HISTOFLUORESCENCE AND HISTOCHEMICAL ANALYSIS OF THE ADRENERGIC AND CHOLINERGIC INNERVATION OF THE LUNGS IN BURNS

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Neurohistochemical methods of detection of adrenergic and cholinergic nerve plexuses of the lungs have been rarely used in the past. Modern views on the architectonics of the nerve plexuses of the lungs and upper respiratory tract are based on studies undertaken by the classical methods of neurohistology [1, 2, 7, 8, 10]. However, the onset of the mediator stage of ontogens of the autonomic innervation of the lungs, and also comparison of the formation of adrenergic and cholinergic nerve plexuses have not yet been subjected to special scrutiny.

Extensive and deep burns are known to give rise to various kinds of long-lasting and distinctive functional and morphological changes in internal organs and systems, including the lungs, where they are often complicated bs pneumonias of varied severity [3-6, 9, 12]. Because of the urgency of the problem of the sequelae of burns it is important to study the reactions of different parts of the peripheral nervous system with the aid of modern neurohistological techniques, capable of identifying adrenergic and cholinergic elements of nerve structures. The study of the structural-chemical organization of the adrenergic and cholinergic nerve plexuses of lung tissue in burns is not only of theoretical, but also of practical importance.

EXPERIMENTAL METHOD

A study was made of autopsy material from 30 patients dying at different times after burns (from shock, toxemia, and septicotoxemia). The victims were aged from 14 to 82 years. Autopsy was carried out soon (1.5-4 h) after death. Various portions of lung tissue served as the test objects. Adrenergic and cholinergic structures were revealed by incubating the sections in a 2% solution of glyoxylic acid and by the method in [11] respectively. The sections also were stained with hematoxylin and eosin, with picrofuchsine, and by Van Gieson's method. Material taken from clinically healthy persons dying accidentally from trauma was used as the control.

EXPERIMENTAL RESULTS

Bright emerald green fluorescence of adrenergic nerve terminals was found in the control lungs by the histofluorescence method. Fluorescent nerve fibers were distributed mainly in nerve plexuses along the course of the vessels and bronchi within the lungs. Adrenergic nerve plexuses as a rule accompanied first- and second-order branches of the bronchi, and these plexuses gave off terminals which penetrated directly into the parenchyma of the organ.

In burn trauma complicated by pneumonia the density of distribution of the nerve terminals and the brightness of their fluorescence were considerably reduced, depending on the stage of the burns. Mediator exhaustion was found to be focal in character, and fluorescence was still present in individual terminals, mainly in thicker nerve fibers and also along the course of branches of the intrapulmonary vessels and bronchi. In the period of burn shock the number of adrenergic nerve terminals was sharply reduced and they exhibited only weak fluorescence in various parts of the lung tissue (Fig. 1a). Besides changes in the lung parenchyma, lesions of the receptor apparatus and destruction of sensory nerve endings also were observed.

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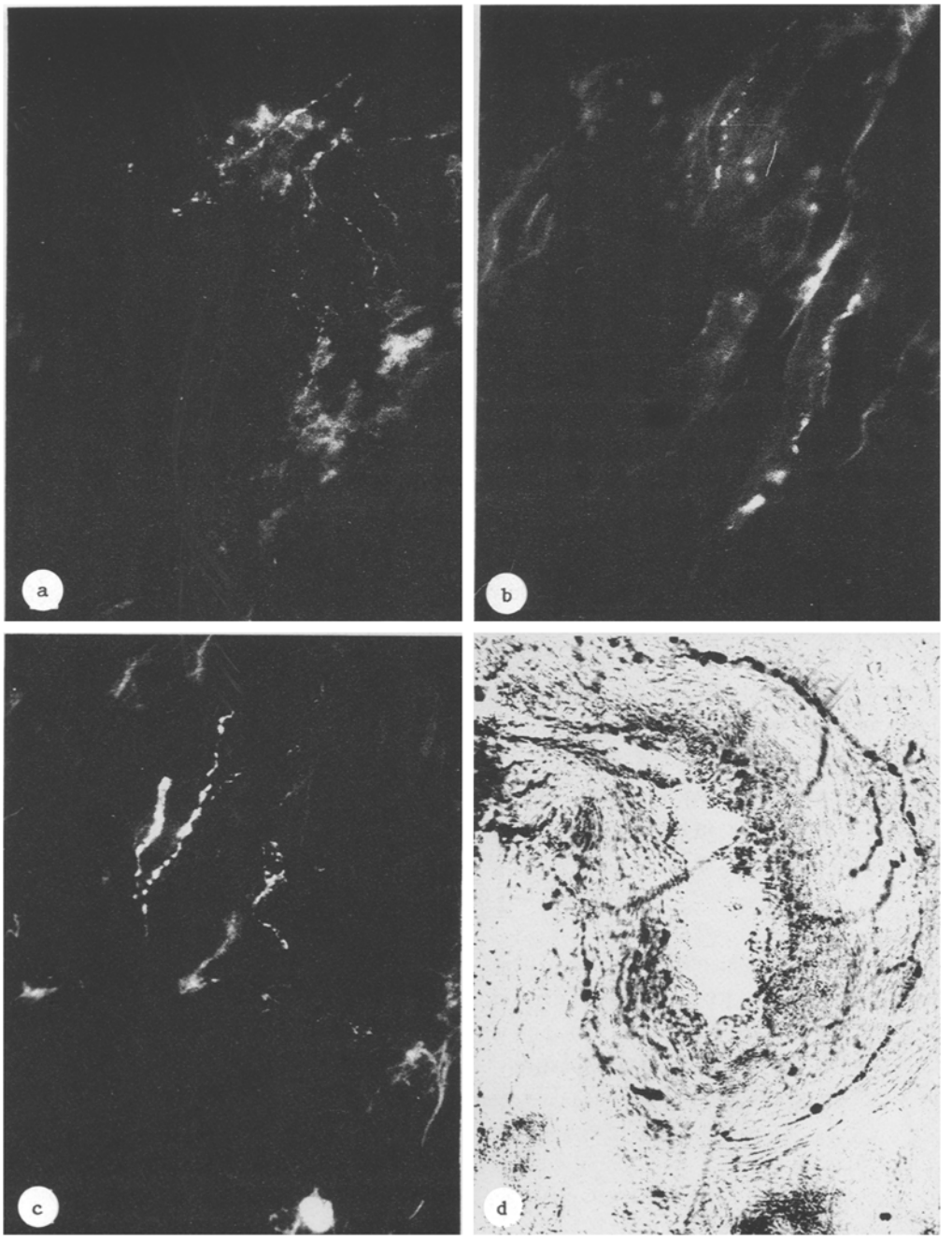

Fig. 1. Changes in adrenergic and cholinergic nerve structures of lungs in burns: a) sharp decrease in number of adrenergic nerve terminals and their weak fluorescence in perivascular zone of lung tissue. Woman aged 82 years. Burn shock; b) uneven fluorescence of adrenergic nerve fibers along course of pulmonary vessels. Man aged 39 years. Burn toxemia; c) bright fluorescence of individual adrenergic nerve terminals in walls of small pulmonary vessels. Spherical thickening of one of them is visible. Man aged 49 years. Burn septicotoxemia; d) AChE-positive nerve plexuses in wall of bronchus (transverse section). Girl aged 14 years. Burn toxemia complicated by pneumonia. Magnification 120×; a, b, c) sections incubated in 2% solution of glyoxylic acid, d) method *[11]*.

The study of adrenergic nerve structures in the period of burn toxemia revealed bright fluorescence of catecholamines in the cytoplasm of neurons of the intramural microganglia, whereas terminals of nerve bundles in the lung tissues revealed a marked weakening of luminescence. In some places characteristic varicose thickenings were found on the adrenergic nerve fibers. In the hilar region of the lungs adrenergic nerve plexuses were visible both along the course of the blood vessels and in the walls

of bronchi of different caliber and of bronchioles; these plexuses were distinguished by the presence of modified sympathetic nerve terminals – tapering of some of them, with signs of varicose swelling and weakening of luminescence (Fig. 1b).

In some sections mediator activity in the adrenergic nerve plexuses was depressed in the hilar region of the lungs, especially in periods of burn toxemia and septicotoxamia. Attention was drawn both to a decrease in the intensity of luminescence and to a decrease in the density of the adrenergic nerve plexuses located around the blood vessels of the lungs. Besides the appreciable reduction of some adrenergic nerve structures in neighboring areas of lung tissue fragments of adrenergic nerve plexuses still remained intact. Isolated spherical thickenings of adrenergic nerve fibers also were found in these sections (Fig. 1c).

Hypertrophied adrenergic terminals penetrating into the lung parenchyma along the course of blood vessels were observed in patients dying in the period of burn toxemia and septicotoxemia, and numerous newly formed terminals could be traced into the hilar region of the lungs. Club-shaped and spherical thickenings were discovered on adrenergic nerve fibers, evidence of a tendency toward restoration of neurotrophic influences on the damaged tissues and of compensatory and adaptive changes in the efferent sympathetic component of the nervous apparatus of the lungs.

Analysis of these observations leads to the conclusion that in later life adrenergic fluorescence in the structural elements of the lungs is much weaker than in young people. It was demonstrated that in different stages in the course of burns the adrenergic innervation of organs of the pulmonary circulation undergo definite structural changes, which modify the efferent regulation of these organs.

The study of total acetylcholinesterase (AChE) activity in lung tissue by the method in [11] revealed an AChE-positive nerve plexus. Cholinergic nerve terminals stained dark brown and appeared unchanged along the course of the intrapulmonary vessels and bronchi of varied caliber. At different stages in the course of burns weakening of AChE activity was observed in the cholinergic nerve plexuses. In the later stages of burns complicated by pneumonia of varied severity, marked structural changes were found in the AChE-positive nerve plexuses in the hilar region of the lungs and along the course of blood vessels and bronchi (Fig. 1d).

A study of the adrenergic and cholinergic innervation of the lungs and, in particular, of the perivascular and peribronchial sympathetic nerve plexuses thus showed that changes in their structure play an important role in the pathogenesis of pneumonias complicating burns. Loss of the adaptive and trophic sympathetic nervous regulation of the lung tissues, including blood vessels and bronchi, leads to weakening of the compensatory and adaptive capacity of the lungs and thus facilitates the development of cardiopulmonary insufficiency. Data on structural changes in autonomic nerve plexuses and ganglia obtained previously by classical neurohistological methods have been confirmed and further developed by the present investigation, using up to date neurohistochemical methods. These findings must be taken into consideration in the clinical treatment of various complications of burns.

LITERATURE CITED

1. V. N. Andriesh, Arkh. Anat., No. 12, 51 (1981).
2. R. A. Askerov and I. A. Shapiro, Nerves of the Lungs [in Russian], Baku (1983).
3. I. R. Vazina and O. A. Vasil'chuk, Arkh. Patol., No. 1, 34 (1982).
4. B. V. Vtyurin and R. I. Kaem, Arkh. Patol., No. 2, 55 (1970).
5. V. N. Galankin, I. I. Kolker, and I. P. Bochkareva, Arkh. Patol., No. 10, 21 (1982).
6. B. V. Golod, Burns [in Russian], Kiev (1988), pp. 87-88.
7. V. F. Lashkov, Innervation of the Organs of Respiration [in Russian], Moscow (1963).
8. V. N. Sachko, Arkh. Patol., No. 5, 12 (1983).
9. C. P. Artz, Burns, Philadelphia (1979), pp. 17-23.
10. A. W. Fischer, Acta Anat. (Basel), **60**, 481 (1965).
11. M. J. Karnovsky and L. Roots, J. Histochem. Cytochem., **12**, No. 2, 219 (1964).
12. S. Sevitt, Reactions to Injury and Burns and Clinical Importance, London (1974).