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EFFECT OF HYPOKINESIA ON BLOOD MICROCIRCULATION

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16. Abstract <p>Blood microcirculation in the region of the scleral bulbar conjunctiva and the nail folds on the fingers and toes was studied in 18 practically healthy men during 182 day antiorthostatic hypokinesia and 30 day rehabilitation period. Marked changes in microcirculation in the sclera and feet and less evident changes on the hands was revealed. A complex of special prophylactic physical exercises had a distinctly favourable effect on circulation in the hands.</p>			
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EFFECT OF HYPOKINESIA ON BLOOD MICROCIRCULATION

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Hypokinesia in recent years, in particular, antiorthostatic, has been /10**
successfully used as an effect that makes it possible to simulate under ground
conditions the influence of certain space flight factors on the organism [1, 4, 5].

It has been shown, that under conditions of antiorthostatic hypokinesia
arterial pressure is not significantly altered, the contractile capacity of the
myocardium and the per-beat volume of the heart gradually is reduced, the regional
blood circulation is drastically altered, especially in the vessels of the head.
Until now there have been absolutely no studies on changes in blood microcircu-
lation. At the same time, these changes are of primary importance, being an
objective indicator for the blood supply to tissues during cardiovascular dis-
eases [2, 3, 6-8].

It was important to compare changes in the microcirculatory system from
data of conjunctival biomicroscopy with changes in the state of the capillary
bed in other regions of the vascular system, in particular, the extremities.

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A study was made in order to clarify the features of blood microcirculation under conditions of lengthy antiorthostatic hypokinesia.

TECHNIQUE

The method of conjunctival biomicroscopy and capillaroscopy of the periungual bed studied the blood microcirculation in 18 practically healthy men during 182-day antiorthostatic hypokinesia.

The unit for biomicroscopy consists of an optical system, illumination and photographic adapter. The optical system is an ultrapack with epilens 5 X. The combined illumination system consists of a STs-61 incandescent lamp and IFK-120 xenon flash lamp that are engaged at the moment of photographing. Glass filters are placed in front of the illumination source: green to intensify the contrast of the image, and heat to eliminate warming of the object. Observation and photographing the image (photometric adaptor MFN-10) were conducted with magnification of 60-80 X. Usually the duration of the procedure of conjunctival biomicroscopy, including examination and photography, did not exceed 3-5 minutes. Features of the blood microcirculation were examined in all individuals in the initial condition, on the 65th, 120th and 176th day of antiorthostatic hypokinesia and also on the second and 30th day of the rehabilitation period. A criterion for evaluating the condition of microcirculation was the following indices: correlation of diameter of arterioles and venules, number of perfusing capillaries in the visual field, presence or absence of such signs as discontinuity in blood flow, microhemorrhages, microthromboses and microaneurysms. In the same periods, the method of capillaroscopy was used to study the condition of the capillary bed of the cutaneous periungual fold of the IV finger and the I toe (magnification 28 times). An analysis was made of the

number of perfusing capillaries in one linear millimeter, and the shape of the capillaries was noted. All the individuals were separated into three groups of 6 people each. In the first group during the 6 month stay under conditions of bed rest pattern the men did not fulfill any physical exercises, in the second and third group they fulfilled a daily set of physical exercises of correspondingly moderate and considerable intensity.

RESULTS AND DISCUSSION

In the initial period, in all the subjects the blood microcirculation in the area of the bulbo-conjunctiva were in limits of the normal (see the figure, A on the insert) [not included]. The microphotograph indicated, that a light transparent background of the sclera is normal for the subjects. The arterioles, precapillaries, capillaries and venules are arranged at a varying depth. The ratio of diameter of arterioles to the diameter of the accompanied venules corresponded on the average to 1:2.5. Blood flow in the arterioles and venules was discontinuous, in the arterioles--faster. A network of capillaries with erythrocytes moving in them was clearly defined. Aggregation of the erythrocytes in the microvessels was noted only in one person. According to the data of capillariscopy in the region of the periungual cutaneous fold of the finger the number of functioning capillaries fluctuated in different individuals from 6 to 11, and in the region of the toe--from 6 to 10 in 1 mm. Here the dominance of normal pin-shaped or slightly elongated capillaries was characteristic.

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On the 65th day of hypokinesia, in all subjects according to the data of conjunctival bionicroscopy changes were noted in the blood microcirculation in the form of a decrease in the number of perfusing capillaries, slowing down of blood flow in the microvessels, especially in the venules and capillaries,

as well as clouding of the sclera background due to the moderate venous stasis and phenomena of edema. A change was found on the correlation of arteriole and venule diameters (see figure, B). In 13 people it was moderate (1:3 or 1:4), in 3--drastic (1:5) and in 2--very drastic--(1:6). Discontinuity in the blood flow in the capillaries linked to aggregation of erythrocytes was noted in two people.

In the later periods of hypokinesia the correlation of arteriole and venule diameters was stabilized (120th day 1:3.5, 171st day--1:3.9). At the same time other indices of blood microcirculation were significantly altered. By the 120th day of hypokinesia the slowing down of blood flow became more pronounced in the venules, the number of perfusing capillaries was sharply reduced, and clouding and paleness of the sclera were preserved. In several cases, phenomena of discontinuous blood flow were noted in the venules with diameter 30-40 μm (see figure, C) and in arterioles with diameter 15-20 μm . By the end of the period of hypokinesia, there was a reduction in the phenomena of venous stasis, and correspondingly edema of the sclera and the number of perfusing capillaries rose. However, in addition to a certain improvement in blood microcirculation, other changes progressed: in 10 people phenomena of aggregation of erythrocytes in the venules were noted, in 3--microhemorrhages and microthromboses of the venules.

By the 30th day of rehabilitation in the majority of individuals a significant improvement was noted in the indices for microcirculation in the bulbo conjunctiva. In only two people were sharply pronounced deviations preserved, including in the form of a microaneurysm in one (see figure, D).

A comparison of the results from a study for the three groups indicated, that physical exercises conducted during the antiorthostatic hypokinesia did not have a significant effect on blood microcirculation in the vessels of the bulbo conjunctiva.

A study of the capillary bed of the vessels in the skin folds of the fingers and toes demonstrated that the microvessels of these body regions, like the vessels of the bulbo conjunctiva, under the influence of antiorthostatic hypokinesia undergo significant changes. Thus, there was a reduction in a number of perfusing capillaries in the vascular network of the fold. The first signs of these changes were noted on the 18th day of hypokinesia, and they became more pronounced by the 60th day (see table).

TABLE. DYNAMICS FOR CHANGE IN NUMBER OF PERFUSING CAPILLARIES IN THE REGION OF PERIUNGUAL SKIN FOLD OF TOE (M+m)

Conditions of Study	Number of Capillaries			
	Original Condition	60th Day of Hypokinesia	172nd Day Hypokinesia	30th Day of Restoration
Hypokinesia	8±0.3	6±0.2	6±0.4	8±0.4
Hypokinesia in combination with preventive exercise of moderate intensity	7±0.16	6±0.2	5±0.6	7±0.44
Hypokinesia in combination with preventive exercises of considerable intensity	8±0.2	7±0.3	6±0.4	7±0.3

Note: Differences from original data are reliable-- $P < 0.05$.

In the individuals who did preventive physical exercises during hypokinesia, the reduction in the quantity of perfusing capillaries was noted in later periods. There was a significant change in the shape of the capillaries, which was expressed in a shortening of their arterial and then venous branches. Appearing in the 3rd week of hypokinesia, these changes progressed: on the 172nd day in /12

14 of the 18 people capillaries dominated with very shortened arterial branches, as well as capillaries that had the shape of dots and commas. In three people by this period the capillaries had a pin-shaped form, and in one were very elongated with sharply twisting arterial and venous branches. In the individuals who did preventive exercises, disorders in the shape of the capillaries appeared in later periods.

By the 30th day of the restoration period the number of perfusing capillaries in the region of the foot skin were restored to the original amount. However, the shape of capillaries in 13 of the 18 people remained changed. These changes were expressed in the dominance of capillaries of twisted shape or a spasm in the arterial branch.

The capillary network of the skin of the hand under the influence of hypokinesia changed less significantly. The number of perfusing capillaries in the region of the periungual fold of the fingers did not significantly change by the 60th day of hypokinesia. It was reliably reduced at the end of hypokinesia only in the individuals who did not do physical exercises. In the latter, the shape of the capillaries was also very altered--they acquired the shape of dots or commas. The arterial branches of the capillaries became poorly distinguishable. In the individuals who did physical exercises during hypokinesia the number of capillaries was maintained on the original level or even exceeded it.

Thus, under the influence of antiorthostatic hypokinesia significant changes occur in the blood microcirculation. They are manifest in a change in the correlation of arteriole and venule diameter, the number of functioning capillaries in their structure, as well as the aggregation of erythrocytes in the vessels, less often in the form of microhemorrhages, microthromboses of

the venules and the formation of a microaneurysm. The indicated changes, that were objectively observed during conjunctival biomicroscopy, reflect the changes in hemodynamics in the head vessels. Changes in the capillary bed of the vessels in the fingers and toes during antiorthostatic hypokinesia to a certain degree have a similar nature, appearing in the form of capillary reduction. However, these changes develop in later periods as compared to the changes in the vessels of the bulbo conjunctiva, and can to a certain degree be prevented with the help of preventive physical exercises. We link the development of changes in the blood microcirculation under the given conditions in the first place with the redistribution of blood filling of the vessels during hypokinesia in the antiorthostatic position, and with the unbalance in the regulatory systems of the organism.

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