EFFECT OF HYPERBARIC HYPEROXIA ON BLOOD LEVELS OF PARTIAL PRESSURE OF OXYGEN AND WATER-SOLUBLE LIPID PEROXIDATION PRODUCTS

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According to observations by scientists, during space flights astronauts may develop anemia [6, 7, 14]. It may be caused by inhibition of hematopoiesis [5] and intensification of processes of erythrocyte degradation linked with the state of the membranes [9]. Some investigators state that lipid peroxidation (LPO) reactions are activated in the course of space flights and during simulation of its factors [3, 4]. LPO may be the cause of damage to erythrocyte membranes, leading to their more rapid disintegration. It must also be taken into account that a fall in the tissue oxygen consumption during space flight [12], and the use of an atmosphere with an increased O_2 concentration in the spacecraft cabin at normal or reduced pressure [2], together with desaturation in the process of passing through the block before exit into open space and the use of a single-component oxygen medium at reduced pressure (the hyperbaric hyperoxia factor – HH) in the space suit [2] create a firm basis for the development of hyperoxemia.

The aim of this investigation was to study changes in the partial pressure of O_2 in arterialized blood and of water-soluble LPO products in venous blood during exposure to the HH factor, which arises when human extravehicular activity (EVA) is stimulated.

EXPERIMENTAL METHOD

Experiments were carried out on 8 clinically healthy volunteers, men aged 37 ± 2 years. The ground model of human EVA, developed at the Institute, incorporates an antiorthostatic position of the body, a temperature of −8°C in the pressure chamber, the HH factor, and physical work with the hands. Two alternative gaseous media were used. One was normoxic (NO) and was used on two consecutive days, whereas the other corresponded to HH and was used on the second pair of days, 7-10 days after the experiments under NO conditions. On the 2nd day of NO and HH the physical load was increased. Immediately after the end of action of the factors of the model, the partial pressure of O_2 (pO_2) in arterialized blood was recorded by a transcutaneous polarographic method ($tcpO_2$) [13] in the chest, and 5 ml blood was withdrawn from the cubital vein into heparinized test tubes. The blood was centrifuged at 1000 rpm for 10 min and concentrations of water-soluble LPO products in the resulting plasma were determined by the reaction with thiobarbituric acid (TBA-active products) by the method in [10] with modifications.

EXPERIMENTAL RESULTS

An increased O_2 concentration in the external medium leads to many pathological processes at cellular and subcellular levels [1].

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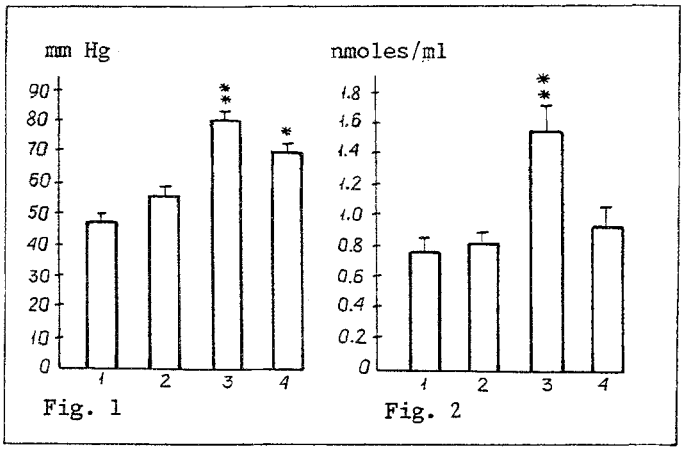

Fig. 1. Partial pressure of O_2 in arterialized blood ($tcpO_2$) after work under conditions simulating extravehicular activity (n = 8). 1) 1st day of NO, 2) 2nd day of NO, 3) 1st day of HH, 4) 2nd day of HH; *p < 0.1, **p < 0.05, compared with background value on corresponding day.

Fig. 2. Concentration of TBA-active products in venous blood plasma after work under conditions simulating extravehicular activity (n = 8). 1) 1st day of NO, 2) 2nd day of NO, 3) 1st day of HH, 4) 2nd day of HH; **p < 0.05 compared with background value on corresponding day.

During simulation of EVA in the presence of HH factor an increase in $tcpO_2$ was observed (Fig. 1: 3, 4) compared with work under NO conditions (Fig. 1: 1, 2). The reduction of $tcpO_2$ on the 2nd day of exposure of HH (Fig. 1:4) compared with the 1st day (Fig. 1:3) may perhaps be connected with the development of adaptation of the operator to experimental conditions on the 2nd day.

In a study of the content of TBA-active products in the blood plasma (Fig. 2) they also increased on the days of work under HH conditions (Fig. 2: 3, 4) compared with work during NO (Fig. 2: 1, 2), and on the 2nd day the difference was less marked than on the 1st day. This may be connected with activation of the antioxidant defense system.

When transcutaneous polarography was used, it must be recalled that pO_2 of the blood measured by this method is an integral parameter, which may be influenced not only by direct oxygenation of the blood, but also by factors such as the regional blood flow and microcirculation, differences in the structure of the skin, and the rate of diffusion of O_2 to the transducer [13]. Even in children with thin skin, values of pO_2 in the blood determined by the transcutaneous method are often too low [11]. Considering the aim of the investigation, we therefore directed our attention mainly toward the trend of the changes in $tcpO_2$ and in TBA-active products.

The results of this investigation and data in the literature indicate that one factor in the anemia arising during space flight may be the damaging action of LPO products, which possess amphiphilic properties [8], and which also modify the phospholipid composition of membranes, leading to a change in protein–lipid interactions [15].

When the results are analyzed, it can be concluded that when EVA of human subjects is simulated in the presence of the HH factor relative hyperoxemia and activation of LPO processes in the blood take place compared with the corresponding data for work under NO conditions. Changes in pO_2 and in the concentration of water-soluble LPO products in the blood change in the same direction.

REFERENCES

1. I. I. Antonov, Temperature Homeostasis and Hyperoxia [in Russian], Moscow (1989), p. 127.
2. O. G. Gazenko, Space Biology and Medicine [in Russian], Moscow (1987).

3. N. V. Delenyan and A. A. Markin, Kosm. Biol., No. 4, 34 (1989).
4. A. E. Zazerov, S. M. Ivanova, B. V. Morukov, et al., Kosm. Biol., No. 2, 28 (1989).
5. M. P. Kalandarova, Kosm. Biol., No. 6, 7 (1986).
6. V. I. Legen'kov and Yu. N. Tokarev, Space Flights on "Soyuz" Ships [in Russian], Moscow (1976).
7. V. I. Legen'kov, R. K. Kiselev, V. I. Chudin, et al., Kosm. Biol., No. 6, 3 (1977).
8. V. S. Sokolov, T. D. Churakova, V. G. Bulgakov, et al., Biofizika, No. 1, 147 (1981).
9. V. N. Shvets, A. Vacek, G. I. Kozinets, et al., Kosm. Biol., No. 4, 12 (1984).
10. T. G. Bidder and B. M. Sipka, Lipids, **24**, No. 7, 656 (1989).
11. H. U. Bucher, A. Huch, R. Huch, et al., Perinatale Medizin, Stuttgart (1978).
12. H. Haase, E. A. Kovalenko, A. Vacek, et al., Z. Militärmed., No. 2, 63 (1981).
13. P. Huch, A. Huch, and D. W. Lubbers, Transcutaneous PO, New York (1981).
14. P. C. Johnson, T. V. Driscoll, and A. D. Le Blanc, Skylab Life Sciences Symposium: Proceedings, Vol. 2, Houston (1974), pp. 69-70.
15. S. J. Singer and G. L. Nicolson, Science, **175**, 730 (1972).

CORRECTION OF EXPERIMENTAL ATHEROSCLEROSIS BY Co-35

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Modern agents for the treatment of atherosclerosis and ischemic heart disease, including nitro preparations, beta-blockers, and calcium antagonists, are insufficiently effective in the prevention of myocardial infarction or in reducing patient motality. According to some reports [11], beta-blockers may have an atherogenic action on the body. For this reason the search for new therapeutic agents both for IHD and for atherosclerosis still remains an urgent problem in medicine. We know that cobalt preparations have a hypolipidemic action in atherosclerosis [1-6, 9, 10]. Positive changes in enzyme-dependent processes and reactivity of the cardiovascular system under the influences of small doses of cobalt and its preparations have been described [7, 10].

The aim of this investigation was to study the efficacy of Co-35, a complex compound of cobaltous chloride with an organic substance, and its effect on lipid metabolism and on the blood clotting system.

EXPERIMENTAL METHOD

Rabbits (21) weighing 2.6-2.9 kg were fed for 6 months on cholesterol and developed experimental atherosclerosis. Rabbits (6) of the control group received physiological saline. The group of rabbits for study was divided into two groups: group 1 (7) received 1 mg/kg of Co-35, Group 2 (7) received cobaltous chloride in the same dose for one month. Blood levels of cholesterol, lecithin, beta-lipoproteins, phospholipids, and free fatty acids were determined in all the rabbits before, during, and after treatment. Free fatty acids were investigated on the LKhM-8 MD-5 chromatograph, and in a parallel series, on the Khrom-1 instrument. Phospholipid fractions were determined by thin-layer chromatography. Parameters of the blood clotting system were determined simultaneously by the coagulogram method. The results were subjected to statistical analysis by Oivin's method [8]. During analysis of the

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