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EFFECT OF PROLONGED HYPODYNAMIA ON CERTAIN PHYSIOLOGICAL FUNCTIONS IN DOGS

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16. Abstract

General behavior of the animals and changes in a number of indices were noted in experiments on 20 dogs whose mobility was restricted in special stands. By their reactions to hypodynamia the animals were divided into two groups: 1) with active behavior and 2) with progressive general depression and increasing muscular weakness. During the first 2 weeks the arterial pressure proved to elevate in all the animals, remaining on a high level later; the value of the pressor sinocarotid reflex diminished, and the body weight fell. The pulse rate and the body temperature showed no significant change.

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EFFECT OF PROLONGED HYPODYNAMIA ON CERTAIN PHYSIOLOGICAL FUNCTIONS IN DOGS

by

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General behavior of the animals and changes in a number of indices were noted in experiments on 20 dogs whose mobility was restricted in special stands. By their reactions to hypodynamia the animals were divided into two groups: 1) with active behavior, and 2) with progressive general depression and increasing muscular weakness. During the first 2 weeks the arterial pressure proved to elevate in all the animals, remaining on a high level later; the value of the pressor sinocarotid reflex diminished, and the body weight fell. The pulse rate and the body temperature showed no significant change.

There is no unified opinion about the pathogenesis of functional /10* disorders in hypodynamia. The extensive material accumulated by researchers is contradictory to a great extent [2,6].

Hypodynamia can emerge under different conditions. One of its forms is the stay of man or animals in a closed space of strictly limited volume. Our studies were made on this model.

Material and Technique

The experiments were conducted on 20 male dogs weighing 12-24 kg whose both carotid arteries were preliminarily removed in skin flaps. After complete healing of the wounds the animals were trained in a Pavlov stand

*Numbers in margin indicate pagination in original foreign text.

to record their arterial pressure from the left carotid artery, and they were placed in specially designed machines that sharply limited their motor activity.

In the machines the dogs could make only small movements (stand, see, lie down, eat and perform natural needs). In light of the fact that the dogs belong to the number of animals with horizontal position of the main vessels, the normal conditions of hydrostatics in them were not changed. The dogs were fed twice a day. In the beginning of the experiment, and then every 7 days a study was made of the general behavior of the animals, body weight, body temperature in the rectum, arterial pressure and pressor sinocarotid reflex in response to pinching of the second carotid artery. In addition the total activity of plasma cholinesterase was determined according to Hestrin.

The arterial pressure was recorded according to the method of B. M. Savin [4] in a small modification. A metal three-chamber oncometer with rubber gaskets within each chamber was placed on the carotid artery enclosed in the flap. The terminal gaskets (constricting) were connected to the system of the compression, the middle (recording)--to the system of differential manometer of the recorder of the N-106 physiograph 068. In recording the arterial pressure in the system of the compressor manometer and the corresponding gaskets pressure on the order of 250-300 mm was rapidly created, then decompression was slowly carried out. The moment of passage of the first blood portions through the carotid artery corresponding to the maximum arterial pressure of the animal was noted on the photo film by the appearance of oscillations recorded by the mirror of the differential manometer.

Results

On the first days after placement of the animals in the machines a marked motor agitation was noted: the dogs barked, whined, attempted to crack the partition and get free. On the second-third day the animals, as /11
a rule, calmed down. Roughly on the seventh day of hypodynamia according to behavior the dogs could be divided into two groups: one of them (12

dogs) preserved activity, sat, stood in the machine, always got up at the appearance of the experimenters, the other (8 dogs) were passive, mainly lied and did not always stand up to eat. These differences in the behavior of the animals were especially clear on the 14th day of hypodynamia.

By the end of the two-week stay in the machine in the majority of animals of the second group edema of the rear paws was noted. In four of them there were bedsores in the region of the jumping joints and tubers of the ischium. In several animals small ulcers appeared on the front and hind paws in places that did not touch the structures of the machine.

On the 22nd day of hypodynamia as a result of acute emaciation and general muscular asthenia two of the dogs in the second group died. By the end of the third week of hypodynamia they could not move independently, stand or sit. When fed they preferred liquid food, they swallowed the solid pieces without chewing and did not make any attempts to exit to freedom. The most pronounced trophic disorders were observed in them. When these animals were taken from the machines on the 21st day they whined, attempted to actively defend themselves, but due to the atrophy of the neck muscles lifted their heads with difficulty. Dissection of these animals macroscopically revealed that the internal organs had a normal appearance, generalized atrophy of the skeletal musculature was noted; the cause of death was not established.

In the animals who under conditions of limited freedom conducted themselve more actively by the end of the 14th day of hypodynamia there were no trophic disorders; on the 28th day in some of them an insignificant edema of the rear paws was noted below the jumping joints.

In the initial condition a large spread of amounts of pulse and arterial pressure was observed in the dogs. On the seventh and 14th days of stay in the machines the arterial pressure was increased on the average respectively by 21 and 29% ($D<0.01$), remaining increased even on the 21st and 28th days. After three-week hypodynamia the amount of pressor sinocarotid reflex was reduced, comprising by the 28th day 37% of the initial ($D=0.05$). The rate of cardiac contractions was not significantly altered.

On the 14th day a slight tendency for reduction in the pulse was noted, on the 28th day--uncertain increase in frequency of the pulse on the background of a large spread.

On the 21st day of hypodynamia the body weight was reduced on the average by 17% ($D<0.01$). The body temperature was not significantly altered; in the dogs that died on the 22nd day the temperature was diminished by 1 and 2° as compared to the 14th days.

An increase was noted in the activity of plasma cholinesterase on the 21st day ($D=0.05$) (table).

In a separate analysis of the aforementioned changes in the animals with active and passive behavior in the machines the general directivity of them was the same.

Discussion

The reflex of freedom is one of the innate reflexes and is inherent to all highly-organized animals [1]. Therefore limited motor activity produces in the first stages a violent motor reaction. The varying behavior of the dogs further was evidently determined by the topological peculiarities of the higher nervous activity and left a definite impression on the course of hypodynamia. In the animals who preserved the active pose, the general disruptions and dystrophic processes in the integuments were pronounced to a lesser degree than in the dogs who were lying in the machines and had a passive lifestyle. The edema of the hind paws and trophic disorders observed in the latter were apparently linked to the diminished mobility and impaired efflux of blood from the extremities. /12
An important role in the appearance of trophic disorders is played by the disruption in synthesis of tissue proteins that emerges during hypodynamia and is linked, apparently, to a disruption in the coordinated operation of the enzyme systems of the organism [5]. This to a considerable degree also determines the reduction in body weight in the majority of animals with a good appetite and good eating of food.

CHANGES IN A NUMBER OF INDICES IN DOGS IN 28 DAY HYPODYNAMIA (AVERAGE DATA)

Indices	In hypodynamia (days)				
	initial	7th	14th	21st	28th
Arterial pressure (mm Hg)	174	211 D<0.01	224 D<0.01	225 D<0.01	225 D<0.01
Pressor sinocarotid reflex (mm Hg)	23	23 D>0.05	23 D>0.05	20 D>0.05	14 D=0.05
Pulse	100	96 *	94 *	104 *	124 *
Body weight (kg)	17.0	16.8 D>0.05	15.9 D>0.05	14.1 D<0.01	14.2 D<0.01
Activity of plasma cholinesterase (mg of acetylcholine broken down by 1 ml of plasma in 1 h)	26.9	25.5 D>0.05	29.7 D>0.05	32.1 D=0.05	28.5 D>0.05

Note: The values of D are given as compared to the initial amounts.

Muscle asthenia and lack of coordination in movements after emergence from the machine in addition to losses of training of the nerve-muscle apparatus are evidently linked still to the atrophic processes in the muscle tissue.

The initial period of hypodynamia in a closed space of limited volume occurs on the background of pronounced emotional stress in which the maximum stress in the operation of the endocrine glands occurs in the first 1-5 days, and then a period of adaptation of the organism to the condition that is new for it occurs [3]. The detected changes in arterial pressure (sharp increase by the end of the first week, preservation of this trend by the end of the second week, and then stabilization on a new, higher level) apparently are governed by these processes. A considerable reduction in the pressor sinocarotid reflex on the 28th day of hypodynamia on this background can be an indication of the developing fatigue of the pressor section of the vasomotor center, and govern further in a physical load the development of hypotensive states. One can assume that under conditions of hypodynamia a reconstruction occurs in the operation of the vasomotor center on a new functional level whose cause in the initial period is emotional stress.

* $D > 0.05$

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