SPIKE ACTIVITY OF DEPRESSOR STRUCTURES OF THE HYPOTHALAMUS DURING VASCULAR REFLEXES

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UDC 616.833.8:612.826.4

Stimulation of mechanoreceptors of the urinary bladder, accompanied by elevation of the arterial pressure, caused a decrease in spike activity of depressor neurons of the lateral hypothalamus. Conversely, compression of the carotid arteries, also accompanied by elevation of the arterial pressure, stimulated activity of the depressor neurons.

Our earlier investigation [2] revealed the presence of numerous neurons in the posterolateral region of the hypothalamus stimulation of which gives rise to pressor responses, together with a much smaller number of neurons producing depressor responses on stimulation. We later [3] established a relationship between changes in spike activity of the pressor neurons of the lateral hypothalamus and the character of afferent impulses reaching the central nervous system.

In the present investigation changes in spike activity of the depressor neurons of the hypothalamus were studied during reflex responses of the vascular system.

EXPERIMENTAL METHOD

Experiments were carried out on 50 cats weighing from 2 to 3 kg anesthetized with urethane. The spike activity of the neurons was recorded by means of metallic microelectrodes with a tip 1-4 μ in diameter and insulated except at the tip with varnish. The potentials were fed through an amplifier (transmission band from 50 to 3000 Hz) to a type 9SO-302 9-loop universal oscillograph. Simultaneously with recording of the potentials on the loop oscillograph, the blood pressure in the femoral artery and the respiration were recorded on a kymograph. A unipolar recording technique was used. The reference electrode (a silver plate measuring 2 $\times$2 cm) was placed on the animal's neck muscles. The active microelectrode was inserted into the hypothalamus by means of a Horsely–Clark stereotaxic apparatus in accordance with coordinates of Fifkova and Marsala's atlas [5].

Potentials of neurons in the lateral hypothalamus were recorded at rest and during reflex response evoked by compressing the carotid arteries or raising the pressure in the urinary bladder (30-60 mm Hg). At the end of recording the electrical activity of the hypothalamus neurons, that point was stimulated electrically through the same microelectrode and changes in blood pressure were recorded. This showed whether or not the investigated neurons belonged to the depressor structures of the hypothalamus. At the end of the experiment the position of the electrodes was verified by electrolytic destruction of the point of stimulation and subsequent analysis of brain sections.

EXPERIMENTAL RESULTS AND DISCUSSION

The results demonstrated the existence of changes in spike activity of neurons located in the depressor structures of the hypothalamus during vascular reflexes. It is clear from Fig. 1, illustrating these changes, that neurons from which potentials were recorded belonged to the depressor hypothalamus structures, because their electrical stimulation produced a decrease in systemic blood pressure (Fig. 1B).

Elevation of the pressure within the urinary bladder to 40 mm Hg, as Fig. 1 (kymogram A) shows, caused an increase in blood pressure. This was accompanied by a marked slowing of the spike activity of the depressor neurons (oscillogram E) compared with their initial background activity (oscillogram D).

Laboratory of Physiology and Pathology of Respiration and the Circulation, Institute of Normal and Pathological Physiology, Academy of Sciences of the USSR, Moscow (Presented by Academician P. K. Anokhin). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 66, No. 8, pp. 6-8, August, 1968. Original article submitted March 27, 1967.

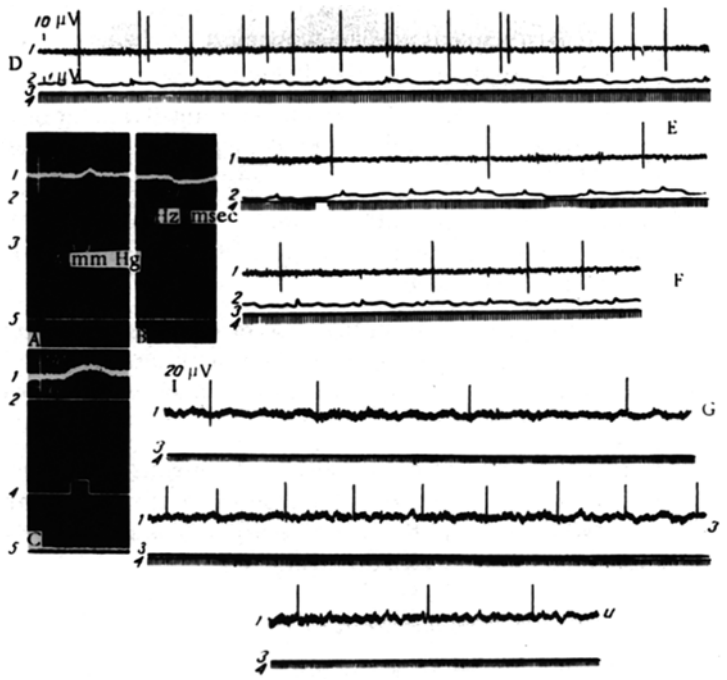

Fig. 1. Decrease in spike activity of depressor neurons of lateral hypothalamus during elevation of pressure in urinary bladder and increase in spike activity of depressor neurons during compression of carotid artery. Coordinates of position of microelectrode tip (Fifkova and Marsala, 1960): AP +7.5, S 3.7, V 4.5. Kymograms: A) Pressor effect during elevation of pressure in urinary bladder; B) depressor effect during hypothalamic stimulation; C) pressor effect during compression of carotid artery. On kymograms (from top to bottom): 1) blood pressure; 2) marker of hypothalamic stimulation; 3) marker of elevation of pressure in bladder; 4) marker of compression of carotid artery; 5) time marker (1 sec). Oscillograms: D) initial background of spike activity of depressor hypothalamic neurons; E) decrease in spike activity of same neurons during elevation of pressure in urinary bladder; F) increase in spike activity of same neurons after discontinuing inflation of urinary bladder; G) initial background of spike activity of depressor hypothalamic neuron; H) increase in frequency of spike activity of same neuron during compression of carotid artery; I) slowing of spike activity of same neuron after compression of carotid artery. Legend to oscillograms D-I (from top to bottom): 1) spike activity of depressor hypothalamic neurons; 2) ECG; 3) marker of reflex stimulation; 4) time marker (0.02 sec).

After the end of stimulation of the bladder mechanoreceptors, activity of the depressor neurons was increased (oscillogram F), although it did not reach the initial level.

Opposite changes in spike activity were observed in neurons belonging to the depressor structures of the hypothalamus during a pressor reflex evoked by compression of the carotid arteries.

It can be seen from kymogram C in Fig. 1 that compression of the carotid artery likewise evoked a pressor response. However, the frequency of the spike activity of the depressor neuron was almost doubled in this case (oscillogram H) compared with its previous background activity (oscillogram G). When compression of the carotid artery was stopped, the frequency of spike activity of the depressor neuron (oscillogram I) was reduced. The frequency of spike activity of the neuron then approximated to its level recorded before stimulation (oscillogram G).

The results indicate that reflex changes produced by compression of the carotid artery or stimulation of the mechanoreceptors of the urinary bladder are accompanied by changes in electrical activity of hypothalamic neurons concerned with regulation of vascular tone.

This phenomenon is evidently connected with the extensive involvement of hypothalamic structures in responses to fluctuation of pressure within the urinary bladder previously described by Porter and Bors [6] and Adamovich and Borgest [1].

The experimental results also showed that afferent influences of different kinds, producing changes of the same character in the systemic blood pressure, may give rise to different electrical responses of neurons of the depressor hypothalamic structures.

We found a similar relationship previously in the case of neurons belonging to the pressor structures of the hypothalamus. However, on comparing changes in electrical activity of the pressor and depressor neurons in response to the same reflex influences, a noteworthy feature is the presence of reciprocal relationships between them.

The opposite nature of electrical responses of individual neurons in the anterior portion of the hypothalamus was described by Brooks and co-workers [4] during the action of certain afferent stimuli (muscle afferents and the vagus nerve). We have found the same relationships between the pressor and depressor structures of the lateral hypothalamus during vascular reflexes.

LITERATURE CITED

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