IMPULSE ACTIVITY OF PRESSOR STRUCTURES OF THE HYPOTHALAMUS IN REACTION TO VASCULAR REFLEXES

(UDC 612.826.4.423.4-06:612.1:616.815.1)

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 58, No. 9, pp. 17-20, September, 1964

Original article submitted June 15, 1963

In a previous communication [1] we showed that during local stimulation through a micro-electrode applied to the postero-lateral region of the hypothalamus a large number of neurones were found whose stimulation elicited pressor responses; there were a far smaller number of neurones whose stimulation resulted in a depressor response. The stability of the response with respect to changes in the intensity, frequency, and duration of the stimulating impulses revealed the specialized function of these neurones.

To study the part played by the pressor and depressor hypothalamic neurones in regulation of the regional blood supply it was important to determine the change in their impulse activity during various vascular reflexes.

A study of the impulse activity of the hypothalamic neurones has attracted very little attention. Brooks and his co-workers [5] recorded responses from neurones of the anterior hypothalamus in response to various stimuli; from his results he concluded that the cells of the supra-optic region of the hypothalamus are excited by many nervous and chemical agents. The activity of the neurones of the posterior hypothalamus were studied by Baust and his co-workers [3, 4] who consider that the change in the activity of the neurones in a restricted region of the posterior hypothalamus is brought about by internal pressure receptors, and only a very small proportion of the tonic influences on blood pressure are mediated by pressoreceptors.

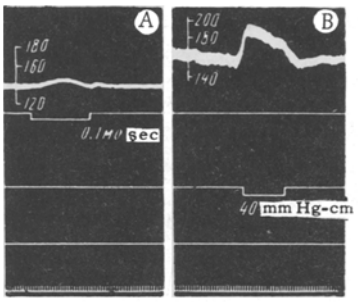
A study of the electrical activity of single hypothalamic neurones in relation to changes in osmotic pressure of the blood within the internal carotid artery and portal vein of the liver by B. F. Tolkunov [2] revealed a change in the rate of discharge in nerve cells of the supra-optic nucleus, pre-optic region, and lateral hypothalamus, a change which he interprets as the result of reflex influences from various osmoreceptor fields.

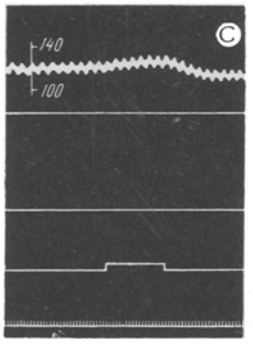
We have set out to determine changes in the impulses from pressor neurones in the lateral hypothalamus in relation to reflex actions from various reflexogeneous zones which elicit pressor responses.

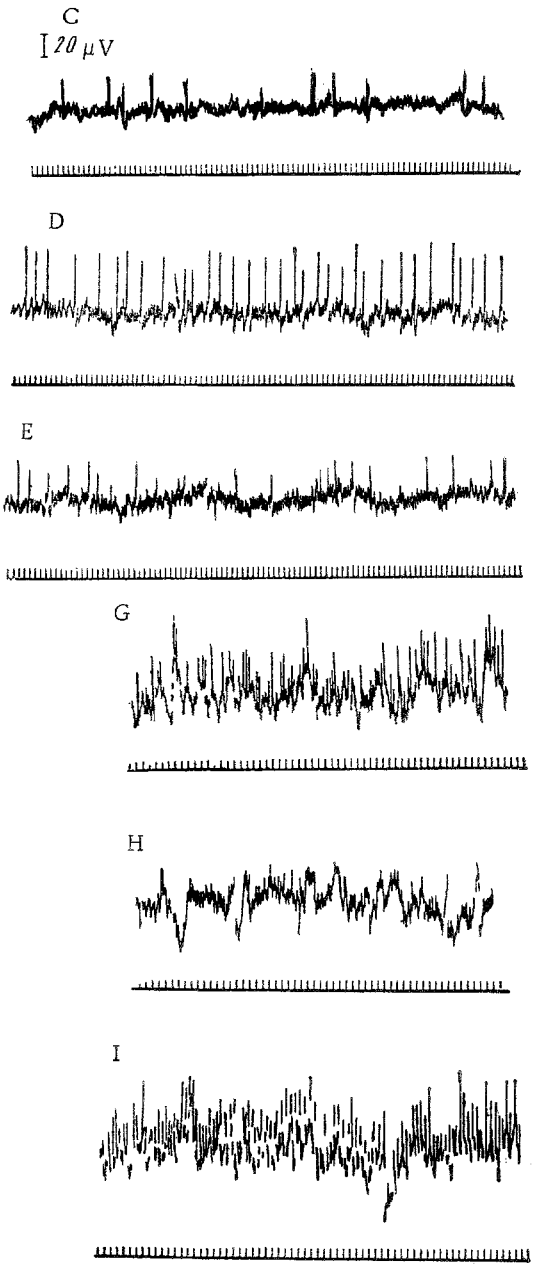
EXPERIMENTAL METHOD

The experiments were carried out under urethane anaesthesia on 58 cats weighing from 2 to 3 kg. Impulse activity of the neurones was picked up by metal micro-electrodes having a tip free from insulating varnish of diameter 1-4 μ; the amplifier had a pass-band from 50-3000 cycles, and the output was taken to a 9-string universal oscillograph, type 9SO-302. A record was made on a kymograph of the respiration and the blood pressure in the femoral artery simultaneously with the record of electrical potentials.

A unipolar electrode was used. The indifferent electrode was a silver plate of area 2 × 2 cm placed on the muscles of the neck. The different electrode was introduced into the hypothalamus by means of a Horsley-Clarke stereotaxic apparatus, and was directed in terms of the coordinates given in the atlas of Fifkova and Marsala [6].







Increase of impulse activity in pressor neurones of the lateral hypothalamic region in response to increase of pressure in the urinary bladder; reduction of impulse activity in the same neurones in response to pressure applied to the carotid artery. Coordinates of the position of the micro-electrode tip in the lateral hypothalamic nucleus (AHL) from atlas of the feline brain by Fifkova and Marsala [6] AP + 7.5 S; 3.2 V −4.25. Kymograms; A) Pressor effect in response to hypothalamic stimulation; B) pressor effect in response to increase of pressure in a urinary bladder; C) pressor effect in response to compression of the right carotid artery. Curves, top to bottom: blood pressure; hypothalamic stimulus marker; pressure in urinary bladder; compression of carotid artery; time marker (1 sec). Oscillograms: C) Initial level of impulse activity in hypothalamic pressor neurones; D) increase of impulse activity of the same neurones during increase of pressure in urinary bladder to 40 mm Hg; E) reduction of impulse activity in the same neurones after removal of pressure in urinary bladder; G) initial impulse activity of hypothalamic pressor neurones; H) marked reduction of impulse activity in the same neurones during compression of the right carotid artery; I) increase of impulse activity in the same neurones after compression of the carotid artery. Curves, top to bottom: impulse activity of the hypothalamic neurones; marker showing reflex stimulation; time marker 0.02 sec.

We recorded potentials from neurones in the lateral hypothalamus during rest, and during reflex reactions evoked by compression of one or both carotid arteries, or by increase of pressure in the urinary bladder (30-60 mm mercury). After recordings had been made of the electrical activity of hypothalamic neurones, the same micro-electrode was used to produce stimulation at the same point from a stimulator, and to record changes in blood pressure; by this means we were able to determine whether the neurones investigated were part of a pressor or a depressor hypothalamic structure.

At the end of the experiment the position of the electrodes was controlled by electrolytic destruction of the area stimulated, and this action was followed by a study of brain sections treated with formalin.

EXPERIMENTAL RESULTS

The results showed that the impulse activity of neurones forming part of pressor structures of the lateral hypothalamus changes differently according to the action (increase of pressure in the urinary bladder or compression of the carotid arteries) which produces reflex increase of blood pressure. The change of the blood pressure may be the same in both cases.

The neurones from which the potentials were picked up belonged to pressor structures in the hypothalamus; this was known because their electrical stimulation induced a pressure response (see figure, A) . Increase of pressure in the urinary bladder to 40 mm Hg caused a considerable increase of blood pressure (see figure, B). The pressure effect is illustrated at the point E in the kymogram, and was due to compression of the right carotid artery. The impulse activity of the neurones was considerably increased by stimulation of the mechanoreceptors of the urinary bladder (see figure, D), and the activity level rose considerably above the original state (see figure, C). At the end of stimulation the electrical activity of the pressor neurones was considerably reduced (see figure, E).

In this experiment, as in most others, superimposed on the increased blood pressure evoked by compression of the right carotid artery (see figure, H) we observed a marked reduction in the impulse activity of neurones of the lateral hypothalamus, of which the stimulation evoked a pressor response.

After recovery of the circulation through the carotid artery the impulse activity of the neurones was enhanced (see figure, I), and even rose above the original level (see figure, G).

The results of these experiments indicate that changes in the impulse activity of neurones of the lateral hypothalamic region causes no change in pressure, as has been postulated by Baust and Katz [3] for the posterior hypothalamus, but are related to reflex actions on the vascular system. In this case the afferent actions evoking changes of the general blood pressure all of the same type may be the cause of quite different electrical responses in neurones contributing to the identical pressor or depressor hypothalamic structure.

These results also show that reflex changes evoked by compression of a carotid artery or by stimulation of the mechanoceptors of the urinary bladder are not restricted to the participation of the bulbar vaso motor center, but are associated with a change in the electrical activity of hypothalamic neurones related to regulation of vascular tone.

In 1962 a description was given [7] of neurones in the cat brain stem of which the activity was reduced by compression of the common carotid artery. It was pointed out that these neurones are activated by pressoreceptor volleys. Our results lead us to suppose that in the region of the lateral hypothalamus there are also present neurones which are activated by afferent impulses from pressoreceptors; the reason for this conclusion is that elimination of the latter by compression of the carotid arteries caused a reduction in the activity of these neurones.

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