PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

ON THE PATHOGENESIS OF HYPERTENSION

COMMUNICATION I

HYPERTENSION IN DOGS AND A QUICK METHOD OF ACHIEVING ACUTE HYPERTENSION

A. N. Gordienko, V. I. Kiseleva, R. B. Tsynkalovskii, B. A. Saakov

From the Chair of Pathophysiology (Chrmn.-Prof. A. N. Gordienko) of the Rostov Medical Institute

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Changed vascular tonus, especially higher tonus, is a very common pathological condition in man. Hence the great interest in studying the reasons and mechanisms for the development of this imbalance is understandable.

The occurrence of hypertension among animals has hardly been studied. Investigation of this question will allow correct judgment of whether hypertension is a "privilege" of man or whether it occurs among animals also. In addition, the establishment of the occurrence of hypertension in animals will allow consideration of experimentally produced hypertension not as a doubly artificial phenomenon, but as the expression of what might occur under natural conditions. However, this problem has hardly been touched on in the literature. Many investigators silently agree that the blood pressure of dogs always remains constant and that natural hypertension is never found in them.

I. P. Pavlov wrote that in the majority of cases the blood pressure of dogs, measured in a cutaneous artery, is 130 mm, sometimes reaching 150 mm.

Increased blood pressure has been noted in monkeys living under the conditions of the Sukhumi animal farm (with a normal pressure of 125/75 mm, up to 190/110 mm was found in 6.6% of them [3]).

The blood pressure of 1195 dogs was measured in our laboratory; it was determined on the carotid and femoral arteries by means of a mercury manometer. In this way, very low blood pressure was observed in some dogs, disproportionately high in others.

If 101-150 mm is accepted as normal blood pressure, lower pressure as hypotension and higher as hypertension, then animals with normal and abnormal tonus were distributed as shown in Figure 1.

As shown in Fig. 1, about 55% of animals had normal blood pressure, the pressure of the remainder exceeded normal limits. Hypotension was clearly evident in a small number of animals. No acute illnesses were observed in these dogs, so the presence of hypotension should be related to a decrease in the vascular tonus. Hypertension was observed in many animals (if blood pressure above 150 mm be considered as this).

If the classification of the acuteness of hypertension in man be accepted, according to which the blood pressure reaches 200 mm in the light form of hypertension, 200-250 mm in the average form, and over 250 mm in the acute form, then among our dogs, the light form was observed in 37.64%, the average in 2.51%. The acute form was not found, although this does not mean that it does not occur in dogs.

The development of hypertension in dogs living under natural conditions is connected with a disruption in the relationship between the basic physiological processes of excitation and inhibition in the central nervous system, an occurrence possible under the influence of various factors. Investigations show that a dislodgement

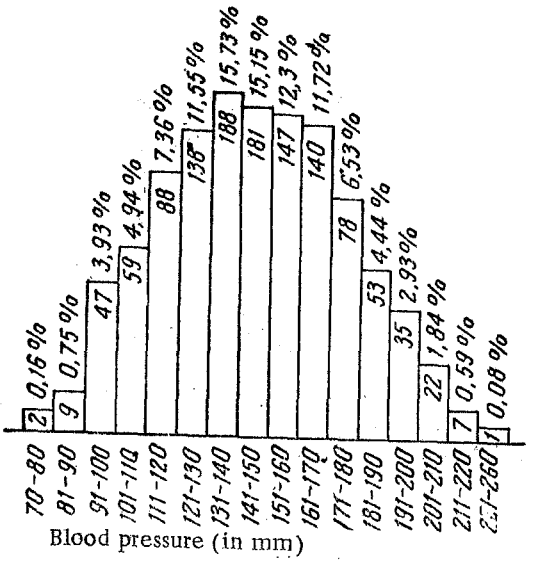

Fig. 1. Blood pressure of the dogs under investigation. The numbers inside columns are the number of dogs.

of the inhibitory and stimulatory process, sharp affects, mechanical stimulation of the central nervous system, etc. cause the development of hypertension [1, 2, 4, 5].

As we have already said, no direct investigations of the role of these processes in the development of hypertension have been carried out as yet. It seems to us that this is explained first of all by the lack of an experimental model of hypertension such as would permit the independent observation of the development of hypertension during changes in the intensity of the inhibiting or stimulating process in the brain cortex.

The acute hypertension which develops on elimination of the pressoreceptor zone of the carotid sinus and aortic arch by anesthetizing agents can, it seems to us, to be such a model. It differs favorably from the model which is produced by operative destruction of the function of the indicated reflexogenic zone, which often leads to symptoms of shock and clouds the dynamics of the physiological changes which lead to increased blood pressure.

EXPERIMENTAL METHOD

A median incision was made in the neck of dogs fastened to a vivisection table, the carotid arteries were bared, dissected out to the carotid sinuses and picked up on ligatures. The vagus nerves, through which depressor nerves pass in dogs, were also picked up on ligatures. After recording the initial blood pressure and respiration, 2% solution of Novocaine was injected under the adventitia of the sinus by means of a fine

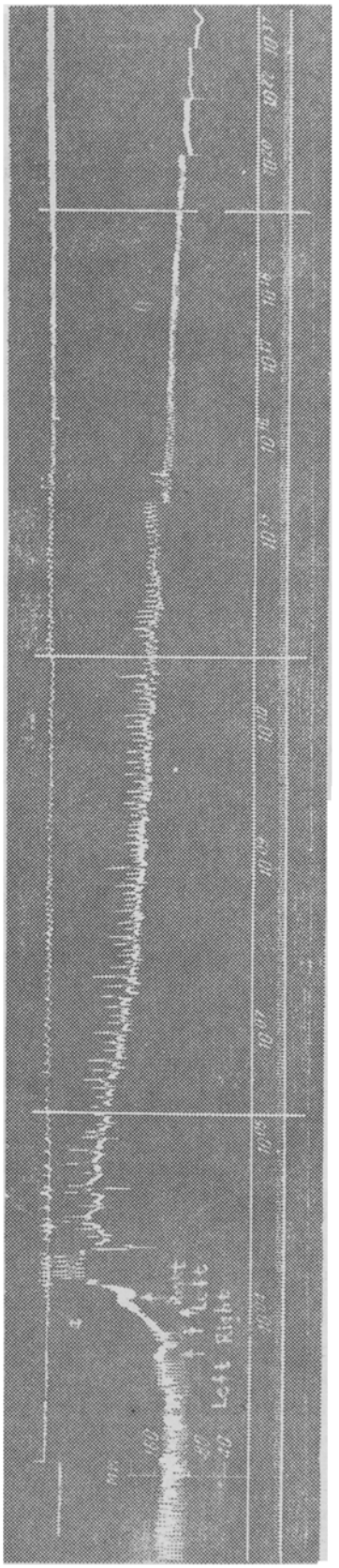

Fig. 2. Development and course of acute reflexogenic hypertension in dogs after administration of Novocaine (↓) into the carotid sinuses and depressor nerves.
Curves (top to bottom): respiration, blood pressure, null line, designation of time (2 seconds).

needle, forming a muff around the carotid sinus. Anesthesia of the depressor nerves was produced by introduction of a 2% solution of Novocaine into the vagus nerve tracts.

EXPERIMENTAL RESULTS

Bilateral anesthesia of the carotid sinuses and depressors produced a considerable rise in blood pressure after 30-60 seconds. In the course of 1-3 minutes (1.7 minutes average), the rise in blood pressure reached a maximum (Fig. 2).

Before anesthesia, the blood pressure was an average of 158.3 mm and varied between 150-170 mm. After anesthesia, it rose to an average of 301.3 mm with variations between 230-360 mm, i.e. approximately doubled, or increased by 90.3%. The blood pressure remained high for 7-24 minutes (an average of 12.5 minutes), after which it returned to the initial level.

Next the blood pressure fell below the initial figures. The fall continued 30-76 minutes; the pressure reached 84-142 mm, an average of 106 mm.

The blood pressure remained low for a short time, after which it began to return to the initial level. The amount of the decrease in blood pressure after its initial rise is, in our opinion, an expression of the power of the inhibitory process which arose during stimulation of the central nervous system as a manifestation of simultaneous induction. The duration of the fall in blood pressure can be regarded as an indicator of the amount of inhibition which occurred subsequent to the disappearance of the focus of stimulation. If this is so, then, by producing anesthesia of the indicated zones again, the amount and duration of the inhibitory process, which is connected independently with the neuro-reflex mechanism which regulates the blood pressure, can be determined.

During repeated anesthesia, the blood pressure increased in the same way, but somewhat more slowly — in the course of from 1 to 5 minutes, an average of 3.2 minutes. It increased to 46.6% above the initial level and returned to normal more slowly, in the course of 18.4 minutes.

A sharp fall in blood pressure was observed in 2 dogs, with a fatal outcome in one case. The duration of the period of decreased blood pressure and the size of the rise were smaller than during the first anesthetization. Thus, we succeeded in carrying out anesthesia 4 times in one experiment: the first time, the blood pressure increased by 93.8%, the second by 50%, the third and fourth times by 80%. All of this indicates that during repeated anesthesia changes occur in the relationship of the stimulatory and inhibitory processes of the brain cortex and the neuro-reflex mechanisms of the cardiovascular system. The force of the stimulant process decreases after the first anesthetization. As a consequence, the rise in blood pressure and its duration decreases during repeat anesthetization with Novocaine. Subsequently, more complicated relationships are established and additional investigation will be required for their analysis.

In some cases, the development of reflexogenic hypertension was accompanied by sharp changes in respiration: in some cases the depth of the respiratory movements increased, in others their frequency; sometimes periodic breathing appeared indicating a close connection between the vasomotor and respiratory centers, as well as indicating profound changes arising in the central nervous system in connection with the disruption of the pulsation on the part of the peripheral apparatuses of the internal organs.

The data obtained by us testify to the fact that hypertension and, more rarely, hypotension, are found in dogs living under natural conditions.

Insufficient models exist for the study of the role of various physiological processes, namely, of the inhibitory and stimulant condition of the central nervous system, in the development of disorders of the tonus of blood vessels as regards its increase.

For this purpose, the easily produced reflex hypertension, evoked by Novocaine anesthesia of the basic reflexogenic zones, can be employed. Anesthesia with Novocaine of the carotid and aortic zones evokes a quick and considerable rise in blood pressure which remains for 12-1/2 minutes on the average.

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