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Dynamics of Changes of Monaminoxidase Contents in Some Hypothalamic Nuclei after Different Periods of Food Deprivation and Restoration of Food Regime

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Monaminoxidase contents were determined by quantitative cyto-photometric method in neuronal organization of lateral nucleus, ventro-medial nucleus, paraventricular nucleus and supraoptic nucleus of hypothalamus after different periods of food deprivation and restoration of food regime. Monoaminergic system of laternal nucleus is probably necessary for keeping of informational and energetic potentials of the neuronal organizations of laternal nucleus and also for supporting of functional connections with all levels of food functional system. The neuro-transmitter system of ventro-medical nucleus is necessary for gradual realization of energetic sources of the organism.

Key Words: Food deprivation, Homeostasis, Monaminoxidase.

INTRODUCTION

Biological activity of monaminoxidase (MAO) is related to the metabolism of such physiologically active biogenic amines as dopamine, noradrenalin, serotonin, etc., catalyzing the reaction of oxidative domination; MAO not only inactivates biogenic amines, but as well assists formation of substances possessing biological activity, aldehydes and hydrogen peroxide[1]. Some biogenic amines (dopamine, noradrenalin and serotonin), carrying out the role of neurotransmitters, take part in conducting impulses in nerve cells[2].

It is also assumed now that MAO supports physiological level of neurotransmitter in presynaptic endings of nervous fibres and this constitutes its main function in mediating nervous impulses.

Studying of neurochemical organization of hypothalamic regulation centres of food intake allowed some authors to propose that[3, 4] the mechanism of animals' food behaviour regulation is adrenergic by their nature. A number of advantages of histochemical methods give an opportunity to study the morphochemical reactions of separate hypothalamic nuclei in food behaviour formation that, perhaps, will allow elucidating the understanding of central mechanisms of food directed reactions regulation.

The purpose of the present study is to reveal the brain enzyme system (MAO) in dynamics of sequenential changes of an organism's homeostasis as well as the

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revealing neurochemical status of energy turnover in different brain structures under different levels of food motivation.

EXPERIMENTAL

The work was conducted on Wister male rats of the same age, of 170–200 g weight. The experimental animals were not given food during 1, 3 and 5 days accordingly, but they had a free water access. The animals were culled into 2 subgroups. The experimental animals were decapitated by hilotine knife after different periods of food deprivation. The first subgroup of animals was sacrificed after indicated periods of food deprivation, while for the second subgroup the animals' food regime was restored and they were sacrificed after different periods of its restoration (after 2, 6, 24 h, 3 and 5 d). During these periods the experimental animals received food *ad libidum.* The controls were kept on the usual food regime. For each variant of experiments five albino rats have been used. On the whole, 70 white rats have been used. The lateral nucleus, ventro-medial nucleus (VMN), paraventricular nucleus (PVN) and supraoptical nucleus (SON) of the hypothalamus were studied.

The brains of experimental animals were entirely removed and hypothalamus with adjacent areas was placed on microtome table. On the cryostats MK-25 fresh frozen sections of 18 mkr thickness from hypothalamic nuclei were obtained.

The histochemical revealing of the MAO activity was performed with the method of Glenner and Burriner[5]. The cytospectrophotometry of preparations was carried out on the photometer on 585 nm for MAO with the objective of 40 magnifications. The diameter of the sondre on the surface the preparation was 8 μm[6]. There were 120–150 indicators of photometry in neurons in each experiment.

RESULTS AND DISCUSSION

The highest enzymatic MAO activity was noticed in adrenergic terminals of the hypothalamic VMN and lateral nucleus. The results of photometric studies of separate hypothalamic nuclei in standard and in different periods of feeding behaviour are presented in Tables 1–3 and Figs. 1–3.

TABLE-1
MAO ACTIVITY IN THE MONOAMINERGIC TERMINALS OF SOME HYPOTHALAMIC NUCLEI AFTER DIFFERENT PERIODS OF FOOD DEPRIVATION

Hypothalamic nuclei		Control M ± m	Duration of food deprivation								
			1 day			3 days			5 days		
			M ± m	p	%	M ± m	p	%	M ± m	p	%
LN	M	13.1 ± 0.1	13.0 ± 0.8	> 0.05	19.9	16.8 ± 0.2	> 0.05	12.8	23.7 ± 0.8	> 0.05	18.1
VMN	MAO	16.4 ± 0.2	18.8 ± 0.4	< 0.001	11.5	22.3 ± 1.1	< 0.001	14.0	27.2 ± 0.5	< 0.001	16.6
PVN	MAO	17.3 ± 0.4	17.1 ± 0.3	> 0.05	9.9	19.5 ± 0.2	> 0.05	11.3	26.7 ± 1.2	< 0.001	15.4
SON	MAO	15.7 ± 0.2	15.0 ± 0.4	< 0.01	9.6	17.3 ± 0.7	> 0.05	11.0	22.7 ± 0.6	> 0.5	14.4

TABLE-2
MAO ACTIVITY IN MONOAMINERGIC TERMINALS OF SOME HYPOTHALAMIC NUCLEI DURING RESTORATION OF FOOD DEPRIVATION AFTER 3 DAYS

Hypothalamic nuclei		Control (M ± m)	3 days (M ± m)	Periods of restoration of food regime after 3 days of food deprivation								
				2 h			6 h			24 h		
				M ± m	p	%	M ± m	p	%	M ± m	p	%
LN		13.1 ± 0.1	16.8 ± 0.2	17.0 ± 0.3	> 0.5	12.9	16.5 ± 0.2	< 0.01	12.6	15.8 ± 0.2	< 0.02	12.1
VMN	MAO	16.4 ± 0.2	22.8 ± 1.1	22.1 ± 0.3	< 0.01	13.4	21.6 ± 0.1	> 0.05	13.2	20.8 ± 0.2	> 0.05	12.7
PVN	MAO	17.3 ± 0.4	9.5 ± 0.2	20.0 ± 0.1	< 0.01	11.6	19.0 ± 0.1	< 0.001	10.9	18.6 ± 0.2	< 0.01	10.8
SON	MAO	15.7 ± 0.2	17.3 ± 0.7	17.7 ± 0.2	> 0.5	11.3	16.9 ± 0.2	> 0.05	10.8	16.9 ± 0.1	> 0.01	10.6

TABLE-3
MAO ACTIVITY IN MONOAMINERGIC TERMINALS IN SOME HYPOTHALAMIC NUCLEI DURING RESTORATION OF FOOD REGIME AFTER 3 DAYS

Hypothalamic nuclei		Control M ± m	3 days of food deprivation			The periods of restoration					
						3 days			5 days		
			M ± m	p	%	M ± m	p	%	M ± m	p	%
LN	MAO	13.1 ± 0.1	16.9 ± 0.3	< 0.001	129	15.0 ± 0.5	> 0.001	115	13.3 ± 0.5	< 0.010	10.1
VMN	MAO	16.4 ± 0.2	22.5 ± 0.3	< 0.001	137	19.4 ± 0.5	< 0.001	118	17.5 ± 0.4	< 0.001	10.6
PVN	MAO	17.3 ± 0.4	19.6 ± 0.5	< 0.001	113	17.0 ± 0.2	> 0.001	98	17.2 ± 0.4	< 0.001	9.9
SON	MAO	15.7 ± 0.2	16.7 ± 0.3	< 0.001	106	15.8 ± 0.3	> 0.001	100	14.5 ± 0.4	< 0.010	9.2

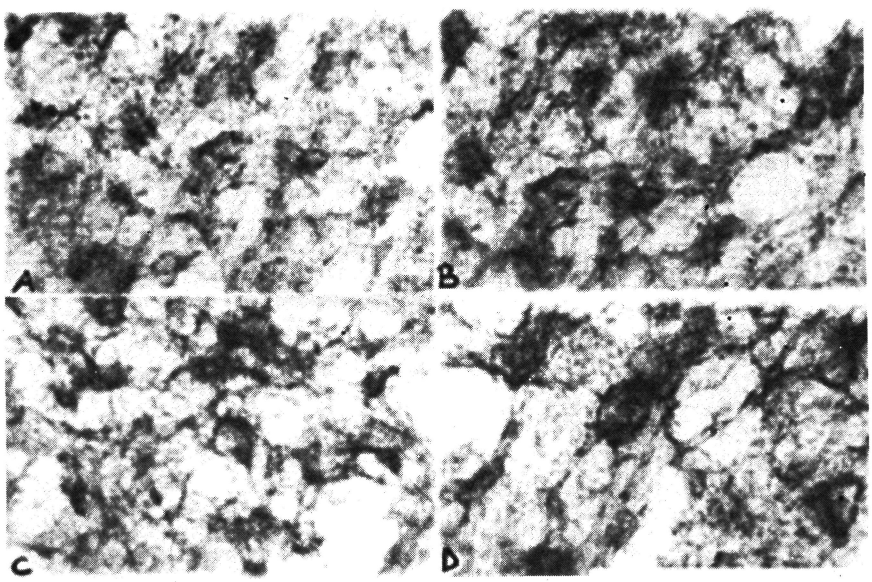

Fig. 1. Activity of monamineoxidase (MAO) in LN (A), VMN (B), SON (C) and PVN (D) of the hypothalamus after three day food deprivation X400

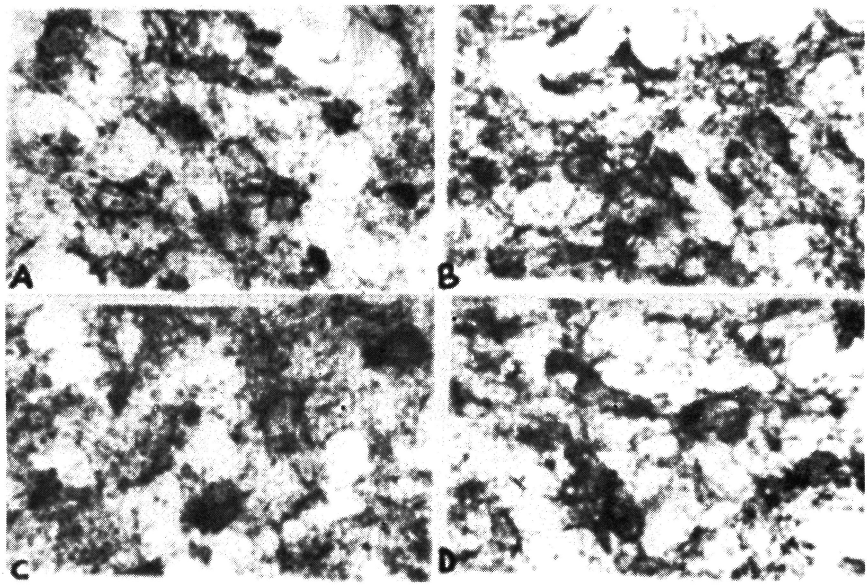

Fig. 2. Activity of monamineoxidase in LN (A), VMN (B), SON (C) and PVN (D) of the hypothalamus after one day food deprivation X400

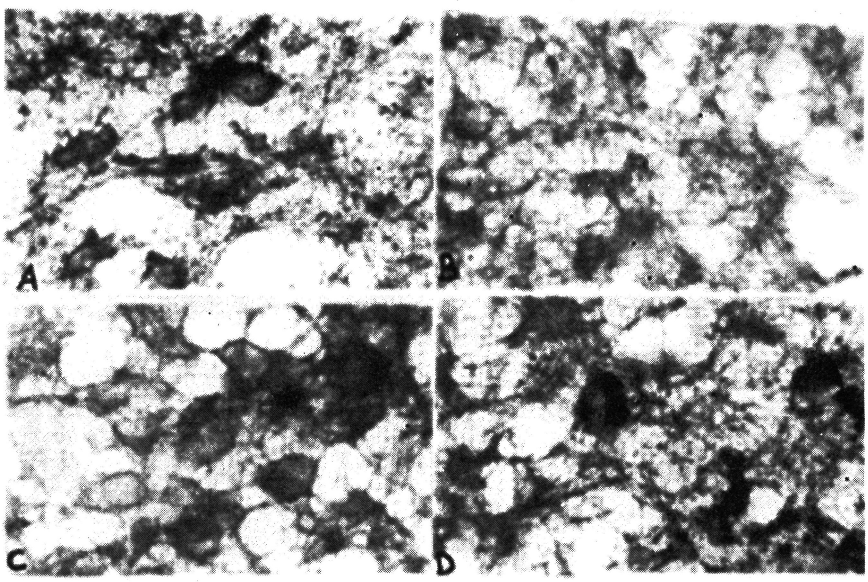

Fig. 3. Activity of monamincoxidase in LN (A), VMN (B), SON (C) and PVN (D) of the hypothalamus of control animals X400

There has been noticed a slight increase of MAO activity in VMN terminals of the hypothalamus in these periods of food deprivation (115% in comparison to control). In favour of this assumption, the data of predominance of sensitivity of monoamine structures in lateral nucleus has been shown. Some decrease of MAO activity in all studied hypothalamic nuclei in these periods of food deprivation is probably related with the release of depoted catecholamine from monoaminergic terminals in the initial periods of hunger which has fine correlation with the results obtained in our laboratory[7]. (The reduction of catecholamine luminescence in MAO-ergic terminals of hypothalamic nuclei after one-day food deprivation was studied). The lack of visible changes in MAO activity in investigated brain structure (with exception of VMN) in earlier periods of food deprivation (the first days) testifies that the brain catecholaminergic system is not sensitive to the changes in the organism's homeostasis in that period. The dominant role in the perception of initial food deficiency belongs to the cholinergic systems which are believed to be more informative than monoaminergic one, so far as it has been established the polysinapticity of its switching in the rising system while the monoaminergic paths are monosynaptic[8].

Some increasing of MAO activity in the varicosities of the VMN monoaminergic terminals in that period of food deprivation is connected with the sensitivity of the VMN catecholaminergic structure to starvation factors. The correctness of such assumption is also supported by the observation conducted on saturated animals at the background of administration of adrenergic substances. In the VMN the increase of food uptake has been observed[9, 10].

It should be noticed that together with the behaviour activity the simultaneous mobility of the organism's homeostasis is also necessary which is regulated by the vagal and hypothalamic-hypophysal system[11, 12]. It follows that the increased enzymatic activity of lateral nucleus observed during the animals' motivated behaviour, reflects the involvement of cholinergic afferent neurons of the studied brain structures, which provide rapid rearrangement in the organism's homeostasis. In this period of starvation the further increase of MAO activity in the VMN and lateral nucleus terminals was observed (140 and 128% correspondingly). Intensification of the enzymatic activity was also noticed in the varicoses of PVN monoaminergic terminals –113%. The marked increase of MAO activity in VMN indicates the deep rearrangement in energy turnover of food deprived animals and intensification of the functional role of hypothalamic-hypophysal-adrenal system which is found to be in perfect agreement with the findings of other researchers[13], who noticed the increase of 11-OKS content in the blood; increase of adrenaline and noradrenaline contents in the blood in adrenal and hypothalamus; increase of catecholamines content in lateral nucleus and VMN monoaminergic terminals as well. The increase of MAO activity in PVN indicates the participation of this nucleus in the regulation of animals' feeding behaviour. The correctness of such assumption is also confirmed by morphological data[12, 14]. It has been shown that PVN has direct connections with the vagal dorsal motor nucleus and solitary tract nucleus and across this system together with the liver portal system probably participates in the regulation of hunger and saturation centres. It was noticed that[4, 15] adrenergic stimulation of PVN increases food uptake and at the same time indicates the important role of this hypothalamic nucleus in the regulation of food behaviour.

Results showed that food deprivation of animals up to 5 d is characterized by maintenance of high enzymatic MAO activity in all the studied structures (further increase of activity was noticed in some structures). It is known that the leading role in energy providing of emotional stress belongs to the adrenal system which increases adrenaline secretion by reflex way, also pancreas increasing glucagons-insulin formation functions and thereby the level of glycemia is changed[13, 16]. During activation of these glands the crucial role belongs to hypothalamic-hypophysis system[17] being launched by hypothalamic centres, the adrenergic structures of which simultaneously activate the brain cortex through the brain stem reticular system.

The results of the present studies showed that deepening the stressful effects of hunger promotes the mobilization of sympathy-adrenal system for regulation of the organism's energy homeostasis. Preservation of relatively high catecholamine activity in the LN and VMN monoaminergic terminals[18, 19] and simultaneous maintenance of high MAO activity in all these nuclei indicates that the central monoaminergic regulator mechanism of hypothalamic-hypophysis-adrenal system is very sensitive one.

The purpose of the second part of this work was to study the interrelations between these mediator systems at the background of restoration of food regime after 3 d food deprivation. The results of these studies are presented in Tables 2 and 3. The performed studies showed the lack of any changes in MAO activity during food deprivation restoration for 2 h after 3 d of animal's deprivation. Restoration of food deprivation for 6, then 24 h in the same animals was accompanied by slight decrease of MAO activity in varicosities of VMN and lateral nucleus monoaminergic terminals. While continuing food uptake to 3 and 5 d in animals having been deprivated during 3 d we observed the considerable decrease of MAO activity in monoaminergic terminals in all the studied hypothalamic nuclei.

Changing in MAO activity during food regime restoration is probably due to the catecholaminergic neurotransmitter system in which periods of activation and inactivation of these neurotransmitters are increased[20]. Our data are also in accord with the available data that keeping deficit in feeding behaviour in rats with insured hypothalamic structures after the restoration of sensorimotor functions is connected with the prolonged disturbance of unspecific motivation components mediated by dofaminergic neurons[21].

Thus, the obtained results of the histochemical researches of MAO activity in separate hypothalamic structures on different periods of food deprivation showed that monoaminergic system of lateral nucleus is probably necessary for keeping of informational and energetic potentials of the neuronal organization of lateral nucleus and also for supporting of functional connections with all levels of food functional system. Our concept coincides finely with the opinion of Nicolaids[22] who considers that the states of hunger and satiety are regulated by the speed of intracellular energic production, which depends on the accessibility of food substrates and character of hormonal secretion. The preservation of the high level of neuronal organization of the VMN is necessary for gradual realization of energetic sources of the organism[11, 23].

All these allow us to conclude that the function of laternal nucleus is closely related to the organization of the neurophysiological mechanisms of regulation of the energetic sources of the organism after various periods of food deprivation and after restoration of the food regime.

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