Structural Characteristics of Rat Tracheal Wall and Its Lymphoid Formations in the Acute Period of Hemorrhagic Stroke

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The effect of experimental hemorrhagic stroke on the structure of the wall and lymphoid formations in the lower portion of the trachea was studied on male Wistar rats. Destruction and extensive desquamation of epithelial cells, edema of the submucosa, and hemorrhages were detected in the tracheal wall. Redistribution of lymphoid cells in lymphoid structures, increase in their number in the epithelium, intensification of lymphoid cell degradation in all structures of the tracheal wall indicate disorders in local immunity.

Key Words: *hemorrhagic stroke; lymphoid structures; trachea*

Results of numerous clinical observations suggest that the complications of stroke more often become the causes of death than the underlying disease. Early complications of hemorrhagic stroke are tracheobronchitis and pneumonia [1,7] developing in 20-25% patients [6]. The reaction of lymphoid formations of the respiratory organs under these conditions is virtually not studied. On the other hand, it is worthy of note that the relationship between the nervous and immune systems was confirmed by numerous findings [5,10,11].

We studied the effect of experimental hemorrhagic stroke on the cytoarchitectonics of lymphoid formations in rat tracheal wall.

MATERIALS AND METHODS

The lower compartment of the trachea was studied in 30 male Wistar rats (250-300 g). Stress resistance of animals was evaluated by their behavior in the open field test [4] and stress-sensitive animals were selected. The animals were divided into 3 groups: intact, control, and experimental, 10 rats per group. Hemorrhagic stroke was induced in experimental animals in the left caudate nucleus area by a modified method (two injections of autoblood) [9]. Autoblood (60 μl) without heparin was injected to narcotized animals (400 mg/kg chloralhydrate intraperitoneally) by stereotaxic coordinates (A 0.7 mm, L 3 mm, H 6 mm) through a 0.5-mm hole in the skull through a needle No. 22 with a rounded tip. After 5 min the cannula was slowly removed, the hole in the skull was closed with dental cement, and the skin was sutured. By its location, hemorrhagic stroke corresponded to hemorrhages developing in humans after rupture of the lenticulostriatal arteries.

Controls were subjected to the same manipulations except blood injection. The animals were decapitated on the next day after surgery. All manipulations on animals were carried out in accordance with the Order of the Ministry of Higher Education of the USSR No. 742 of November 13, 1984 "On Regulations of Studies on Experimental Animals". The material was fixed in 10% neutral formalin. Paraffin sections (4-5 μ) were stained with azur II and eosin, hematoxylin and eosin, after Brachet and van Gieson. The cells were counted on a standard area of a histological section (880 μ^2) in 10 visual fields. The results of estimations were statistically processed.

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Changes in cell counts in lymphoid formations were evaluated using SPSS software (T test for paired comparison and analysis of the variables, ANOVA).

RESULTS

Significant structural changes develop in the tracheal wall of rats during the acute period of hemorrhagic stroke. The first event is destruction of the epithelial layer along its entire length. Destruction involves not only the cilia, but also the apical parts of ciliary cells. Thinning of the basal part of epitheliocytes and their complete detachment from the basal membrane develop in the presence of cell decomplexation. The epithelium is populated by lymphocytes. The number of small lymphocytes among epithelial cells varies from 0 to 3 per unit of examined area of tracheal wall section. Lymphocytes and erythrocytes are released into the lumen of the organ.

The lamina propria of the mucosa and the submucosa of the tracheal wall are edematous. Solitary lymphocytes are seen in the glandular lumen. Lymphoid accumulations are surrounded by dilated lymph vessels with coagulates in the lumen. Blood vessels are plethoric, their walls are thick and edematous. Erythrocyte aggregation and parietal stasis are seen in the lumen of blood vessels. Hemorrhages in the lymphoid accumulation parenchyma and in the adventitium are detected.

These morphological signs can be caused by microcirculatory disorders in the tracheal wall, resulting from changes in the regulation of the vascular tone and in blood rheology under conditions of hemorrhagic stroke [2,3].

Control animals also developed changes in the tracheal wall structure, consisting in partial destruction of the tracheal epithelial lining. Epitheliocyte changes consisted in adhesion of the cilia and their destruction. Signs of the epithelium decomplexation were seen. Epithelial cells lost their apical parts. The submucosa changed less in comparison with the experimental group. Blood vessels were dilated, plethoric, but without parietal stasis of erythrocytes, observed in the experimental group.

In addition to structural changes in elements of the tracheal wall, experimental hemorrhagic stroke led to the development of quantitative changes in the lymphoid tissue composition. Cell density in the central part of the lymphoid nodule increased significantly in experimental animals (from 29.00±2.13 in the control to 37.30±1.35 in experiment). An opposite picture was observed in the apex and base of the lymphoid nodule: cell density decreased from 33.80±2.28 and 33.10±1.96 in the control to 32.80±1.71 and 27.30±0.74 in experiment, respectively). These data indicate redistribution of lymphoid cells as early as on day 1 after hemorrhagic stroke (Fig. 1).

The number of destroyed lymphoid cells increased during the acute period of the disease, especially in the apex and in the central part of lymphoid nodules, where their numbers increased by 2.6 and 2.8 times, respectively, in comparison with the values in the control group. This process could be also caused by total tissue hypoxia under conditions of disordered microcirculation in the organ wall [8]. Despite increased number of destroyed cells, the number of macrophages in the apex and central part of the lymphoid nodule increased (from 0.30±0.15 and 0.3±0.1 in the control to 1.30±0.25 and 1.60±0.16 in experiment, respectively). Presumably, this was caused by their migration into these zones from the nodular base, where their counts

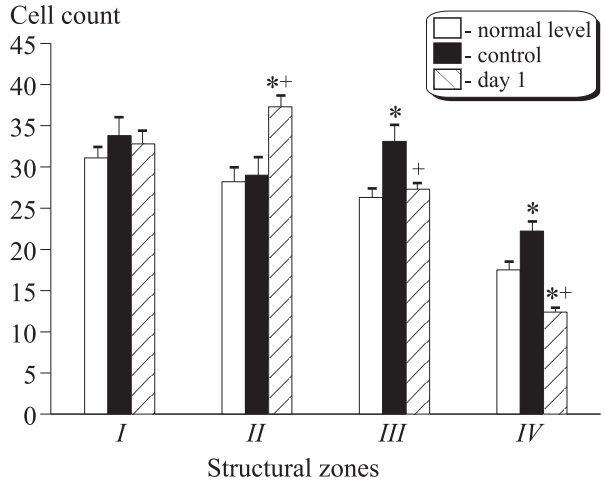

Fig. 1. Density of cell distribution in lymphoid formations of rat tracheal wall. *I*) lymphoid nodule apex; *II*) lymphoid nodule center; *III*) lymphoid nodule base; *IV*) diffuse lymphoid tissue. $p \leq 0.05$ compared to: *control; +normal values.

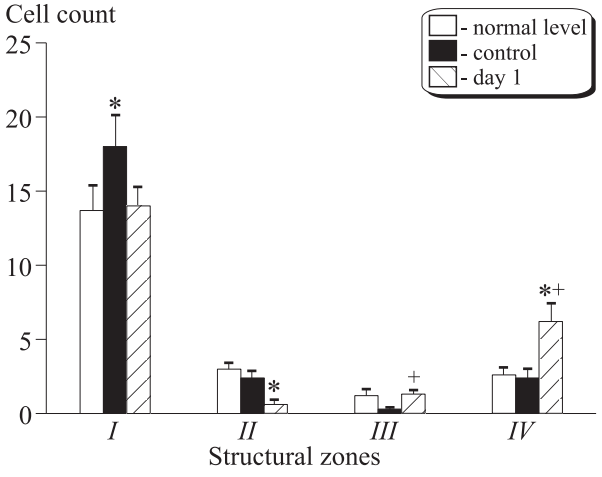

Fig. 2. Cell composition of lymphoid nodule apex in rat tracheal wall. Here and in Fig. 3: *I*) small lymphocytes; *II*) plasma cells; *III*) macrophages; *IV*) destruction. $p \leq 0.05$ compared to: *control, +normal values.

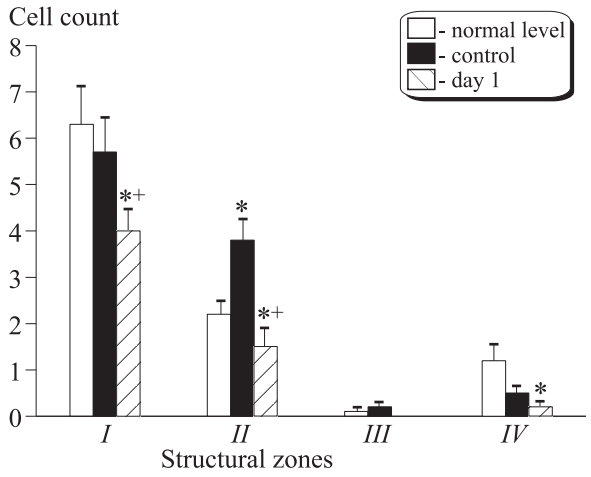

Fig. 3. Cell composition of diffuse lymphoid tissue of lamina propria of rat tracheal mucosa.

decreased. In addition, the count of plasma cells in the central part of the lymphoid nodules decreased in hemorrhagic stroke in comparison with the control, while the count of medium-sized lymphocytes increased significantly. It is noteworthy that the number of large lymphocytes increased significantly in all compartments of the lymphoid nodule (in the apex, center, and base) from 0.90±0.27, 1.8±0.9, and 0.50±0.16 in the control to 2.70±0.47, 2.80±0.53, and 1.90±0.45, respectively, on day 1 after experimental hemorrhagic stroke. The count of small lymphocytes tended to decrease in the apex and decreased significantly in the lymphoid nodule base (Fig. 2).

Diffuse lymphoid tissue in lamina propria of the tracheal mucosa of experimental animals was characterized by a significant reduction of cell distribution density in a standard section area. The number of small lymphocytes decreased by 1.4 times in comparison with the control as a result of their migration to the organ lumen. In parallel with this, the number of destroyed cells decreased in the lamina propria of the mucosa (at the expense of reduced total count of lymphoid cells; Fig. 3).

Hence, changes developing in rat tracheal wall during the acute period of hemorrhagic stroke consist in destruction of the epithelial lining and edema of the tracheal wall submucosa, presumably because of microcirculatory disorders in tissues. Lymphoid formations react to this process by redistribution of lymphoid cells in the lymphoid formations and diffuse lymphoid tissue of the lamina propria, from which they migrate directly into the lumen of the organ. The number of small lymphocytes and plasma cells decreased during this period. In parallel, the count of large lymphocytes increased in all compartments of the lymphoid nodule. This morphological picture suggests that the immune defense in rat tracheal wall is reduced as early as 24 h after experimental hemorrhagic stroke.

REFERENCES

1. R. I. Borisenko and F. I. Vasilenko, *Immunopathology of Nervous and Mental Diseases* [in Russian], Moscow (1985), pp. 26-27.
2. E. I. Gusev, *Zh. Nevropatol. Psikhiatr.*, No. 7, 12-16 (1990).
3. E. I. Gusev, A. Ya. Konovalov, and G. S. Burd, *Neurology* [in Russian], Moscow (2000).
4. E. V. Koplik, *Vestn. Nov. Med. Tekhnol.*, **9**, No. 3, 16-18 (2002).
5. E. A. Korneva, *Introduction in Immunophysiology (Training Aid)* [in Russian], St. Petersburg (2004).
6. Yu. S. Martynov, O. N. Kevdina, N. A. Shuvakhina, *et al.*, *Nevrol. Zh.*, No. 3, 18-21 (1998).
7. V. I. Skvortsova and V. V. Krylova, *Hemorrhagic Stroke* [in Russian], Moscow (2005).
8. N. K. Khitrov, D. S. Sarkisov, and M. A. Pal'tsev, *Manual of Human Pathology* [in Russian], Moscow (1999).
9. W. Deinsberger, J. Vogel, W. Kuschinsky, *et al.*, *Neurol. Res.*, **18**, No. 5, 475-477 (1996).
10. G. Reifenberger, J. K. Mai, S. Krajewski, and W. Wechsler, *Cell Tissue Res.*, **248**, No. 2, 305-313 (1987).
11. H. Tsuboi, H. Miyazawa, M. Wenner, *et al.*, *Neuroimmunomodulation*, **9**, No. 1, 1-5 (2001).