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INFLUENCE OF PROLONGED HYPODYNAMIA ON CERTAIN PHYSIOLOGICAL FUNCTIONS IN DOGS

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16. Abstract

In experiments on 20 dogs, lasting 14-28 days, the general behavior of the animals and the modification of a number of parameters were studied with restriction of the motor activity of the animals in special stands. The animals were divided into two groups on the basis of their reactions to hypodynamia: 1) those with active behavior, 2) those with progressive general inhibition and early development of muscular weakness. During the first two weeks, all of the animals showed a gradual increase in arterial pressure, which remained elevated subsequently; the level of the pressor sinocarotid reflects decrease, and the body weight fell. The pulse rate and body temperature did not change appreciably.

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INFLUENCE ON PROLONGED HYPODYNAMIA ON CERTAIN PHYSIOLOGICAL FUNCTIONS IN DOGS

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There is no uniformity of opinion regarding the pathogenesis of disturbances of functions during hypodynamia. The large body of material which has been accumulated by researchers is largely contradictory [2, 6]. /10*

Hypodynamia can arise under various conditions. One of its forms is the restriction of a human being or animal to a closed space with strictly limited volume. Our studies were performed on such a model.

Material and Method

The experiments were performed on 20 male dogs weighing 12 to 24 kg, both of whose carotid arteries had previously been brought out in fistulas. After the wounds from the operation had healed completely, the animals were placed in a Pavlov stand to record the arterial pressure from the left carotid artery and then placed in specially designed stands which severely limited their motor activity.

After they had been placed in the stands, the dogs could only make minor movements (stand, lie down, sit, take food and attend to their natural functions). Inasmuch as dogs are animals with a horizontal arrangement of the main vessels, the normal conditions of hydrostatics were not altered. The dogs were fed twice a day. At the beginning of the experiment, and every 7 days thereafter, the general behavior of the animals was tested, with recording of the body weight, body temperature as measured rectally, arterial pressure and pressor sinocarotid reflex in response to compression of the second carotid artery. In addition, the total plasma cholinesterase activity was determined according to Hestrin.

The arterial pressure was recorded using the method of B. M. Savin [4] with a minor modification. A metal 3-chambered oncometer with rubber sleeves

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*Numbers in the margin indicate pagination in the foreign text.

inside each chamber was applied to the fistula containing the carotid artery. The end sleeves (used for compression) were connected to the compression system, while the middle one (used for recording) was connected with the system of a differential manometer of a N-106 recorder of a 068 physiograph. A pressure on the order of 250-300 mm was produced when recording the arterial pressure in the system of the compression manometer and the corresponding sleeves, then decompression was carried out slowly. The moment at which the first amounts of blood passed through the carotid artery, corresponding to the maximum arterial pressure in the animal, was recorded on film in the form of oscillations recorded by the mirror of the differential manometer.

Results

During the first 24 hours after the animals were placed in the stands, they showed pronounced motor activity: the dogs barked, whined, and made attempts to break through the restraints and free themselves. On the 2nd and /11
3nd days the animals quieted down as a rule. By about the 7th day of hypodynamia, the dogs could be divided into 2 groups on the basis of their behavior: one group composed of 12 dogs retained its activity — the animals sat down, stood up in the stand, always arose when the experimenters appeared while the other 8 dogs were passive and generally laid down, not always getting up to eat. These differences in the behavior of the animals were particularly marked by the 14th day of hypodynamia.

By the end of the 2nd week of immobilization in the stands, most of the animals in the second group showed edema of the rear paws, 4 had decubitus ulcers in the area of the saltatory joints, and sciatic tubers. Some dogs had small ulcers on the front and rear paws in locations which were not in contact with the structure of the stand.

On the 22nd day of hypodynamia, as a result of acute emaciation and a general muscular fatigue, 2 dogs in the second group died. By the end of the 3rd week of hypodynamia, they were unable to move about under their own power, or to stand up or sit down. They preferred a liquid diet, swallowing solid pieces without chewing them and making no attempts to escape. They also showed very pronounced trophic disturbances. When such animals were removed from the

stands on the 21st day, they whined, attempted to defend themselves actively, but could raise their heads only with difficulty due to atrophy of the neck muscles. When these dogs were autopsied, the macroscopic appearance of the internal organs was normal, with generalized atrophy of the skeletal musculature; the reason for death was not established.

The animals which led a more active form of life under conditions of limited freedom showed no trophic disturbances by the end of the 14 days of hypodynamia; on the 28th day, some of them showed minor edema of the rear paws, below the saltatory joints.

In their initial states, the dogs showed a wide range of pulse rates and arterial pressure. On the 7th and 14th days of confinement in the stands, the arterial pressure rose by 21 and 29%, respectively ($P < 0.01$), remaining elevated on the 21st and 28th days. Following 3 weeks of hypodynamia, the level of the pressor sinocarotid reflex decreased, amounting to 37% of the initial value on the 28th day ($P = 0.05$). The frequency of the cardiac contractions did not change significantly. On the 14th day there was a slight tendency toward slowing of the pulse and on the 28th day an unreliable acceleration of the pulse against a background of considerable scatter.

On the 21st day of hypodynamia, the body weight had fallen by 17% on the average ($P < 0.01$). The body temperature had not changed significantly; in those dogs which died on the 22nd day, the temperature had fallen by 1 and 2° in comparison with the 14 day values.

An increase in plasma cholinesterase activity was observed on the 21st day ($P = 0.05$) (see the table).

In a separate analysis of the changes mentioned above which occurred in animals with active and passive behavior in the stands, the general tendency was found to be the same in both groups.

Evaluation

The freedom reflex is one of the congenital reflexes and is found in all highly organized animals [1]. Therefore, restriction of motor activity produces violent motor reactions during the first stages of exposure to it. The

different behavior of the dogs during subsequent periods was evidently governed by topological characteristics of the higher nervous activity and superimposed a definite impression on the course of hypodynamia. In those animals which retained an active posture, general disturbances and dystrophic processes in the integuments were less pronounced than in those dogs which lay down in the stands and adopted a passive form of life. The edema of the rear paws and trophic disturbances which were observed in the latter were evidently linked to the reduced mobility and difficulty in expelling blood from the extremities. An important role is played in the development of trophic disturbances by the /12 disruption of the synthesis of tissue protein, which occurs during hypodynamia and is evidently linked to a disruption of the ability to coordinate the function of the enzyme systems in the organism [5]. This is also largely responsible for the decrease in body weight in most animals, with a good appetite and an attractive diet.

Muscular weakness and lack of coordination in movement following removal from the stand, together with a loss of training of the neuromuscular apparatus, are evidently linked to atrophic processes in the muscle tissue.

CHANGES IN SEVERAL PARAMETERS IN DOGS EXPOSED TO 28 DAYS OF HYPODYNAMIA (AVERAGE DATA)

Parameters	Hypodynamia (days)				
	Initially	7	14	21	28
Arterial pressure (mm Hg)	174	211 $P<0,01$	224 $P<0,01$	225 $P<0,01$	225 $P<0,01$
Pressor sinocarotid reflex (mm Hg)	23	23 $P>0,05$	23 $P>0,05$	20 $P>0,05$	14 $P=0,05$
Pulse	100	96 $P>0,05$	94 $P>0,05$	104 $P>0,05$	124 $P>0,05$
Body weight (kg)	17,0	16,8 $P>0,05$	15,9 $P>0,05$	14,1 $P<0,01$	14,2 $P<0,01$
Plasma cholinesterase activity (mg of acetylcholine, broken down by 1 ml of plasma in 1 hour)	26,9	25,5 $P>0,05$	29,7 $P>0,05$	32,1 $P=0,05$	28,5 $P>0,05$

Note: The values of P are given in comparison with original values.
Commas indicate decimal points.

The initial period of hypodynamia in a closed space with limited volume takes place against a background of extreme emotional stress, in which the maximum stress on the function of the endocrine glands takes place during the first 1-5 days, followed by a period of adaptation of the organism to the new

conditions [3]. The changes which are observed in the arterial pressure (sharp rise by the end of the 1st week, retention of this tendency until the end of the 2nd week, followed by stabilization at a new, higher level) are evidently due to these processes. The significant decrease in the pressor sinocarotid reflex on the 28th day of hypodynamia against this background may be the indication or may be an indication of developing fatigue of the pressor area of the vasomotor center and under subsequent physical stress may lead to the development of hypotensive states. It is possible that an adjustment of the function of the vasomotor center at a new functional level takes place under hypodynamic conditions, with emotional stress being the cause in the initial period.

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