Catecholamine Supply and Morphofunctional Characteristics of Lymph Nodes of Different Specialization under Conditions of Acute Intoxication with Benzpyrene

V. A. Izranov

UDC 616.428-018-02:615.277.4]-092-07

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 116, № 12, pp. 636-638, December, 1993
Original article submitted June 29, 1993.

Key Words: *benzpyrene; catecholamines; lymph nodes*

Benzpyrene is a widespread representative of polycyclic aromatic hydrocarbons and is one of the indicators of contamination of the environment [4]. Its embryotoxic, teratogenic, and carcinogenic effects are well known [5]. The effect of benzpyrene on lymphoid tissue as a bridgehead for the development of immune reactions of the organism has been studied to a lesser degree.

The aim of the present investigation was to find a correlation between the morphofunctional and cytological changes of lymph nodes of different specialization and the catecholamine dynamics in the structural components of organs under conditions of benzpyrene intoxication.

MATERIALS AND METHODS

For the study, 9 Wistar rats were injected i.p. with benzpyrene at 30 mg/kg body weight twice (total dose 60 mg/kg) over 2 days. On the day after the second injection the animals were decapitated. Intact animals (5 rats) were the control. The popliteal, inguinal, mesenteric, iliac, and mediastinal lymph nodes were studied. When taken, every node was dissected in two at the level of the hilus. One part was put in Tellesnitskii fixative. Paraffin slides prepared routinely were stained with azure-eosin, and subjected to morphometrization of the functional zones and the cellular composition was determined on a standard area of 1600 μ^2. The second part of each organ was frozen in a cryostat and processed by the luminescence-histochemical method to detect catecholamines [2]. The relative content of catecholamines was determined by the microfluorometric method using a LYuMAM-IZ microscope with a FMEL-IU attachment. The density of adrenergic nerve fibers was determined by the point technique using methods described elsewhere [2].

Department of Normal Anatomy, Novosibirsk Medical Institute. (Presented by Yu. I. Borodin, Member of the Russian Academy of Medical Sciences)

RESULTS

The spatial density of free sympathetic terminals in the cortical substance is markedly decreased (2.71±0.13 versus the normal 3.43±0.14 c.u.) in the mesenteric lymph node of the experimental group of animals as well as that of the free sympathetic terminals in the stromal elements (2.21±0.09 vs. 2.67±0.09 c.u. in the norm). The level of catecholamines in the nerve fibers shows a significant drop, which is more pronounced in varicoses of sympathetic terminals, regardless of their localization both in the cortical (124±6.1 c.u.) and in the medullary (128±6.2 c.u.) substance (normally 151±5.2 and 183±6.1 c. u., respectively). There is no decrease of transmitter concentration in the intravaricose regions.

The catecholamine content in the perivascular sympathetic plexuses remains on the intact level.

0007-4888/93/0012-1545$12.50

The concentration of catecholamines in the parenchyma of the cortical and medullary substance is not changed as compared to the intact animals.

The cortico-medullary index decreases to 0.5 (in the norm 0.83) due to an increase of the relative area of the pulp cords and medullary sinuses and a decrease of the area of the paracortical zone. Synchronously with the decrease of the relative area of the cortical substance as compared to the intact animals the area of the germinative centers of the primary nodes increases. The number of matured plasmocytes rises in the medullary cords.

The spatial density of the sympathetic innervation in the iliac lymph node tends to decrease markedly for all types of adrenergic fibers evenly.

The relative catecholamine content significantly decreases in the varicoses of the free sympathetic terminals in the cortical and medullary substance and stromal elements (132±6.5, 121±6.1, and 123±6.1 c.u. vs. the corresponding normal parameters 173±8.7, 154±7.2, and 163±8.2 c.u.).

There is only a tendency toward a decrease of the catecholamine level in varicoses of the perivascular sympathetic plexuses. The transmitter concentration in the cortical and medullary substance and in the stromal elements is not changed.

The morphometric analysis for light microscopy revealed a decrease of the relative area of the cortical substance and an increase of the medullary area due to the pulp cords and medullary sinuses. In spite of a decrease of the relative area of the peripheral cortex (10.3±5.1 vs. 17.4±0.87 normally), there is an increase of the area of the germinative cénters (2.86±0.14 vs. 1.91±0.09). The cell composition of the organ changes mostly in the pulp cords, namely there is an increase of the number of mature plasma cells.

Other results are obtained in the study of the popliteal lymph nodes. All experimental animals preserve the intact level of catecholamine supply, the cell composition, and general structure of the popliteal lymph nodes. Characteristic for lymph nodes localized outside the peritoneal cavity, both somatic (the inguinal lymph node) and visceral (the mediastinal lymph nodes), is just a tendency toward a lower catecholamine supply, which does not reach the level of statistical reliability. The cellular composition of these organs and the relative area of the structural components do not change.

Thus, it was found that the density of distribution of the adrenergic nerve fibers in the lymph nodes localized in the peritoneal cavity is decreased and the intensity of catecholamine luminescence in these structures is lowered.

It was also found that depletion of transmitter in the adrenergic nerve fibers of the peritoneal lymph nodes occurs locally, the supply being preserved in the nerve trunks along the vessels and in the largest nerve terminals. In some parts the transmitter is preserved but the intensity of its luminescence is lower. This is evidence that the perivascular sympathetic plexuses are more resistant to the toxic impact and display a lesser lability than the adrenergic terminals. Tayushev et al. showed [3] that for an impact on the hypothalamus the adrenergic nervous elements of the rat mesenteric lymph nodes tend to show inhibition of functional activity, which is most pronounced in the nervous apparatus of intraorganic blood vessels. The present study demonstrates that the perivascular sympathetic plexuses of lymphoid organs are more resistant to external impacts than are the free sympathetic terminals.

The analysis of the general construction of the organs in benzpyrene intoxication permits several assumptions to be made. The i.p. administration of the toxicant caused the rearrangement of the peritoneal lymph nodes. The cortico-medullary (C/M) index markedly decreases in the mesenteric and iliac lymph nodes due to a shrinking of the relative area of the cortical substance and an increase of the medullary area. There is a significant increase of the area of B-zones in these organs, which are the germinative centers and pulp cords. The changes of the cell composition of the organs also attest to the involvement of the B-component of the immune system in the process, namely the number of plasma cells reliably rises in the pulp cords of the mesenteric and iliac lymph nodes.

However, the typological construction of a node changes depending on the initial state of the organ. The mesenteric node, normally belonging to the fragmentary type (C/M index 0.83), under conditions of acute postnatal benzpyrene intoxication aggravates the features of this type (C/M index 0.5, an increase of the relative area of the sinus system). A decrease of the relative area of the cortical substance due to a decrease of the paracortical zone is characteristically accompanied by a marked lowering of the spatial density of the free cortical sympathetic terminals localized predominantly in the paracortex. The change of the general architectonics of the iliac node takes the same direction. However, the initial state of the organ (it belongs under intact conditions to the compact type, C/M index 2.01) determines its more radical rearrangement, resulting in its transference to another type of group - that of the fragmentary nodes.

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Changes in the Blood-Brain Barrier During Experimental Cirrhosis of the Liver

V. A. Mishchenko, O. A. Goryukhina, and R. D. Ilyuk

UDC 616.831-002:616.36-004

Translated from *Bulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 116, № 12, pp. 638-641, December, 1993
Original article submitted July 28, 1993

Key Words: *blood-brain barrier; experimental liver cirrhosis*

The state of the blood-brain barrier (BBB) is essential for nervous system functioning and for vital activity as a whole. According to current notions, the barrier is represented by perivascular processes (connecting piece), capillaries including the endothelium, and a basal membrane with cells closely knit with it - pericytes and mast cells. The basal membrane consists of two components: an acellular component, characterized by a fibrillar structure and amorphous substance adjoining the endotheliocytes, and a cellular component, represented by pericytes composing a duplicate of the basal membrane [9]. Numerous pericyte processes envelop the capillary, some of them penetrating through the acellular component of the basal membrane and terminating on endotheliocytes. Pericytes are believed to contribute to the capillary "motor innervation" and to transfer to capillaries information on changes in the metabolic environment. As a result, brain capillary endotheliocytes develop a response to biologically active substances such as histamine, serotonin, etc. [13].

Other authorities [8] believe that pericytes also produce an intermediate substance and act as a barrier.

The processes of the plasmalemma laminar surface (glycocalyx) contribute to metabolite capture and transfer from the capillary bed.

Recently tissue basophils (mast cells) with organ specificities typical of the nervous system were referred to the BBB [5]. These cells are considered to be mediators regulating metabolic processes by secreting and absorbing from adjacent tissues bioactive substances (histamine, serotonin, heparin, catecholamines, and some proteolytic enzymes).

The brain's microcirculation is 85% controlled by astrocyte perivascular processes [1,7]. These cells provide not only support and transport of substances to neurocytes, but an oxygen reserve as well, which is indispensable for them, particularly so in extreme situations.t Such a conclusion was drawn in a study of the animal brain's reaction to hypoxia [5]. Neurocytes directly adjacent to the capillary wall in the hypothalamic area were found to be the first to react to hypoxia. Besides, astro-

Department of Nervous Diseases, St. Petersburg State Medical Institute of Sanitation and Hygiene. (Presented by I. P. Ashmarin, Member of the Russian Academy of Medical Sciences)

0007-4888/93/0012-1547$12.50