RESPONSE OF THE ANTERIOR HYPOTHALAMUS TO UNILATERAL INJURY TO THE SCIATIC NERVE

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The state of the neurosecretory nuclei of the anterior hypothalamus was studied at various times (12, 48, 96, and 192 h) after unilateral injury to the sciatic nerve. In the supraoptic and paraventricular nuclei of the anterior hypothalamus of the experimental rats the area of cross section of the neurosecretory cells of both nuclei was increased uniformly, but unequally on the ipsilateral and contralateral sides. Asymmetry of the anterior hypothalamic nuclei, which were larger on the right side, was most marked on the 2nd-4th day of the experiment, after which it diminished somewhat. The presence of this asymmetry indicates that impulses from the peripheral organs exert their effect on the hypothalamus via afferent nerve fibers.

Key words: anterior hypothalamus; neurosecretion; injury to sciatic nerve.

Previous investigations by the writer's group showed that stimuli applied to one of a pair of peripheral organs (for example, to one lobe of the thyroid gland, to one adrenal, one ovary, and also to one uterine cornu or one kidney) are reflected by a definite response in the hypothalamic neurosecretory nuclei, different in degree on the right and left sides. This response is not transmitted by the humoral effect of hormones, for under these conditions the hormonal balance of the organism is preserved. Meanwhile the asymmetry of the response is evidence that it is caused by distortion of the afferent impulse flow into the CNS from the peripheral organs studied, and reflected in the hypothalamus [1-3].

The observation described below was a continuation of the study of the response of the anterior hypothalamic nuclei to unilateral interference through injury with the normal flow of afferent impulses along the sciatic nerve.

EXPERIMENTAL METHOD

Male rats were used. The sciatic nerve was injured as follows. After division of the skin and subcutaneous cellular tissue in the upper part of the right buttock the muscles were divided by blunt dissection and the sciatic nerve was brought on a ligature to the surface of the wound. It was then ligated with a silk thread previously soaked in formalin oil (vegetable oil, kept in contact with whole formalin for 10 days). On the central side of the ligature the nerve was crushed with artery forceps. Combined mechanical and chemical injury to the nerve was thus produced. After the operation as described the wound was closed without drainage. The animals were decapitated after 12, 48, 96, and 192 h. The hypothalamic region and pituitary were fixed in Bouin's fluid. To detect neurosecretory granules of the supraoptic and paraventricular nuclei, sections were stained with paraldehyde-fuchsin and counterstained with carmine by the methods of Gabe and Nissl'.

The activity of the neurosecretory cells was determined from the degree of swelling of their perikarya (as shown by changes in their size and in the content and distribution of their neurosecretory granules) [1].

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In each animal the area of 100 neurosecretory cells of the supraoptic and paraventricular nuclei on the right and left sides was measured. The results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

The area of cross section of the neurons in both nuclei of the anterior hypothalamus, on both the ipsilateral and contralateral sides, was significantly increased compared with the control 12 h after the operation. Neurons of the supraoptic nucleus on the ipsilateral side reached $322.0 \pm 2.7\ \mu^2$ (control $217.8 \pm 2.9\ \mu^2$), and on the contralateral side $341.4 \pm 3.2\ \mu^2$ (control $272.6 \pm 3.1\ \mu^2$). The neurons on both sides were larger, juicy, and their content of neurosecretion was low. The nucleus contained one nucleolus, displaced toward the periphery; less frequently two nucleoli were present. All the neurons had a low content of neurosecretion, the nucleoli in the nuclei on the ipsilateral side were displaced toward the nuclear membrane, but on the contralateral side they were located in the center. The area of cross section of the neurosecretory cells of the paraventricular nucleus on the ipsilateral side was $292.6 \pm 3.3\ \mu^2$ (control $231.6 \pm 2.9\ \mu^2$), and on the opposite side $311.5 \pm 4.6\ \mu^2$ (control $228.6 \pm 1.8\ \mu^2$).

Cells with degenerative changes and neurons with a high content of neurosecretion were found 48 h after the operation in the supraoptic nucleus of the anterior hypothalamus on the ipsilateral side in animals with injury to the right sciatic nerve. These changes were not found on the contralateral side. The main group of neurons on both sides had a low content of neurosecretion. The area of cross section of the neurons on the ipsilateral side was $344.1 \pm 4.1\ \mu^2$ and on the contralateral side $402.1 \pm 6.1\ \mu^2$. The neurons of both sides of the paraventricular nucleus also contained little neurosecretion. The area of cross section of their neurons on the ipsilateral side was $287.8 \pm 2.0\ \mu^2$ and on the contralateral side $330.0 \pm 3.22\ \mu^2$.

The supraoptic nucleus on the ipsilateral side 96 h after the operation was formed by large juicy neurons, some of which had a high content of neurosecretion and some showed degenerative changes. The area of cross section of the neurons on the ipsilateral side was about $354.4 \pm 1.7\ \mu^2$ and on the contralateral side $377.4 \pm 1.7\ \mu^2$. The neurons of the supraoptic nucleus on this side were very large, with a low content of secretion. The nucleoli were confined to the center of the nucleus, which was large and pale. The paraventricular nuclei on the ipsilateral and contralateral sides consisted of very large, juicy neurons. Their area of cross section on the ipsilateral side was $333.7 \pm 2.7\ \mu^2$ and on the contralateral side $323.0 \pm 3.6\ \mu^2$.

Most of the neurons in the supraoptic nucleus on the ipsilateral side 192 h after the operation were large and juicy, with a low content of neurosecretion, but a few among them had a moderate content of neurosecretion. The mean area of cross section of the perikarya on this side was $312.3 \pm 3.9\ \mu^2$. In most nuclei the nucleoli were located in the center, and fewer were close to the nuclear membrane. On the opposite side most neurons in the supraoptic nucleus had a low content of neurosecretion. Their area of cross section was $333.7 \pm 7.6\ \mu^2$ – rather more than on the side of the operation. The nucleoli were centrally situated in the cell nuclei. The neurosecretory cells of the paraventricular nucleus on both sides were juicy, with a low content of neurosecretory granules and with large, transparent nuclei and centrally situated nucleoli. On the side of the operation the mean area of cross section of neurons of the paraventricular nucleus was $271.9 \pm 2.1\ \mu^2$, and on the opposite side $282.2 \pm 3.1\ \mu^2$.

The tigroid substance in the neurons of both neurosecretory nuclei was present in a very small quantity.

Analysis of the changes in the neurosecretory nuclei of the anterior hypothalamus of rats after injury to the right sciatic nerve, interfering with the conduction of afferent impulses, at various times after the operation leads to the following conclusions.

1. During the first day there was a steady increase in area of cross section of the neurosecretory cells of both nuclei.

2. On the 8th day the cells of both nuclei were appreciably smaller again, although their area of cross section was still above normal.

3. Throughout the experiments the response of the supraoptic nuclei on both sides of the hypothalamus developed asymmetrically. The asymmetry was most marked on the 2nd–4th day of the experiment, after which it tended to disappear.

4. In the paraventricular nuclei the asymmetry developed to a lesser degree than in the supraoptic nuclei; it reached a maximum on the 2nd day of the experiments and then declined.

5. However, despite the gradual decrease in the response, the perikarya of both nuclei were still larger than initially 8 days after the operation.

The responses arising in the supraoptic and paraventricular nuclei to the same stimulus thus differed to some degree. Since the paraventricular cells respond feebly to afferent stimuli from the skin and muscles [4], the reason for these differences could be a lower reactivity of these neurosecretory cells compared with the supraoptic. Under certain circumstances, however, the paraventricular cells exhibit the contrary – increased sensitivity. The differences in the responses are evidence not of reduced reactivity of the paraventricular nucleus but that the neurosecretory cells of both nuclei of the anterior hypothalamus, despite their common origin and their total similarity in structure, shape, size, and the presence of Gomori-positive granules, have differentiated functionally in different directions [3].

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