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Morphological and functional changes of lungs with the complex effect of immobilization and hypothermia

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Abstract

In experiments on rats with the use of tetrapolar rheograph method and coloring of lungs tissue with hematoxylin and eosin were studied morphofunctional changes of pulmonary circulation during the combined influence of immobilization and hypothermia. It was determined that abnormalities run at the level of microvasculature vessels of lungs tissue and are accompanied by blood filling reduction, development of arteriolospasm signs, capillaries and post-capillary venules plethora with sustainable increase of vascular wall permeability.

Keywords: *stress factors, immobilization, hypothermia, pulmonary circulation, cardiorespiratory system, lung morphology, rheogram.*

I. Introduction

Environmental factors are often extreme for an organism, and as a rule affect it in a complex. Some literary data testify that the complex of jointly functioning irritants often leads to the complication of the shifts arising in an organism, in comparison with their isolated influence [1,2]. In other works, on the contrary it is found a protective effect of one of the stressors during the complex influence of several ones [3,4,5,6].

We found out no data on the complex effect of immobilization and hypothermia on lungs morphofunctional changes in available literature.

The aim of the research was to study lungs morphofunctional changes under the influence of the complex effect of hypothermia and immobilization.

II. Material and methods

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Researches were conducted on 20 (there are10 control among them) non-pedigreed, white rats weighing from 160 to 250 g.

The complex effect of hypokinesia and hypothermia was simulated by the placing of experimental rats into the 80 cm3 camera designed by us, which has connection with the ambient environment within 6 hours for 10 days at the temperature of + 3+4°C.

Registration of pulmonary hemodynamics was carried out with the help of rheogram record (RG) on the RPG2 – 02 unit by the technology modified by us [6].

With the aim of studying the pathomorphological changes in the lungs of experimental rats, lungs tissues were taken out during the dissection (by Shore). The study of morphological changes of lungs was carried out with the help of coloring of histologic cuts of lungs with hematoxylin and eosin.

III. Results and consideration

According to the rheographic research data during the combined stress determined by hypothermia against the background of immobilization, changes of pulmonary circulation of all animals were unidirectional from first till third hour of the experiment and there were determined the following principles: reduction of blood filling, increase of vessels tonicity of lungs pre -capillary bed and passive congestion in a lesser circulation. The evidence is decrease of As, shortening of Es, Ed and T. From the fourth hour and until the end of the experiment (the 6th hour), these rates of some rats on the RG tend to the level of control data, possibly due to the activation of reflex mechanisms of blood redistribution, however, the changes were unreliable. Unreliable reduction of pulmonary vessels tonicity with the increase of local blood filling of pulmonary tissue was noted in 10% of the tests (table 1).

Table. 1 Dynamics of the main rates of RG within six-hour hypothermia against the background of immobilization

Rate	Control	1 hour	2 hour	3 hour	4 hour	5 hour	6 hour
As, mOm	69,0 ±0,8	56,3 ±2,4*	49,8 ±2,0*º	43,4 ±1,6*º	51,6 ±1,8*º	58,4 ±1,7*º	63,2 ±2,5*
E_s, ms	80,7 ±0,5	76,3 ±1,8	74,1 ±1,0*	72,2 ±0,9*	73,9 ±1,5*	75,2 ±1,3*	78,8 ±2,0
E_d, ms	194,7 ±1,0	178,1 ±3,0*	162,2 ±2,7*º	158,7 ±1,5*	167,5 ±2,3*	189,8 ±2,1*º	194,3 ±2,6
T, ms	285,7 ±1,0	255,5 ±3,3*	244,8 ±3,5*	243,2 ±5,9*	247,1 ±5,4*	272,3 ±4,7	285,1 ±7,5

Note: * -*distinction reliability of rate with the initial p<0,01 level; - distinction reliability of rates with the previous measurement of p<0,01*.

The dynamics of morphological changes of lungs tissue of rats was studied on the 5th and10th days from the beginning of the experiment.

In the dynamics of experimental observations there were determined characteristics of the progressive increase of morphological features of blood circulation disturbance at the level of the lungs microvasculature of rats from experimental groups.

Thus, on the 5th day of the research, in lungs tissueof experimental rats were noted the progression of sharp plethora of capillaries and post-capillary venules with erythrocytes stasis. Also it was noted interalveolar septum oedema and diapedetic hemorrhages from vessels of capillary type (Fig. 1).

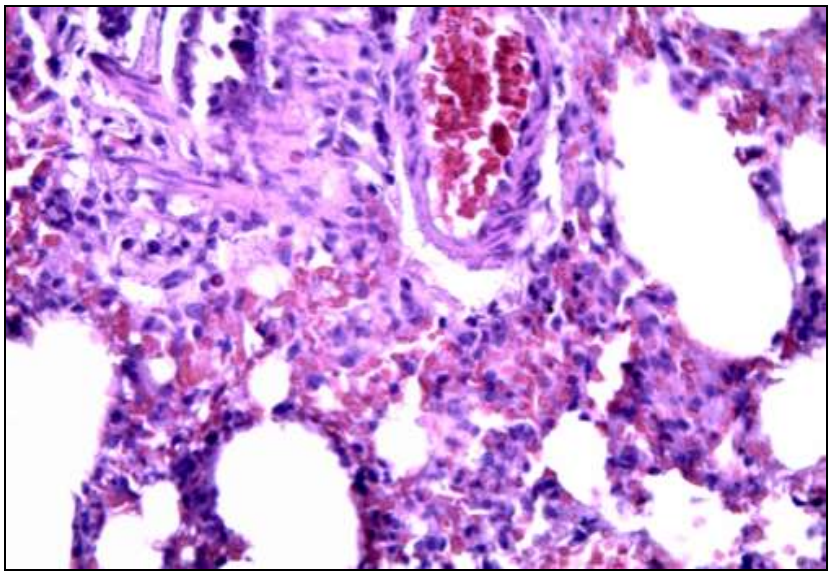

Fig. 1 Lungstissue of an experimental rat on the 5th day of hypothermal stress against immobilization. Coloring with hematoxylin and eosin.Enlarging x200.

Against the background of plethora of the microvasculature venous sector was noted a partial spasm and blood deficiency of alveoli, and fibroid swelling- in vascular walls (Fig. 2).

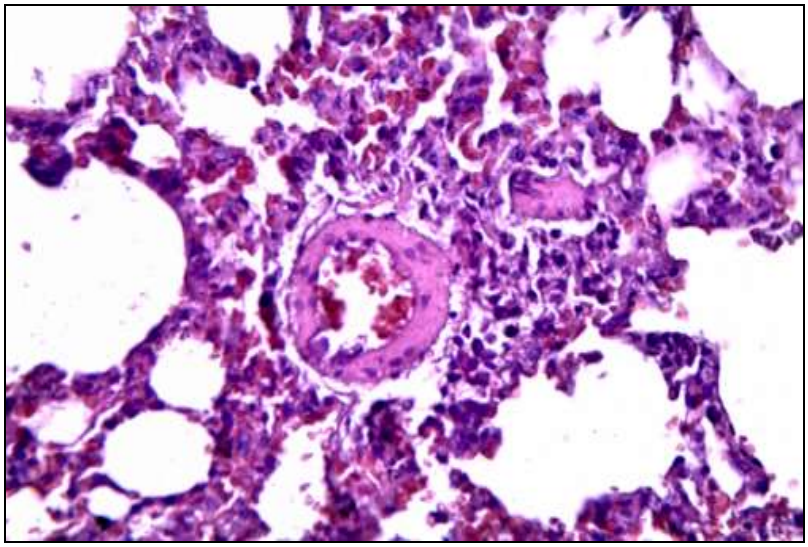

Fig. 2 Lungstissue of an experimental rat on the 5th day of a hypothermal stress against immobilization: fibroid swelling of a wall of partially spasmed arteriole; there is insignificant quantity of erythrocytes in a bore. Coloring with hematoxylin and eosin. Enlarging x200.

Imbalance of microhemocirculation was followed by paretic capillaries congestion and erythrocytes sludge in vessels bore, progressing of tissue hypoxia (Fig. 3).

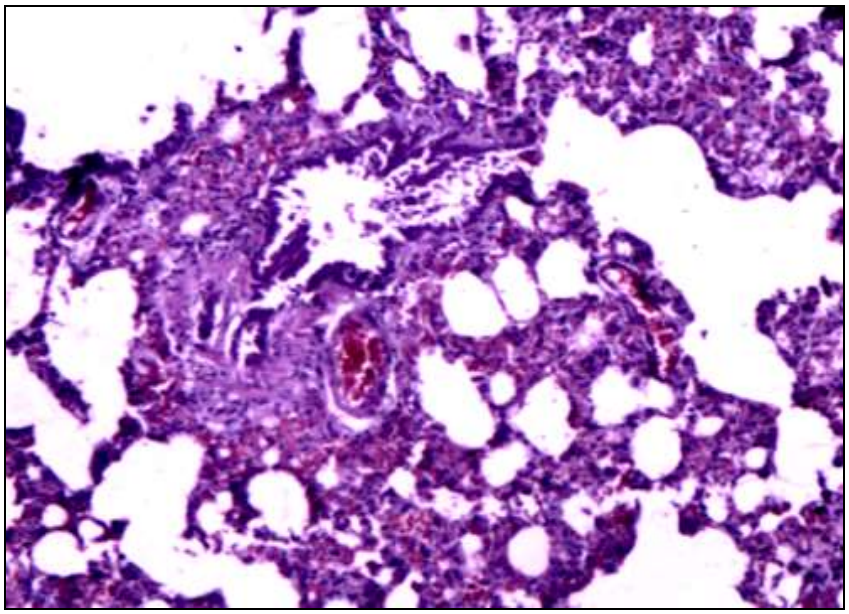

Fig. 3 –Lungs tissue of an experimental rat on the 5th day of a hypothermal stress against immobilization: erythrocytes sludge in a bore of paretic capillary congestion. Coloring with hematoxylin and eosin. Enlarging x200.

In 10 days from the beginning of experimental observation there remained congestion of vessels microvasculature venous part with hypostasis of interalveolar septum in lungs tissue of the tested rats (Fig. 4).

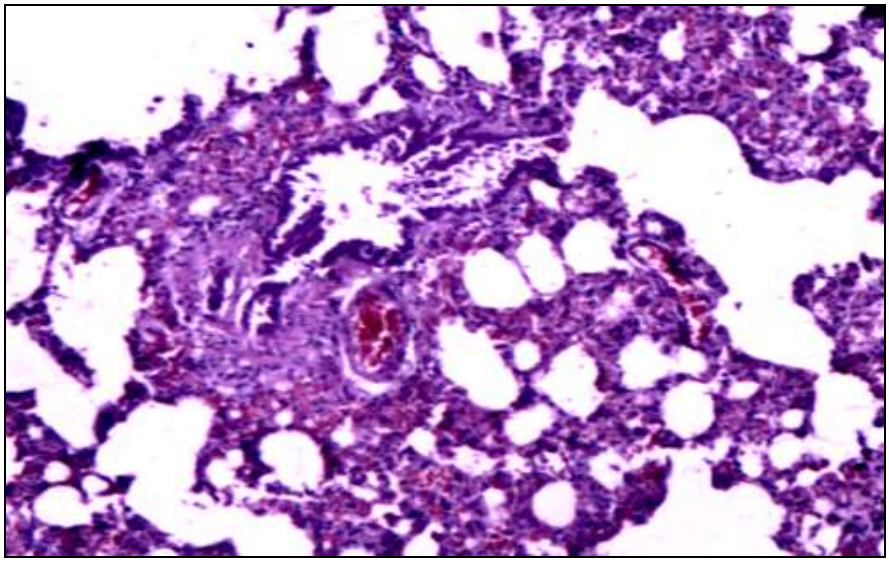

Fig. 4 –Lungs tissue of a rat on the 10th day of hypothermal stress against immobilization. Coloring with hematoxylin and eosin. Enlarging x200.

Along with the pulmonary emphysema, there were observed dystelectasis of pulmonary parenchyma where bores of alveolus had a form of the slit-like alveolar canals, in bores of which were determined desquamated alveolocytes and erythrocytes (Fig. 5).

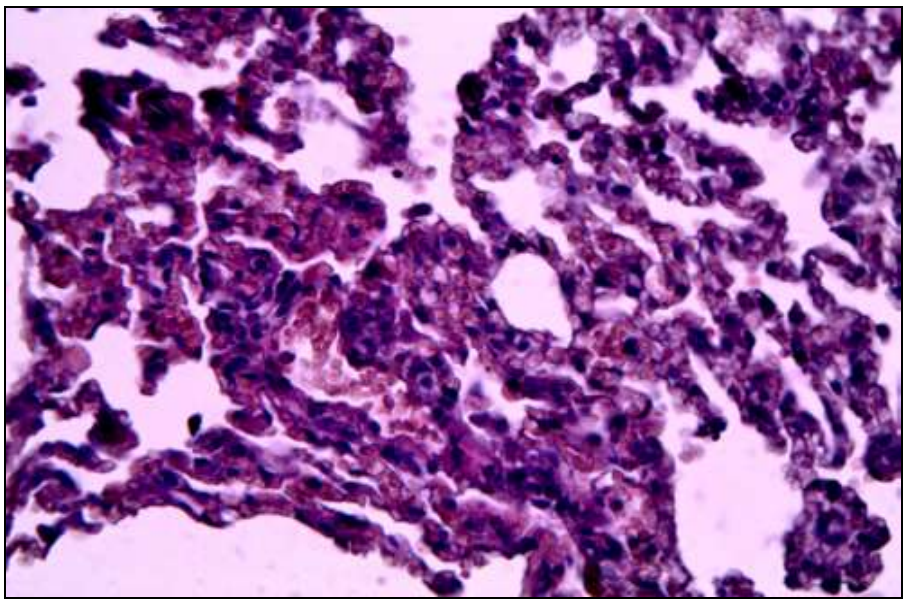

Fig. 5 –Lungs tissue of an experimental rat on the 10th day of a hypothermal stress against an immobilization. Coloring with hematoxylin and eosin. Enlarging x160.

In the peribronchial spaces were traced the signs of vessels plethora with diapedetic hemorrhages, into peribronchial tissue as well as into bronchial tubes (Fig. 6).

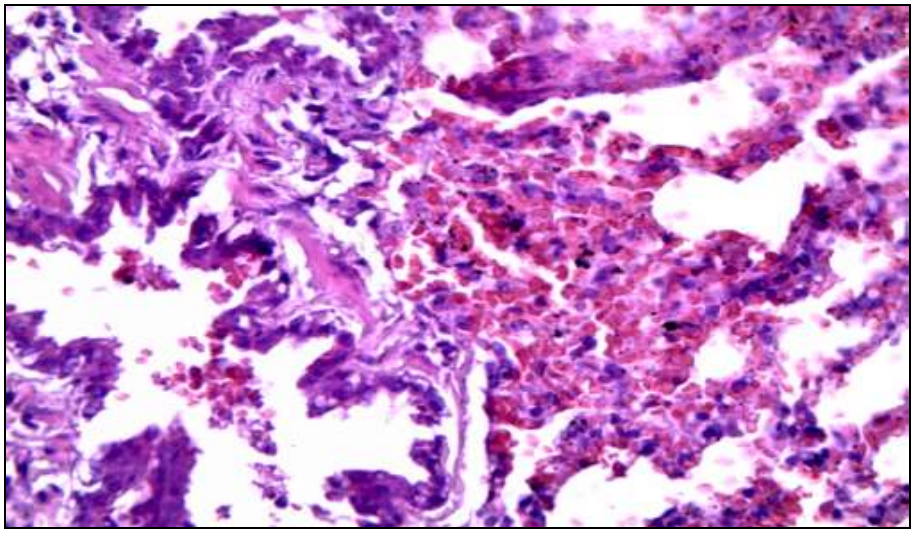

Fig. 6 –Lungs tissue of an experimental rat on the 10th day of a hypothermal stress against immobilization. Coloring with hematoxylin and eosin. Enlarging x200.

Tissue hypoxia caused on the one hand by microhemocirculation imbalance, and on the other - a bronchospasm with development of dystelectasis and focal emphysema of pulmonary parenchyma, contributed to the progressing increase of permeability of microvessels vascular wall with the following migration of lymphocytes in paravasal spaces from a lymphocytic infiltration of bronchial tubes wall and interalveolar septum (Fig. 7).

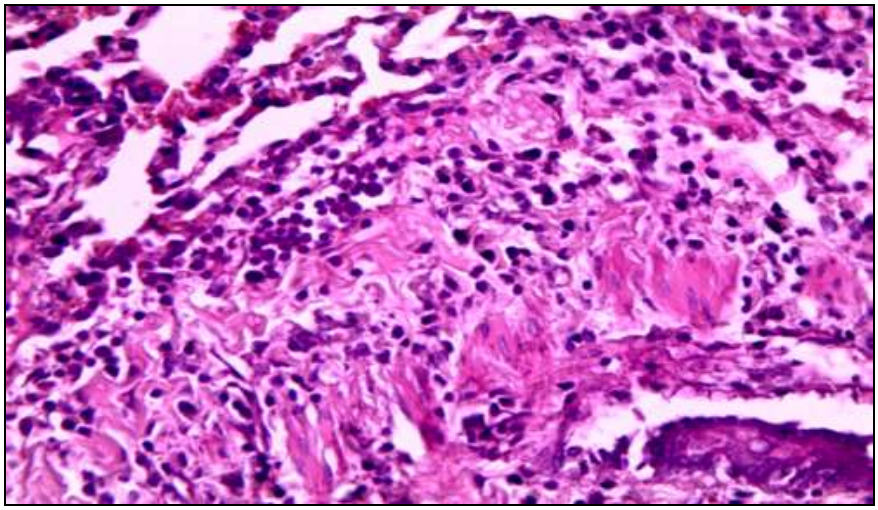

Fig. 7 –Lungs tissue of an experimental rat on the 10th day of a hypothermal stress against immobilization. Coloring with hematoxylin and eosin. Enlarging x200.

IV. Conclusions

Complex six-hour impact of plethora and immobilization on rats cause unidirectional changes of pulmonary circulation of rats: reduction of blood filling, increase of vessels tonicity of lungs precapillary bed and venous blood congestion in a lesser circulation. Morphological imbalances progress at the level of the microvasculature vessels of lungs tissue and are followed by the appearance of arteriolo spasm signs, plethora of capillaries and post-capillary

venules with the sustainable increase of vascular wall permeability. Reactive bronchospasm, by the end of the experiment, leads to the progression of focal emphysema and dystelectasis of pulmonary parenchyma.

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