CHANGES IN DENDRITES OF THE LATERAL HYPOTHALAMIC AREA IN FOOD-DEPRIVED RATS

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The lateral hypothalamic area (LHA) is one of the most important structures of the CNS, and afferent impulsation from the digestive tract and afferent impulses from the digestive tract and "hungry blood" factors act on it to form food motivation. This area of the hypothalamus is regarded as the hunger center. Only isolated morphological studies of LHA during food deprivation, conducted at the light-optical level [1, 4], can be found in the literature, and there have been no investigations at the ultrastructural level.

The object of the present study was accordingly to examine ultrastructural changes in the rat LHA during starvation. Since dendrites, which perform the receptive function of neurons, play an important role in CNS activity, special attention was paid to a study of the dynamics of pathomorphological changes in the dendrites in LHA during food deprivation.

EXPERIMENTAL METHOD

Experiments were carried out on 25 Wistar albino rats weighing 190-200 g. The animals were deprived of food but were allowed water ad lib. The animals were killed 1, 3, 5, and 7 days after the beginning of the experiment and an electron-microscopic investigation carried out.

EXPERIMENTAL RESULTS

The electron-microscopic investigation showed that the dendrites are the most vulnerable components of nerve cells and are damaged before the other components (soma, axon). The response of the dendrites appeared 24 h after food deprivation; changes appeared soonest of all in medium-sized and large dendrites, and the small branches of the dendrites became involved in the reactive process later during starvation.

The initial form of changes in the dendrites consisted of focal translucency of the dendroplasm, a reduction in the number of neurofilaments and microtubules, and the appearance of small vacuoles. Changes of this kind were seen as early as after 24 h of food deprivation. On the 3rd day fragmentation, focal swelling, and vacuolation of microtubules were observed (Fig. 1a). These changes were particularly marked in medium-sized dendrites. Characteristic changes in the dendrites were edema, swelling, and vacuolation. Vacuoles and large vacuole-like cavities were found in many cross-sections of dendrites (Fig. 1b). In shape and size they were extremely polymorphic: They could be optically empty, filled with finely granular osmiophilic material, or contain smaller vacuoles within the cavity. Vacuole-like cavities were surrounded by a single or double membrane. The membranes frequently had indistinct outlines, and in some areas they appeared to be fused. On the 3rd day of starvation complex structures consisting of concentrically arranged membranes appeared in some dendrites. In the later stages of food deprivation the number of dendrites containing myelin-like bodies increased.

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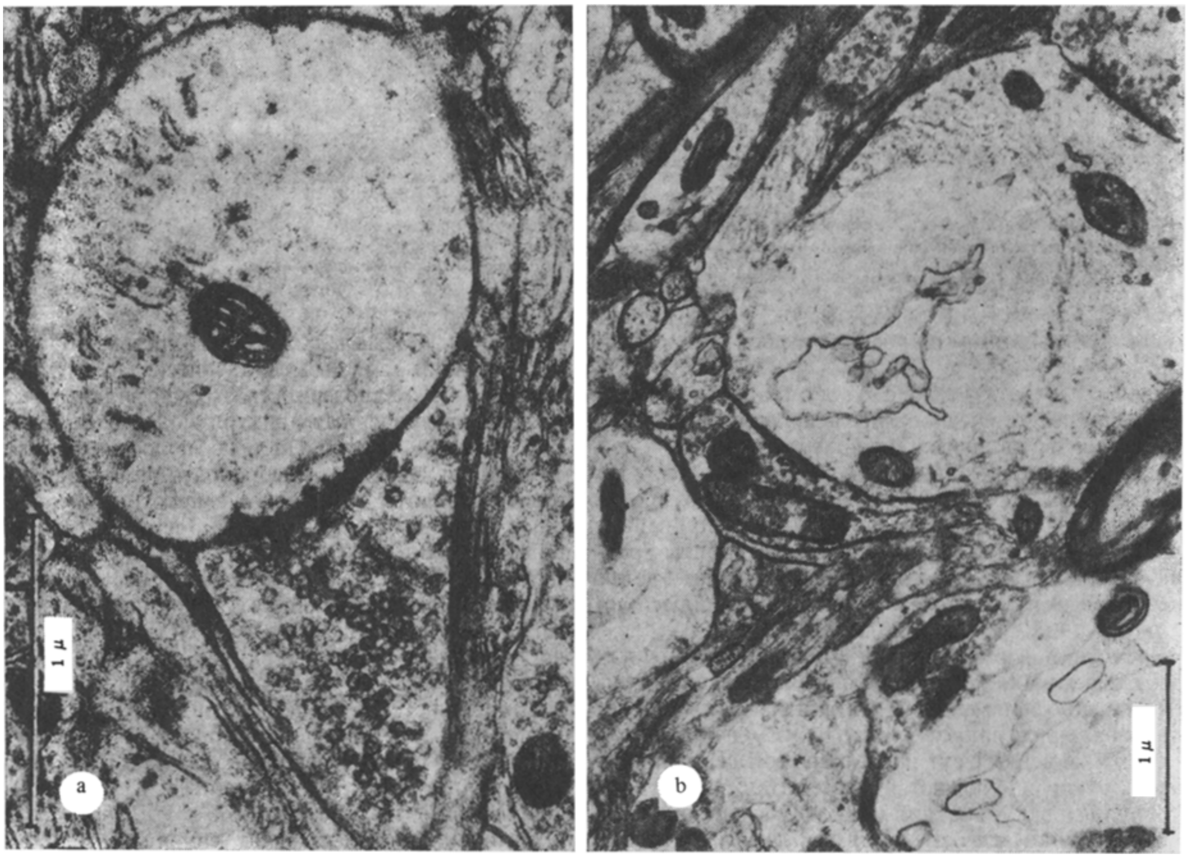

Fig. 1. Changes in dendrites in posterior part of LHA on 3rd day of food deprivation in rats: a) fragmentation, focal swelling, and vacuolation of microtubules; b) focal destruction of axoplasm and formation of large vacuoles and vacuole-like cavities. Scale 1 μ.

On the 5th-7th day of food deprivation thin filamentous structures with small osmiophilic grains on them began to appear in the dendrites. These structures in all probability are edematous, fragmented, and disintegrating neurofilaments (Fig. 2a, b).

The mitochondria in the dendrites began to change in the later stages of starvation (5th-7th day). Two types of changes could arise in them. In some mitochondria the predominant features were swelling, edema, and translucency of the matrix with focal or total destruction of the cristae. In other mitochondria condensation of the matrix, a decrease in the number of cristae, and widening of the lumen of the remaining cristae could be observed. Regions of destruction of the outer membrane of many mitochondria were found.

The most characteristic change in the dendrites, observable after the 3rd day and more conspicuous on the 7th day of food deprivation, was invagination of adjacent structures inside the dendrites. Usually cross-sections of axons underwent invagination in this way, often in the region of synaptic contact (Fig. 2a, b). As a rule translucency of the dendroplasm and absence of cytoplasmic organelles were seen in the region of invagination. Membranes of dendrite and axon in the region of invagination underwent deceptive changes, twisted forms of membranes and dilatations were present, and sometimes the membranes separated to form a wide space between them. Organelles of axons in the regions of invagination also underwent destructive changes. The synaptic vesicles were greatly enlarged and assumed various shapes and sizes, Invaginated regions subsequently evidently were pinched off the main trunks to form some of the vacuole-like cavities with a double membrane observed in the dendrite. Similar invagination of axons, but to a less marked degree and only in the late stages of starvation (7th day), also were observed in the cytoplasm of some neurons.

This investigation thus revealed a definite dynamics of the ultrastructural disturbances in dendrites of LHA in rats in different stages of starvation. The characteristic type of changes which we observed, namely invagination and burying of the pinched-off part of the

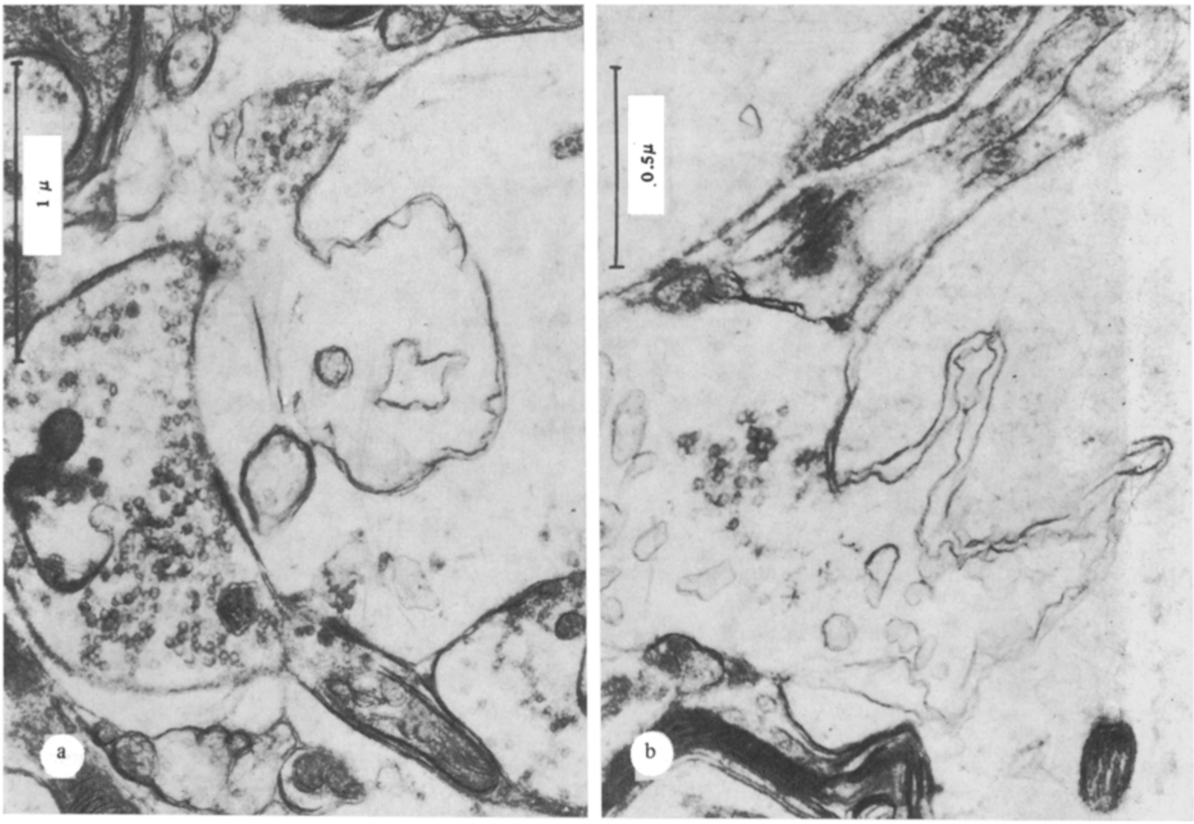

Fig. 2. Invagination of part of an axon inside cytoplasm in cross-section of a dendrite. a) Pinching off of invaginated part and destruction of membranes in this region; b) dilatation and focal destruction of membranes in region of invagination and formation of vacuoles of different shapes and sizes. Scale: a) 1 μ, b) 0.5 μ.

presynaptic process inside the dendrite, on the one hand, may be regarded as a unique mechanism of destruction of interneuronal connections. Similar invagination of neighboring structures into the dendrite alone was observed by other workers under different experimental conditions — in an epileptic focus, after sensory deprivation, and in hypoxia [2, 3, 6].

On the other hand, the possibility cannot be ruled out that as a result of focal destructive changes in dendrites and, in particular, microtubules (swelling and fragmentation) the transmission of mediators and interaction between the presynaptic process and dendrites, which has a receptive function, are disturbed. The process of reception and transmission of mediators may also be disturbed by a change in the ionic mechanisms of synaptic transmission. It is natural to suppose that, to compensate their disturbed functions, the dendrites begin to exhibit increased activity. Invagination of regions of axons with synaptic vesicles containing a particular mediator can be regarded as a compensatory process. This process can be compared with those of pinocytosis observed in dendrites of various brain structures [2, 5, 6].

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