ЕЕ ПОЛОВИНЫ В ЭКСПЕРИМЕНТЕ

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Аннотация. В статье в экспериментальных условиях у кошек оперативным путём удалялась часть тонкой кишки, в определённые сроки изучались кровеносно-сосудисто-нервные взаимоотношения путём инъекции сосудов кишки смесью хлороформа-эфира с измельчённой краской - парижской синькой, затем нервная ткань импрегнировалась нитратом серебра по методу

Бильшовского - Гросса. По состоянию нервно-сосудистых элементов тонкой кишки в разные сроки после резекции её половины можно в приближённой мере судить о степени восстановительных процессов в них, их пластичности и способности восполнить функцию удалённой части органа.

Ключевые слова: эксперимент, кошка, метод Бильшовского - Гросса, резекция тонкой кишки, кровеносные сосуды и нервы, морфометрический анализ.

Introduction. Reconstructive intestinal surgery currently remains one of the most complex areas of clinical surgery [1,2,3]. This is due to the technical difficulties of surgical interventions, high postoperative mortality rates, a large number of complications, and low quality of life for operated patients [4,5]. Relatively few studies are devoted to changes in the finest neurovegetative and vascular structures of the small intestine after resection of its part, whereas these components of the intestinal wall are primarily responsible at the local level for the intense, multifunctional activity of this organ [6,7,8].

Study Objective. To investigate changes in the anatomo-histological structure of blood vessels and nerves of the small intestine after resection of its half in an experiment.

Materials and methods. Experiments were performed on 18 adult cats, in which, under ether anesthesia after midline laparotomy, half of the small intestine (about 40-50 cm) was removed in its middle section with end-to-end anastomosis. The experimental periods were 1, 6, 15, 30, and 90 days. Ten normal animals that underwent laparotomy without intestinal resection served as controls. Vascular-nerve relationships in the intestine were studied by injecting the vascular bed with a chloroform-ether suspension of finely ground Paris blue dye, followed by impregnation of nerve tissue with silver nitrate using the Bielschowsky-Gross method. The resulting film preparations were cleared and subjected to morphometric analysis.

Results. In experiments with small intestine resection, at 1-6 days post-operation, uneven filling of the vascular bed with the injection mass was observed in the afferent and efferent loops, as well as in the area of the myenteric plexus. Arterial and venous links of the microhemocirculatory bed were narrowed. The capacity of microvessels in nerve ganglia per unit area of 0.01 mm^2 was 86.7 ± 4.04 μm^2 in the afferent loop (normal: 136.1 ± 4.4 μm^2, $p<0.001$) and 105.8 ± 5.3 μm^2 in the efferent loop (normal: 153.0 ± 9.9 μm^2, $p<0.001$). Ganglia and strands of the myenteric plexus were difficult to impregnate. Signs of irritation and severe damage to nerve cells were visible, manifesting as argyrophilia, deformation of cell bodies, shrinkage, coarsening and tortuosity of processes, varicose nerve fibers, and the appearance of thin spinous outgrowths on neurocyte bodies. The area of neurocyte-capillary contacts decreased. Starting from day 15 of the experiment, spasm of arterial vessels weakened in the vascular bed of the myenteric plexus and the afferent and efferent segments of the small intestine, while venous congestion increased. The diameter of arterioles supplying blood to ganglia was 19.9 ± 0.53 µm (normal: 21.7 ± 0.49 µm, $p<0.05$); venules – 46.2 ± 0.95 µm (normal: 36.4 ± 0.65 µm, $p<0.05$). The capacity of their microcirculatory bed also increased, reaching 140.5 ± 5.8 μm^2 in the afferent loop ($p>0.05$) and 119.2 ± 3.0 μm^2 in the efferent loop ($p<0.05$). The area of neurocyte-capillary contacts increased, and in isodendritic bipolar neurocytes, it exceeded baseline values. At the same time, alongside dystrophic changes in the nerve structures of the myenteric plexus, compensatory-adaptive manifestations were noted. Nerve cells in the ganglia of the afferent loop hypertrophied. The field of view was dominated by neurocytes with a diameter greater than 45-50 µm, whereas in normal conditions they were rare. By day 30 of the experiment, further stabilization of neurovascular relationships in the myenteric plexus of the small intestine occurred. The vascular bed in both afferent and efferent sections was filled with contrast mass. The network of microhemovessels in ganglionic areas was dense, continuous, with numerous straight, transverse, and oblique anastomoses. Capillary loops around neurocytes often assumed a closed shape, encircling them from all sides. The area of neurocyte-capillary contacts approached normal values and remained at this level until day 180 of the experiment. Adequate blood supply promoted the progression of regenerative processes in nerve structures. On days 90-180 post-operation, the diameter of blood vessels surrounding ganglia and distributing between neurocytes decreased, especially in the efferent loop. Capillary loops evenly enveloped neurocytes in ganglia and had a lumen diameter of 9.1 ± 0.4 μm (normal: 8.9 ± 0.26 μm, $p>0.05$). Arterioles, postcapillaries, and venules approached normal lumen diameters, while precapillaries remained narrowed. No particular changes were observed in the structure of neurocytes in the myenteric plexus of the afferent loop, except for hypertrophied neurocytes and some argentophobic cells with vesicular nuclei. In the efferent loop, argyrophilic and argentophobic isodendritic neurocytes with massive cytoplasmic and single spinous outgrowths deforming cell bodies were present simultaneously. The number of multipolar isodendritic neurocytes was slightly increased compared to bipolar ones. The ganglion area per neurocyte decreased in the afferent loop from 0.023 ± 0.013 mm^2 (90 days) to 0.017 ± 0.001 mm^2 (180 days), and in the efferent loop to 0.019 ± 0.0008 mm^2. The described changes suggest that neuroblasts are mobilized to replace dead neurocytes. This explains the observed increase in the number of neurocytes per ganglion, leading to a reduction in the ganglion area per neurocyte. Analysis of the results showed a close relationship between the structural-spatial organization of microcirculation pathways in the myenteric plexus of the cat's small intestine, reflecting the level of its vascularization, and the state of regenerative processes following resection of half the organ. This serves as the morphological basis for activating local neuro-reflex reactions aimed at restoring lost and acquiring new contacts between neurocytes and innervated tissues.

Conclusion. The study results indicate that the condition of neurovascular elements of the small intestine at different times after resection of its half can approximately assess the degree of regenerative processes, their plasticity, and the ability to compensate for the function of the removed portion. Developing measures to improve microcirculation in the small intestine after its resection may contribute to more effective restoration of its finest neurovascular relationships and functional activity of the organ.

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