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Morphological Manifestations of Stress in Experimental Thermal Injury

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ABSTRACT

Histochemical, luminescent-histochemical and special methods were used to study the structures of the duodenum containing stress monoamines (catecholamines and serotonin), and the morphology of regional spinal nodes under conditions of experimental thermal injury. Varicose changes in adrenergic nerve fibers and quantitative tinctorial changes in catecholamines and serotonin in the cytoplasm of endocrinocytes of the open type of the diffuse endocrine apparatus of the duodenum and retrograde changes in the neurons of the spinal ganglia were revealed.

KEYWORDS: Duodenum, Catecholamines, Serotonin, Spinal Ganglia.

INTRODUCTION

Some cells and tissues contain monoamines, which exposed to certain substances, give color fluorescence and, by studying the configurations and localization of these glows under a fluorescent microscope, one can judge the morphology of these monoamine-containing structures. The intensity of these glows depends on the quantitative content of luminescent monoamine in the composition of certain morphological structures, and the color of the glow depends on the type of monoamine. With the content of the monoamine complex, the hue of the glow depends on their quantitative ratio. Therefore, by studying the degree of luminescence of these monoamines, it is possible to judge the functional and pathological changes in these structures. Many morphological research methods are based on this. Adrenaline and norepinephrine are mediators of the sympathetic nervous system, they respond quantitatively and qualitatively to the stress state of the body. They are produced by the chromaffin tissue of the adrenal gland, autonomic sympathetic neurons and nerve cells of the central nervous system. When treating the studied structures with a solution of glyoxylic acid, catecholamines give an emerald-green glow. These methods are mainly used to identify adrenergic nerve structures (adrenaline-containing nerve structures, as well as catecholamine-containing endocrine cells of the diffuse endocrine system). Another monoamine contained in these structures, when using the above methods of research, giving a glow from yellowish green to white, is serotonin. This bioamine, produced by EC cells (enterochromaffin cells), is involved in many functions of the body in general, in regulating the production of mucus, digestive enzymes and in regulating the function of smooth muscle tissue in the organs of the gastrointestinal tract. At the same time, with an increase in the concentration of serotonin in the structures, yellow and white glow prevails, and with the predominance of the number of catecholamines, the green hue of the glow increases. Consequently, by the color of the fluorescence of morphological structures, it is possible to indirectly judge the presence of one or another monoamine in the studied structures. Fluorescent nerve structures and endocrine cells contain both catecholamines and serotonin. In such cases, the ratio of green and yellow glow in the studied morphological structures can indirectly judge the quantitative ratio of a particular monoamine in them. At a certain concentration of catecholamines (adrenaline, norepinephrine), there is greener in the glow, and in those cases when there is more serotonin and less catecholamines in the structure, yellow glow prevails. A significant amount of research has been devoted to the study of the diffuse endocrine system and adrenergic nervous structures, both in theoretical and practical terms. There are recent studies devoted to the morphology of the diffuse endocrine system [5] and neurohumoral regulation of the functions of the villi of the duodenum. However, the comprehensive study of these two regulatory peptides lags far behind the requirements of today. Based on this, we have studied the morphology of adrenergic (sympathetic) nerve structures and fluorescent cells of the diffuse endocrine system (open type endocrinocytes) of the duodenum. Any adaptive-

trophic process normally and in pathology occurs with the participation of blood vessels, the functional activity of which depends on their nervous apparatus. Consequently, biogenic amines of open type cells of the APUD system and mediators of the sympathetic nervous system (catecholamines) as structures containing stress monoamines, they are also full participants in the regulation of the body's response to extreme factors in general with burn injury in particular. Studying of morphology [5,6,7] and clinical aspects [2,3] of adrenergic (sympathetic, monoaminergic) nervous structures of internal organs and vessels continues in the 21st century. There are also studies on the involvement of the sympathetic nervous system in the pathology of angiogenesis [8].

Identification of morphological changes of internal organs in severe burns is one of the urgent problems. Studying them, especially in the organs of the digestive tract, expands pathogenetic ideas about the origin and prevention of pathological changes due to acute stress. The stress process is accompanied by an increase in catecholamines (adrenaline, norepinephrine) and serotonin in the body, which affects the activity of organs and their vessels. From this point of view, the study of the luminescent-histochemical and tinctorial properties of these monoamines in the structures of the duodenal wall is relevant. Also, the study of the morphology of monoaminergic (adrenergic and serotonergic) nerve structures and open type endocrine cells located in the epithelium of the mucous membrane and containing these monoamines, which regulate their functional activity, and their reactive changes in response to extreme exposures is an urgent issue, the solution of which will help to clarify the pathogenesis of burn stress to a certain extent. Considering that adrenaline and norepinephrine are mediators of the sympathetic nervous system, and serotonin regulates the activity of smooth muscle tissue of internal organs, it is obvious that the assessment of their luminescent-histochemical changes is one of the urgent problems of modern morphology. There are studies devoted to the morphology of internal organs in response to thermal trauma. However, the morphology of these regulatory structures in experimental thermal trauma is almost not studied. The morphology of open-type endocrinocytes containing the same monoamines is also insufficiently studied. It was found that the open type cells of the diffuse endocrine system constitute the "system of primary response, notification and protection" of the body [4]. It was noted that reaching the surface (open-type endocrinocytes) of the mucous membrane and the cavity of the digestive tract, these structures, which initially experience changes in chemoreception and chemoreceptive effects on the inner surface and participate in all functional and pathological processes of these organs. This once again emphasizes the pathogenetic relevance of studying their morphology in the light of clarifying the role of thermal stress in burn disease.

THE PURPOSE OF THE RESEARCH

To study the morphology of duodenal zone structures containing stress monoamines in experimental burn injury.

MATERIALS AND METHODS OF THE RESEARCH

The studies were conducted on 15 rabbits, 3 of them made up a control group. Burn injuries were simulated in 12 rabbits [1]. The experiments were carried out under Nembutal anesthesia with strict adherence to the rules of bioethics. 6 rabbits were euthanized 5 days after the experiment and 6 rabbits were euthanized 10 days later. Euthanasia was also performed under anesthesia with Nembutal in accordance with the rules of bioethics. The first fragments of the obtained material were frozen in a cryostat (without fixation), histotopographic sections were made of them, which were treated with a solution of glyoxylic acid according to the method of Shvalev V.N. and Zhuchkova N.I. Preparations treated with glyoxylic acid were studied and photographed under a LUMAM-I2 luminescent microscope using FS-1-4 and FS-1-6 filters.

RESEARCH RESULTS

As part of the epithelium of the duodenal mucosa, endocrinocytes belonging to its diffuse (dispersed) endocrine system, located singly between epithelial cells, were identified. The broad basal part of these cells is located on the membrane of the same name. The round-shaped nucleus is located in the center of the cell. Our luminescent histochemical studies have also shown that the secrets of these cells contain catecholamines (epinephrine and norepinephrine) and serotonin, which belong to stress monoamines. The higher the number of catecholamines in the secret of cells, the more intense the emerald-green glow, and the higher the amount of serotonin, the brighter the yellow hue of the glow. Our studies have shown that the ratio of open type endocrinocytes in the duodenal epithelium varies to some extent depending on cell activity. When viewed under a fluorescent microscope, the cytoplasm of these cells show heterogeneous fluorescence. When viewed under a fluorescent microscope, the cytoplasm of these cells exhibits non-uniform fluorescence. Areas containing adrenaline are green and areas containing serotonin are yellowish When viewed under a fluorescent microscope, the cytoplasm of these cells exhibits non-uniform fluorescence. Areas containing adrenaline are green and areas containing serotonin are yellowish The areas containing adrenaline are green, and the areas containing serotonin are yellowish (fig.1). The second structure containing the aforementioned monoamines in the intestinal wall turned out to be adrenergic nerve structures in the vascular wall.

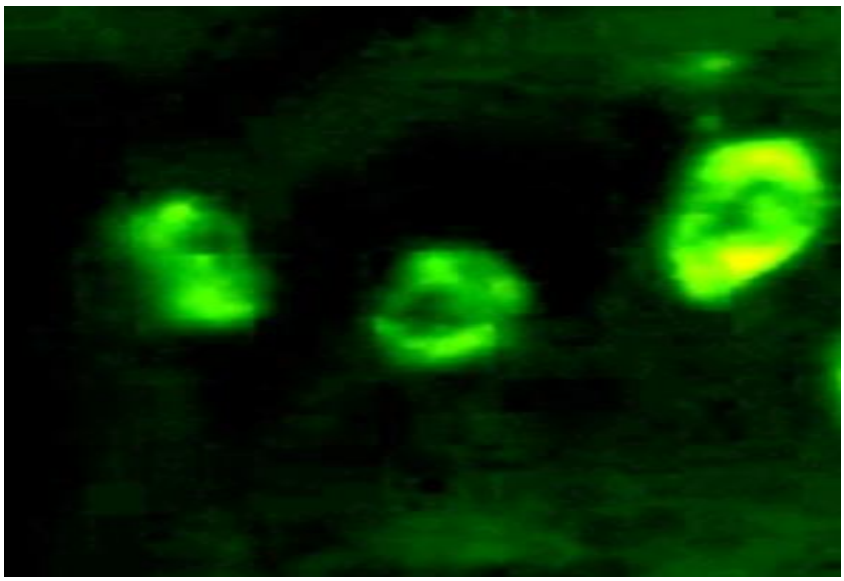


Figure 1. Open-type endocrine cells of the duodenum of a control rabbit. Method of treatment with a solution of glyoxylic acid. x200.

These nerve fibers also glow emerald green due to their catecholamine content. They are located mainly along the wall of the intestinal arteries and have the appearance of a luminous green case in the perivascular sheath that surrounds them from the outside (fig.2).

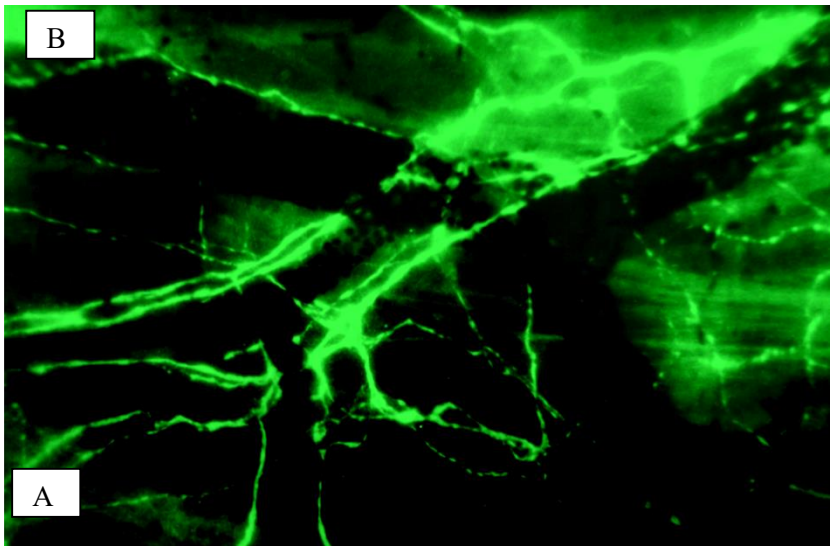


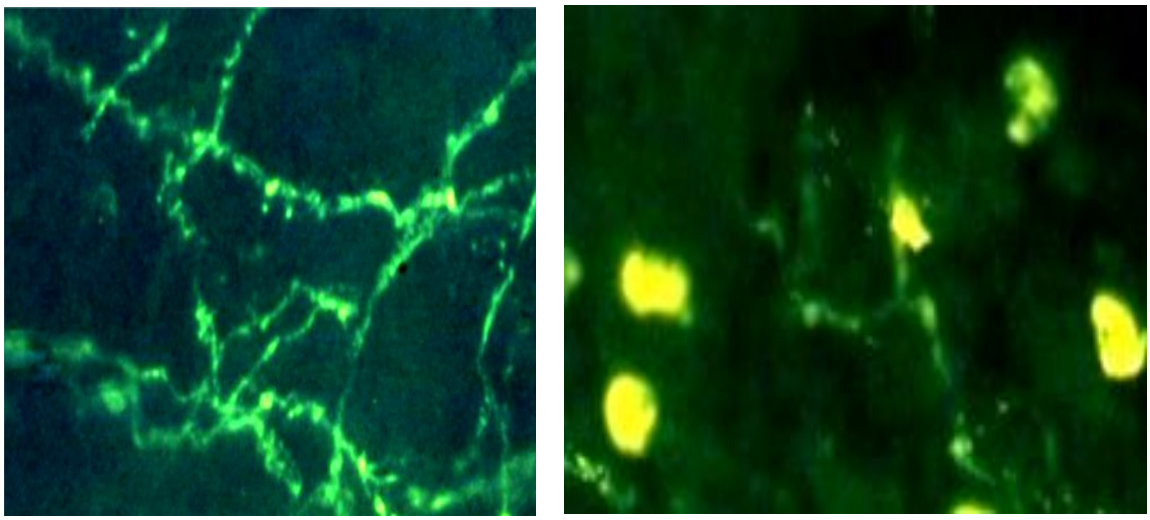
Figure 2. Perivascular plexus and separate adrenergic nerve fibers in the walls of the artery (A) and vein (B) of the rabbit duodenum. Method of treatment with a solution of glyoxylic acid. x200.

On the transverse sections of the arteries, it was noticed that these adrenergic fibers form an intrahepatic plexus located in their muscular membrane.

On the 5th day after the experimental thermal injury, reactive changes mainly occur in the stress monoamine-containing structures of the duodenum. In particular, as a result of the extrusion block in open endocrine cells, the secret accumulates in the cytoplasm of all cells located in the epithelium, which increases the degree of luminescence. In the adrenergic nerve fibers around the arteries, the radiance of mediators increases, and as a result of a violation of the distribution of mediators, the number and size of intensely glowing varicose veins increases.

By the 10^{th} day after thermal trauma, there is a general degranulation of endocrine cells, around which many granules appear, the tinctorial properties of which correspond to secretory granules in the cytoplasm and are practically indistinguishable from them by luminescence. Some granules are connected to the cytoplasm of the cell by a thin leg. It can be assumed that these are separating secretory granules from the cell. We observed that the secretion of open-type endocrinocytes mainly originates from their basal part.

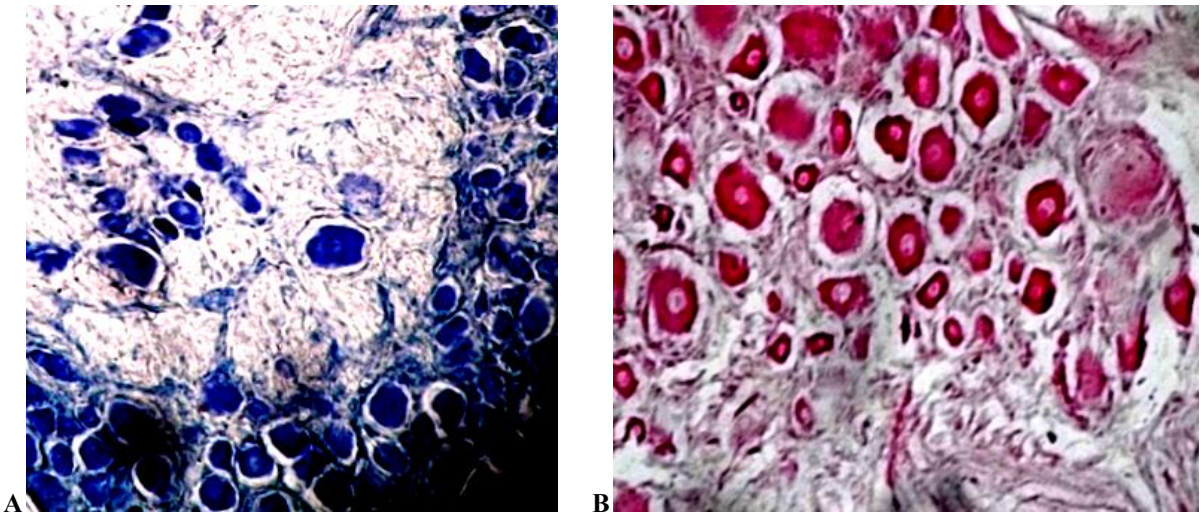
The phenomenon of basal degranulation leads to the hypothesis that information about chemoreception obtained by open-type endocrine cells can be transmitted to nerve structures using biogenic amines, because where there are many open-type cells in the epithelium, there are many adrenergic nerve fibers under the basement membrane and vice versa. 10 days after experimental thermal exposure, the degree of radiance of the adrenergic perivascular plexus decreases slightly, and the size and number of varicose extensions of nerve fibers increase in size (fig.3A). Serotonin increases in the cytoplasm of endocrine cells, and the yellow hue of the glow increases in their cytoplasm (fig. 3B).



A B

Figure 3. The 10th day after the experimental thermal burn. Adrenergic nerve fibers with varicose swellings (A) and endocrine cells of an open-type containing more serotonin (B) in the duodenal wall of a rabbit. Method of treatment with a solution of glyoxylic acid. x200.

To study the morphological basis of pain stress, we studied the morphology of 9-10 thoracic spinal ganglia involved in receptor innervation of the duodenum. In case of burn injury, retrograde changes occur in the bodies of the sensitive neurons of these nodes, which is expressed in the form of pyknotic changes and tinctorial changes in the tigroid substance (fig.4).



A B

Figure 4. Morphological changes in the bodies of neurons of regional spinal ganglia on the 10th day after experimental burn injury. Pyknosis and chromatophilia (A), pyroninophilia and pyknotic changes (B).
A-Nissl staining; B- Brachet staining. x200.

A light ring appears around the bodies of these neurons due to a pyknotic change. A certain number of neurons undergo pyroninophilia.

CONCLUSION

Thus, pain stress during experimental thermal trauma causes morphological and luminescent-histochemical changes in the regulatory structures of the duodenal wall containing stress monoamines (adrenergic nerve structures of blood vessels and open-type endocrine cells), as well as retrograde changes in the bodies of receptor neurons of spinal ganglia involved in sensitive innervation of the intestine. These morphological changes in the complex can lead to disruption of the functional activity of the intestine and the appearance of pathological changes in it.

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