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THE EFFECT OF HYPODYNAMIA ON THE STRUCTURE OF THE INTRAORGANIC BLOOD VESSELS AND THE CAPACITY OF THE BLOOD STREAM IN THE DIAPHRAGM OF WHITE RATS

A. I. Gerus

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16. Abstract

This article describes research on the vascular system with diaphragm deprivation occurding with hypodynamia.

The study was conducted because morphological research on the vascular system under conditions of hypodynamia is scanty.

Test methods used and some results are described.

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The Effect of Hypodynamia on the Structure of the Intraorganic Blood Vessels and the Capacity of the Blood Stream in the Diaphragm of White Rats

A. I. Gerus

Hypodynamia arises as a consequence of the development of a number of functional and organic diseases. According to data from V. V. Parin and F. Z. Meerson [1], deterioration in an organism is the cause of a broad range of cardiovascular diseases.

Morphological research on the vascular system under the conditions of hypodynamia is scanty [2-11].

For this reason we conducted research on the vascular system in a number of muscles [12-14] with diaphragm deprivation occurring with hypodynamia. Here the task proposed is to demonstrate the dynamics of morphological change in the intraorganic blood-stream of the diaphragm under conditions of hypodynamia and to establish the capacity of the intraorganic vascular flow in these muscles.

The research was conducted with 36 mature white rats weighing 180-310 g. Thirty of the rats were suffering from hypodynamia. The course of change in the rats was followed by keeping them in special cages, constructed in proportion to their bodies, to prevent confusing one with another. The test duration was from 7 to 90 days. The control group (6 animals) enjoyed healthful conditions. At the conclusion of the experiment the animals were sacrificed. The vessels were injected with a 50% aqueous solution of a black dye under regulated pressure [15]. The arteries were injected through the pectoral nodes of the aorta, the veins through the caudal section. The material was fixed by a 7-10% solution of formalin. Tissue specimens, 1 x 1.5 cm in size, were excised from the diaphragm and contrasted with the method of Shpal'megol'ts-Zhdanov. Some of the preparations were stained with hemotoxylin-eosin and Van Heizen's method. All such preparations contained intraorganic networks consisting of longitudinal vessels in the muscular mass and in the tendinous center of 1 mm. The growth capacity of the vascular flow in the diaphragm followed the formula [illegible] [16]. The data obtained were treated statistically.

Investigation of the blood vessels in the diaphragm of the control animals established that the muscular part of the diaphragm has blood guaranteed by vigorous vessels, along with the evolution of a rather dense vascular network. Here the arteries are enlarged to a diameter of 400 mk. In tendinous centers the blood supply intensity is less, with artery diameter reaching 200 mk (Figure 1,a). The contours of both arteries and veins are similar. In 7-15 days enlargement of the capillary network distribution began after the failure of vessels in the diaphragms of animals affected by hypodynamia (Figure 1,b). Thirty days after the beginning ot the experiment it was possible to see a number of arteries of small diameter (30-50 mk), along with swollen but sound arteries (100-150 mk, Figure 1,c). The quantity of capillaries definitely increases with the passage of time. Thus, two months after the beginning of the experiment there were enlarged vessels which "broke off" (Figure 1,d). A blurring of the vascular and nonvascular zones was observed. In three months there was a significant shortage of intraorganic arterial vessels. Good enlargement was found only in arteries of sound, mean diameters. Some branches, originating in major vessels, end in lush extravaganzas. The vacuolar parts were stained with dye. Only the enlarged shadows remained when the injected preparations were stained with hemotoxylin-eosin and Van Gieson's stain; the capillaries themselves disappeared.

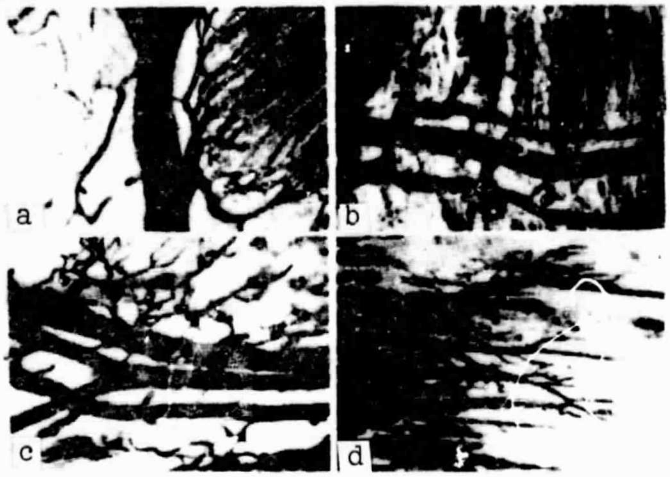

Figure 1. Intraorganic arteries of diaphragms of white rats. a,a sound artery passes through a tendinous center muscle and a muscle mass, with many branches penetrating the muscle mass and a few penetrating the tendinous center (control); b, section of arterial network of a muscle mass (15 days of hypodynamia); c, arteries of mean diameter in a muscle mass, well protected (30 days of hypodynamia); d, vessels in a muscle mass which break off (60 days of hypodynamia). Arteries injected with a 50% aqueous solution of dye. All preparations contrasted. Microphotograph, ab 8, ak 7.

The condition of the venous vessels in the diaphragms of rats with hypodynamia has a singular appearance. As early as 7 days after the beginning of the experiment, dilated venous vessels abounded. Thin veins became swollen (Figure 2,a). The injected mass was saturated with veins. In addition to the dilation, the veins began to grow. The enlarged growths of the venous vessels assumed the shape of crescent rolls (Figure 2,b). Such crescents had their ends expanded in the shape of buns. "Intestines" were noted on thin veins

Figure 2. Intraorganic veins of white rat diaphragm under hypodynamic conditions. Length of observation, 7 days: a, dilated vein in mass of muscle; b, veins growing in form of crescent rolls; c, varicose, dilated (thin veins in intestines); d, vein growth penetrating the muscle mass; e, rod-shaped growths passing intraorganic venous vessels.

Length of observation, 10 days: f, newly formed venous viscera in muscle mass;

Length of observation, 30 days: g, ring-shaped vein in muscle mass;

Length of observation, 60 days: h, veins dilated and growing in the muscle mass.

Injection with 50% aqueous dye solution. All preparations contrasted. Microphotograph, ab 8, ak 7.

after several months (Figure 2,c). Observation of dynamic changes in veins (7,10,15,30,60,90 days) showed that the growth of the veins assumed significant dimensions (Figure 2,d,e). Ten days after the beginning of the research the growth of the veins had led to the formation of venous viscera (Figure 2,f) with an excrescent form. In a month the contrasted preparations of the diaphragm revealed "ring-shaped" veins (Figure 2,g). After prolonged periods of hypodynamia(2 - 3 months), significant growth and dilation of venous vessels was found in all stages. Some veins attained a diameter of 800 mk (Figure 2,a). The venous network was densely packed as a result of the growth and dilation of the venous vessels and of anastomosis between them. T. P. Zhukavaj, B. R. Purin [17] and others have described the dilated vessels found in hypodynamia. Morphological changes occur in the intraorganic vessels of the diaphragm as a result of dead nuclei, found in hypodynamia and leading to hypoxia and toxicosis. A. G. Fedarava [18] noted such changes in veins with the appearance of blood vessels in the rear group of fleshy branches in the contrasted tissue preparations damaged by the obliterated end arteries.

According to the data of the above-mentioned author, the veins were dead-end, round or ring-shaped vessels of protruding and pointed contour.

The morphological changes in the blood vessels in chronic hypoxia are not necessarily organ-specific and some, in agreement with the data in the literature [19-22], are clearly exhibited in both organs and skeletal musculature. The death of capillaries and the growth of veins in our material confirm the data on the successive occurrence of intraorganic vessels in the diaphragm.

Our research demonstrated that the capacity of an intraorganic blood-stream in 1 mm of muscle mass amounts to 12,147,059 mk^2, and similarly amounts to 1,949,277 mk^2 in a tendinous center. The capacity of the blood-stream in the animals examined, after only 7 days with hypodynamia, dropped by 36% and continued to drop, resulting in the death of capillaries by the end of the second week. In a prolonged course of hypodynamia, the capacity of the vascular stream increases at the price of a dispersion of venous vessels.

In this way, as a result of our research, it was determined that the diaphragms of the control animals have abundant blood resources. Inside the diaphragm are enlarged vessels of varied diameter from 5 to 400 mk. The largest healthy artery goes to the flesh between the tendinous center and the muscular mass. The number and diameter of the branches occurring in the muscle mass are significantly greater than those of the branches infiltrating the tendinous center.

It is a well-known fact that there are substantial changes in the intro-organic vascular stream in the diaphragm under conditions of hypodynamia. The processes leading to the death of capillaries and to the compensatory measures of dilated and newly formed veins begin as early as 1-2 weeks.

The increase in the dilated venous vessels is most essential. Adventitious veins grow in the shape of crescent rolls which evolve into rod-shaped growths. Many venous vessels have swellings. We cannot help thinking that the vein dilations are caused by hypoxia conditions occurring during hypodynamia. Analogous situations are found in embryogenesis [23] and in inter-organic growths [24]. As a result of the dilation of venous vessels under hypodynamia, the capacity of the vascular stream from the second week on is found to be proportional to the length of observation. It can be seen that this is a very effective mechanism. The more powerful and the wider the veins, the lower the venous pressure. As a result, conditions arise for a more complete supply of oxygen and an increase in the volume of tissue production.

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