CHANGES IN MONOAMINE CONCENTRATION AND MONOAMINE OXIDASE ACTIVITY IN THE ARCUATE NUCLEUS OF THE HYPOTHALAMUS DURING THE ESTROUS CYCLE

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The concentration of monoamines (MA) and activity of monoamine oxidase (MAO) in the neurons of the hypothalamic arcurate nucleus were investigated during the estrous cycle. The MA concentration was increased in estrus and reduced in diestrus. MAO activity, on the other hand, was highest in metestrus-diestrus and fell sharply in estrus; definite negative correlation was thus observed between these parameters. The overall change in the MA concentration as well as the change in MAO activity in the arcuate nucleus were shown to be brought about by only a relatively small proportion of its cells, about the same in both cases (15-20% of their total number).

KEY WORDS: monoamines; monoamine oxidase; estrous cycle; arcuate nucleus of the hypothalamus.

The important role of the parvocellular "monoaminergic" nuclei of the mediobasal hypothalamus in the regulations of the tropic functions of the adenohypothysis is now generally accepted [1-3, 6, 8, 10-13]. The activity of these nuclei can be judged from the concentration of monoamines (MA), substances that largely determine the functional state of the nerve cell [9], in their neurons and also from the activity of enzymes inactivating MA. The most important of these enzymes in the brain is monoamine oxidase (MAO), which catalyzes the oxidative deamination of MA [5, 14].

Considering the important role of the hypothalamic arcuate nucleus in the regulation of the gonadotropic functions of the anterior pituitary, the dynamics of the MA concentration and MAO activity in the neurons of this nucleus was analyzed during the normal estrous cycle.

EXPERIMENTAL METHOD

Sexually mature female rats weighing 120-150 g were kept under strict conditions of 12 h in light alternating with 12 h in darkness. On the basis of the results of investigation of vaginal smears and the glucocorticoid and protein-bound iodine levels in the plasma, 5 animals in each of the phases of the estrous cycle were selected. The rats were decapitated and their brain tissue frozen in iso-octane. Frozen sections (10 μ) at the level of maximal development of the nucleus were chosen for investigation (verification of the thickness of the sections with the interference microscope showed that variations did not exceed $\pm 10\%$). MA was detected in the cells of the arcuate nucleus by means of a 10% aqueous solution of formalin [4, 7]. To determine the MA concentration in the neurons of the arcuate nucleus the sections were photographed in the ML-4 luminescence microscope and the photographs were subjected to cytophotometry [4]. During photometry the total number of luminescent cells in the nucleus and the mean intensity of luminescence of a single cell of the nucleus and of the nucleus as a whole were taken into account. MAO activity was determined by Glenner's method using nitro-BT and tryptamine hydrochloride as the substrate. The

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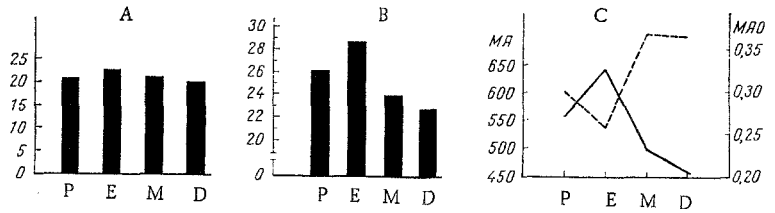

Fig. 1. Changes in the hypothalamic arcuate nucleus in various phases of the sex cycle: A) total number of luminescent cells in the nucleus (ordinate – number of cells); B) intensity of luminescence of a single cell of the nucleus (ordinate – intensity of luminescence of cell in units of the logarithmic scale of the microphotometer); C) intensity of luminescence of the nucleus as a whole (continuous line) and MAO activity (broken line). Ordinate: left – intensity of luminescence of nucleus (in conventional units); right – MAO activity (in optical density units); P) proestrus; E) estrus, M) metestrus, D) diestrus.

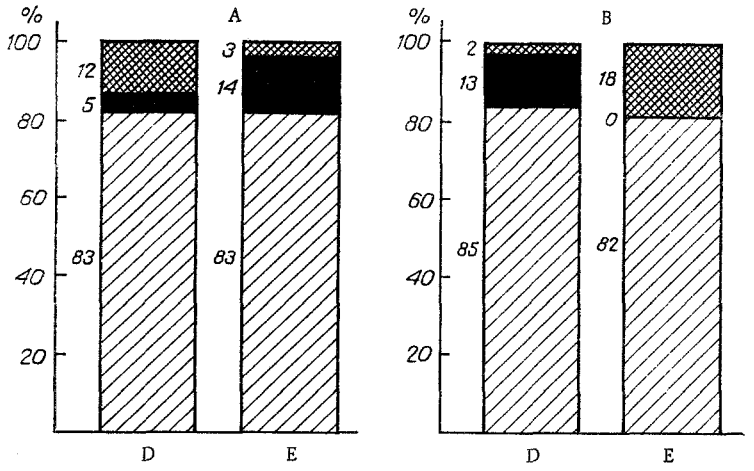

Fig. 2. Changes in relative numbers of cells with different intensities of luminescence (A) and with different levels of MAO activity (B) at various phases of the sex cycle. Cross-hatched parts of the columns denote cells with weak intensity of luminescence (A) or with weak MAO activity (B). Parts of columns shaded black represent cells with a high intensity of luminescence (A) or with high MAO activity (B). Obliquely shaded parts of columns represent cells with average intensity of luminescence (A) or with average MAO activity (B). Abscissa: D) diestrus; E) estrus. Ordinate: percentage of cells.

resulting specimens were studied in the MUF-5 microphotometer by the method of scanning a standard area of the nucleus. Activity of the enzyme was judged from the optical density.

EXPERIMENTAL RESULTS

Investigation of MA showed that the total number of luminescent cells in the nucleus was slightly increased during estrus (Fig. 1A). The change in the mean intensity of luminescence of a single cell of the nucleus was more marked (Fig. 1B). This index was highest in estrus and lowest in diestrus. The dynamic pattern was most clearly marked when the mean intensity of luminescence of the nucleus as a whole was studied (Fig. 1C). This index was lowest in diestrus and highest in estrus ($P < 0.05$).

For a fuller analysis of the changes in the nucleus 3 groups of cells were chosen depending on the intensity of luminescence: with weak luminescence (0-10 units of the microphotometer scale), average

(11-40 units), and high (41-60 units). The number of cells with a high intensity of luminescence was increased in estrus and sharply reduced in diestrus, where the number of weakly luminescent cells, on the other hand, was reduced in estrus and increased in diestrus.

The number of cells with an average intensity of fluorescence, accounting for about 80% of the total number of cells in the nucleus, remained relatively constant (Fig. 2A).

During the investigation of MAO marked activation of the enzyme was observed in metestrus and diestrus and a decrease in its activity in estrus ($P < 0.05$). Just as in the investigation of MA, 3 groups of cells were distinguished: those with low (0-0.16 optical density unit), with average (0.16-0.5 unit), and with high (0.5-0.8 unit) enzyme activity. A marked decrease in the number of cells with high enzyme activity and an increase in the number of cells with low activity were observed in estrus. The opposite relationship occurred in diestrus. The number of cells with an average level of enzyme activity remained relatively constant during the estrous cycle (Fig. 2B).

Definite negative correlation thus is found between the MA concentration and MAO activity in the hypothalamic arcuate nucleus. Analysis of the cellular composition of the arcuate nucleus showed that the change in MA concentration and MAO activity in the various phases of the estrous cycle was brought about by only a relatively small proportion of its cells, about 15-20% of the total number. The accumulation of MA in the neurons of the hypothalamic arcuate nucleus during estrus evidently acts as the "trigger" for fresh cyclic changes in this phase.

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