# HYPOTHALAMIC AFFERENT PROJECTIONS OF THE AORTIC NERVE

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UDC 612.178:612.826.4

Responses of neurons in the anterior, middle, and posterior hypothalamus to electrical stimulation of the aortic nerve were studied. Two groups of neurons were distinguished in the pressor zones of the hypothalamic region. Changes in the discharges of one group of neurons preceded a fall of arterial pressure in response to stimulation of the aortic nerve. Changes in activity of the other group of neurons occurred after the fall of blood pressure. It is concluded that excitation evoked by stimulation of the aortic depressor nerves and afferent influences from the baroreceptors of the blood vessels arriving during the depressor response spread to neurons of the supraoptic, paraventricular, and ventromedial nuclei of the hypothalamus, the anterior and lateral hypothalamic field, and the supramamillary region.
KEY WORDS: aortic nerve; afferent impulsation; hypothalamus; spike activity; blood pressure.

Numerous investigations have shown that electrical stimulation of various parts of the hypothalamic region evokes pressor and depressor responses [1, 5, 6, 8, 12, 14, and others]. Afferent impulsation from the baroreceptors of the carotid sinus, reaching the medulla via Hering's nerve, has been shown to travel upward along the brain stem to structures of the central nervous systems (CNS), including the hypothalamus [2-4, 15, 16, 19, 20].

However, the question of projections of afferent excitation from the baroreceptors of the aortic arch to different parts of the hypothalamus has not yet been settled. It was accordingly decided to study the spread of afferent excitation of the aortic nerve to the various parts of the hypothalamic region.

## EXPERIMENTAL METHOD

Acute experiments were carried out on 59 rabbits of both sexes weighing 2.5-4 kg fixed in a stereotaxic apparatus. The effect of stimulation of the ipsilateral aortic nerve on unit activity was studied in various parts of the hypothalamus as the microelectrode was inserted. Unit activity was derived extracellularly by means of glass microelectrodes filled with 3 M KCl solution and recorded on a Biophase-IV (Alvar Electronic) four-beam cathode-ray oscilloscope. At the end of the experiment the character of the influence of each point of the hypothalamus where unit activity was recorded on the level of the arterial blood pressure was examined. This was done by stimulating that point through a bipolar electrode (distance between the uninsulated tips 0.3 mm). Insertion of the micro- and macroelectrodes into the chosen points of the hypothalamus was carried out in accordance with the coordinates of a stereotaxic atlas [18] by means of a special guiding socket fixed with a solution of phosphate cement to the cranial bones. The blood pressure in the common carotid artery was recorded by means of a "Barovar" electromanometer.

To assess the responses of the hypothalamic neurons poststimulus histograms of the distribution of the number of spikes were plotted.

P. K. Anokhin Institute of Normal Physiology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Yudaev.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 83, No. 6, pp. 643-646, June, 1977. Original article submitted July 26, 1976.

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TABLE 1. Effect of Stimulation of Aortic Nerve on Unit Activity in Various Parts of the Hypothalamus

| Region of hypothalamus | Total number of neurons tested | Total number of responding neurons | Increase in frequency of initial activity | Inhibition of initial activity |
|---|---|---|---|---|
| Region of supraoptic nucleus | 29 | 6 (20,7) | — | 6 (20,7) |
| | | 8 (27,6) | 7 (24,1) | 1 (3,5) |
| Region of paraventricular nucleus | 10 | 2 (20) | — | 2 (20) |
| | | 2 (20) | 2 (20) | — |
| Anterior hypothalamic field | 7 | 2 (28,6) | — | 2 (28,6) |
| | | 1 (14,3) | 1 (14,3) | — |
| Region of ventromedial nucleus | 31 | 8 (25,8) | 3 (9,7) | 5 (16,1) |
| | | 6 (19,4) | 5 (16,1) | 1 (3,3) |
| Lateral hypothalamic field | 21 | 5 (23,8) | 3 (14,3) | 2 (9,5) |
| | | 5 (23,8) | 3 (14,3) | 2 (9,5) |
| Supramamillary region | 26 | 9 (34,6) | 6 (23,1) | 3 (11,5) |
| | | 9 (34,6) | 2 (7,7) | 7 (26,9) |

Legend. Numerator shows number of neurons whose discharge pattern changed before the blood pressure fell; denominator gives number of neurons whose discharge pattern changed immediately after the blood pressure fell. Numbers in parentheses are percentages of total number of neurons tested.

## EXPERIMENTAL RESULTS

Stimulation of the ipsilateral aortic nerve (2-5 V, 0.1 msec, 60 Hz, for 3 sec) caused the blood pressure to fall by 15 ± 5 mm Hg and slowed the heart rate by 40 ± 15 beats/min. Responses of 124 spontaneously active neurons in different parts of the hypothalamic region to stimulation of the aortic nerve were studied. Changes in the discharges of one group of neurons (32 neurons, 25.8%) preceded the cardiovascular reactions, whereas those of the other group (31 neurons, 25%) developed after the fall of blood pressure. This suggested that changes in the activity of the first group of neurons were caused by afferent impulsation from the stimulated aortic nerve and were not the result of secondary afferent influences arriving from the heart and blood vessels. Changes in the activity of the second group of neurons, on the other hand, were evidently due directly to the fall of blood pressure.

By their response to afferent impulsation from the ipsilateral aortic nerve the first group of hypothalamic neurons could be subdivided into two types: neurons with inhibition of activity by 20-96% relative to the spontaneous activity (20 neurons, 16.1%) and neurons with an increase of 27-74% in the frequency of activity (12 neurons, 9.7%). In the region of the anterior hypothalamus (supraoptic and paraventricular nuclei and the anterior hypothalamic field), moreover, neurons whose firing rate decreased in response to afferent impulses from the aortic nerve were recorded. In the region of the middle and posterior hypothalamus (ventromedial nucleus, lateral hypothalamic field, and supramamillary region) neurons were recorded of which some responded to afferent impulses from the aortic nerve by a decrease and others by an increase in firing rate (Table 1).

After the end of stimulation of the aortic nerve changes in spike activity of the first group of neurons in the opposite direction were observed, i.e., activation in the case of inhibition and vice versa. These after-responses of the neurons were evidently in consequence of the accompanying lowering of the general level of the arterial pressure (Fig. 1).

Subsequent stimulation of the hypothalamic structures in which neurons responding to afferent impulses from the aortic nerve were recorded caused the blood pressure to rise. The experimental results thus indicate that afferent excitation from the aortic nerve is projected mainly on the pressor structures of the hypothalamic region.

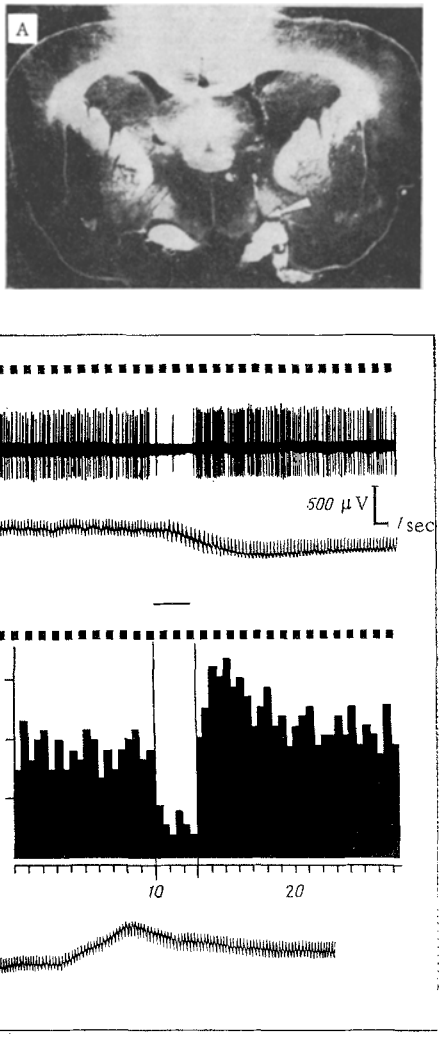


Fig. 1

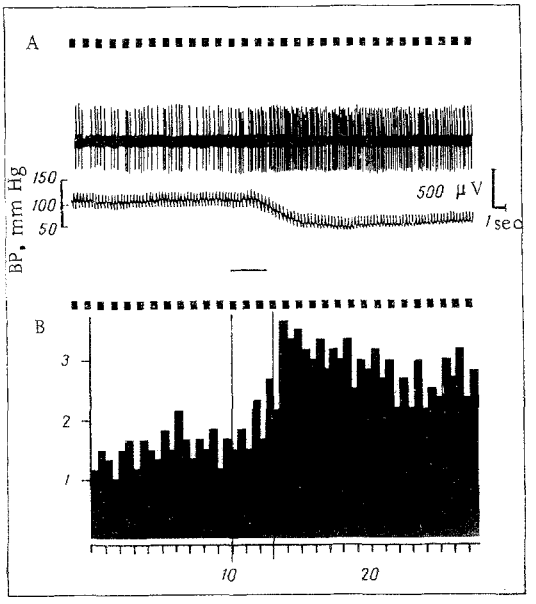


Fig. 2

Fig. 1. Changes in firing pattern of neuron in supraoptic nucleus of hypothalamus in response to stimulation (horizontal line) of aortic nerve: A) section through brain; location of electrode tip marked by arrow; B) response of neuron (above) and change in blood pressure (BP) (below) in response to stimulation of ipsilateral aortic nerve; C) histogram of distribution of number of spikes: abscissa, time (in sec); ordinate, mean number of spikes in 500 msec; vertical lines mark beginning and end of stimulation of aortic nerve; D) changes in blood pressure during stimulation of supraoptic nucleus.

Fig. 2. Changes in unit activity in supraoptic nucleus of hypothalamus in response to fall of blood pressure caused by stimulation (horizontal line) of aortic nerve. A) Response of neuron (above) and change in blood pressure (below) in response to stimulation of ipsilateral aortic nerve; B) histogram of distribution of number of spikes: abscissa, time (in sec); ordinate, mean number of spikes in 500 msec; vertical lines mark beginning and end of stimulation of aortic nerve.

By their response to the fall of blood pressure caused by stimulation of the aortic nerve the second group of neurons could also be divided into two types: those with inhibition of activity by 10-68% relative to their spontaneous activity (11 neurons, 8.9%) and those whose firing rate increased by 25-94% (20 neurons, 16.1%). Excitatory unit responses were recorded in the region of the supraoptic and paraventricular nuclei and in the anterior hypothalamic field (Fig. 2). Both inhibitory and excitatory unit responses were recorded in the region of the ventromedial nucleus and the lateral hypothalamic field. Mainly inhibitory unit responses were recorded in the supramamillary region (Table 1). Subsequent stimulation of these hypothalamic regions showed that they also have a pressor effector action.

The experiments thus showed that excitation evoked by stimulation of the aortic depressor nerves and afferent influences arriving from the baroreceptors of the blood vessels during the depressor response spread widely to neurons in the various parts of the hypothalamic region. This excitation, moreover, is destined for neurons of the pressor regions of the hypothalamus.

Electrophysiological investigations of the composition of the aortic nerve in rabbits have shown that it contains chiefly baroreceptor afferent fibers and no chemoreceptor fibers [10, 13, 17]. Accordingly, the changes in unit activity recorded in the various parts of the hypothalamus in response to electrical stimulation of the aortic nerve must be regarded as the result of the effects of baroreceptor afferent impulses. The question of the role of these neurons in the regulation of the hemodynamics is a matter for further experimental investigation. The available evidence [4, 7, 11] indicates that abolition of afferent influences from the baroreceptors of the aortic arch and carotid sinus activates neurosecretory cells of the paraventricular and supraoptic nuclei of the hypothalamus, which liberate hormones with pressor action (vasopressin and oxytocin) into the blood stream. The results of the present experiments also point to the existence of neurons in these hypothalamic nuclei whose firing rate is reduced in response to baroreceptor afferent impulsation. It can be postulated that the flow of baroreceptor afferent impulsation evoked by electrical stimulation of the aortic nerve is destined for neurosecretory cells, depressing their spike discharge. The problem of the functional role of neurons in other parts of the hypothalamus whose firing pattern is changed in response to electrical stimulation of the aortic nerve requires further experimental investigation.

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