Role of Short-Range Transmitters in Hypothalamic Activities

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With 9 Figures

Summary

Ovariectomy produced a decrease of the hypothalamic catecholamine content which could be restored by estradiol. Local implantation of estradiol resulted in a significant rise of the catecholamine concentration in the basal and medial hypothalamus. Testosterone administration was ineffective. During lactation the catecholamine content of the hypothalamus was higher than in nonlactating females.

Bilateral lesions in the preoptic area produced a decrease of the catecholamine concentration in the median eminence and the estradiol administration did not induce increase in ovariectomized and preoptic lesioned rats. It is assumed that rostral afferentation to the median eminence is involved in the function of catecholaminergic neurons.

Humoral factors involved in the regulation of hypothalamic activities can be divided into categories as follows: (1) chemical transmitters in a classical sense (acetylcholine, noradrenaline, 5-hydroxytryptamine, etc.), (2) the humoral agents which exert specific influences on the target cells located in medium range (e.g., prostaglandins), and (3) the long-range acting hormones (e.g., pituitary hormones, steroids, etc.). Interactions between chemical transmitters of different origins and their mutual participation in the organization of specific nervous activities at the hypothalamic level have been the subjects of numerous studies in the recent decades. The
present paper gives some contributions to the role of short-range transmitters in controlling the hypothalamo-pituitary activities, especially to the changes of catecholamines in response to castration and substitution with sex steroids, on the one hand, and to prolactin administration as well as during lactation.

Catecholamines and Pituitary-Ovary Function

Quantitative changes in hypothalamic catecholamines during the estrous cycle have been established by several authors. By the use of different methods they found a decrease of the noradrenaline and dopamine concentration in proestrus and a peak of these monoamines in diestrous (Fuxe and Hökfelt, 1970; Stefano and Donoso, 1967), although these findings could not be replicated. Similarly, opposite data have been reported on the effects of sex steroids upon hypothalamic catecholamines; thus, estradiol administration resulted in a decrease of noradrenaline concentration (Donoso and Stefano, 1967) which is opposed to the observations of Kurachi et al. (1968) and Tonge and Greengrass (1970) who found a restoration of the hypothalamic catecholamine content by estrogen treatment in castrated rats.

Studying the noradrenaline and dopamine concentration of the hypothalamus with fluorimetric methods (Chang, 1964; Udenfried and Zaltzman-Nierenberg, 1963), we found that 3 to 4 weeks after ovariectomy the catecholamine content is lower than in intact female rats. The administration of estradiol, which was given in 10 per cent ethanol/physiological saline subcutaneously for 7 days, led to the restoration of the decreased catecholamine concentration in the ovariectomized rats (Fig. 1).

In contrast to observations on ovariectomized animals, it was found that estradiol administration to intact females produced a biphasic change of the hypothalamic catecholamine level. Thus, estradiol treatment led to a significant drop of the noradrenaline concentration within 24 hours although there was no significant change in the dopamine level. On the other hand, daily administration of 2 μg/100 g estradiol for 7 days produced a moderate increase of both catecholamines in comparison to the intact groups, treated with physiological saline (Fig. 2).

Intrahypothalamic implantation of 5 to 10 μg estradiol-17β into the median eminence region of castrated females produced a marked rise of the noradrenaline and dopamine levels 7 to 10 days after local hormone application. The animals were castrated one month prior to