THE PARS INTERMEDIA OF THE HYPOPHYSIS DURING SALT LOADING

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The pars intermedia of the hypophysis in animals and man is in close morphological contact with the neurohypophysis, its caudal division. Experimental investigations have shown that the hypothalamic neurosecretion, stored in this division of the neurohypophysis, has a significant effect on the function of the pars intermedia [1, 3, 7]. In amphibians, during the period of metamorphosis and reproduction, we observed [3] morphological signs of secretory activity in the pars intermedia of the hypophysis, and it was precisely at these times that the neurosecretion accumulated intensively in the posterior lobe of the hypophysis, which became considerably hperemic. The morphological signs of hypersecretion in the intermedial cells abated at the same time as did the "atrophic" changes in the posterior lobe, arising during other biological periods, when the passage of neurosecretion into the neurohypophysis was greatly diminished.

These observations on the natural relationships between the neurosecretory activity and function of the pars intermedia of the hypophysis were studied in particular in association with marked changes in the content of neurosecretion in the posterior lobe, and especially when the neurohypophysis was completely free from stored neurosecretory substance. Complete removal of neurosecretion from the posterior lobe is usually achieved by experimental dehydration [3, 4, 5]. This phenomenon was used as the starting point for our present investigation.

EXPERIMENTAL METHOD

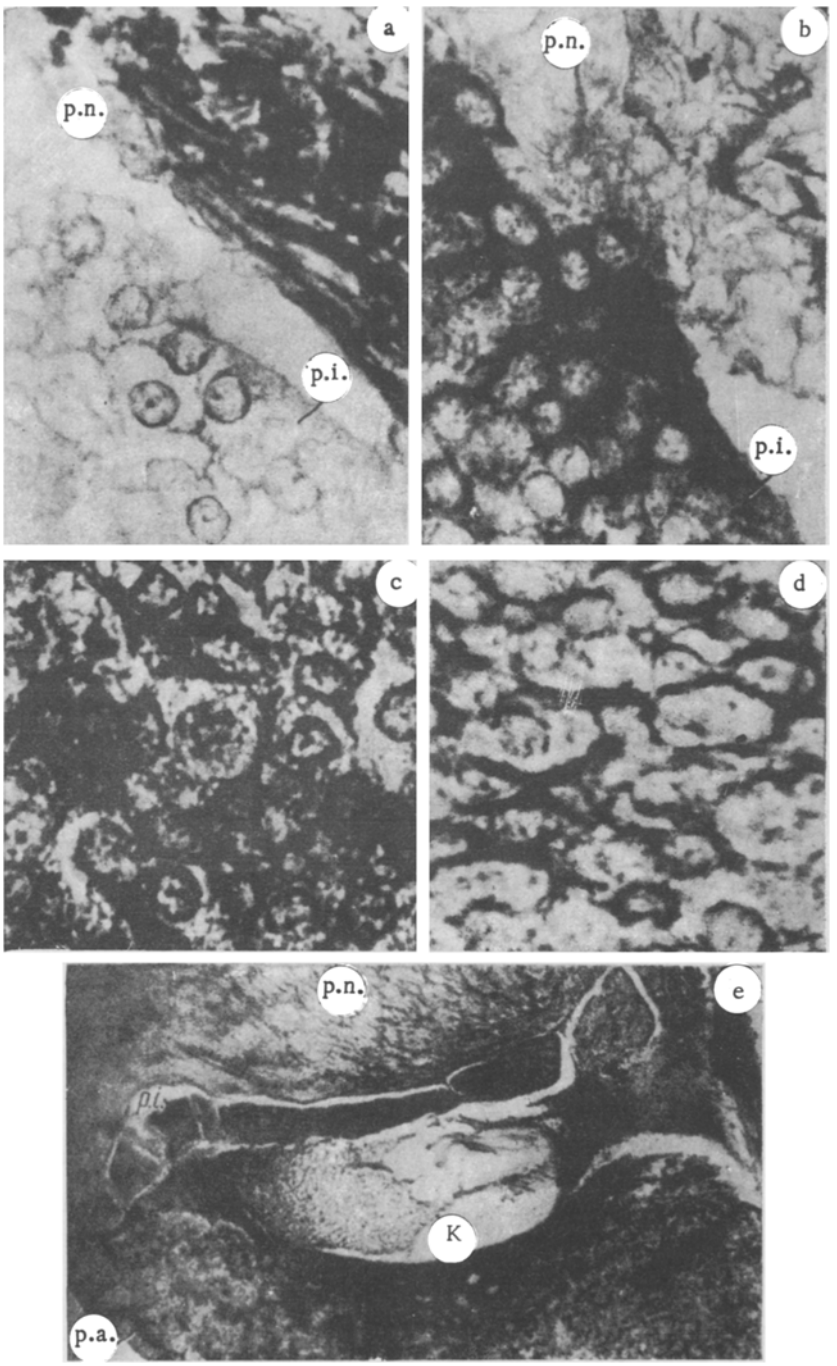
The test object consisted of the pars intermedia of the hypophysis from 25 albino rats, which received a 2.5% solution of common salt for 20 days and which were sacrificed at different periods after the beginning of the experiment (5, 10, 15, and 20 days). Control animals received water to drink in adequate amounts. Histological sections of the hypophysis were stained with paraldehyde-fuchsin by Halmi's method, with chrome hematoxylin and phloxin by Gomori's method, for polysaccharides by the PAS reaction, and for ribonucleoproteins by Brachet's method.

In relatively normal conditions, the pars intermedia of the hypophysis of albino rats contains two types of cells, differing in their structural and staining properties. The large round cells of the first type are characterized by a loose, cellular cytoplasm, staining poorly by the principal methods because of its structure and appearing translucent. These lightly stained cells were predominant in the pars intermedia of the control animals (see figure, a). The epithelial cells of the second type are smaller in size, and polygonal in shape, with processes. The cytoplasm of these cells is homogeneous, highly basophilic, and gives a positive PAS reaction and reaction for ribonucleoproteins. The nuclei of the intermedial cells contain little chromatin and 1 or 2 nucleoli. The karyoplasm of some cells stains intensively with phloxin or orange.

Since we were concerned with the cytology of the pars intermedia during changes in the content of neurosecretion, the most satisfactory method of staining for comparing the preparations of the hypophysis of the control and experimental animals was Halmi's method. In sections of the hypophysis of the control rat stained by this method, the neurosecretion deposited in the posterior lobe stained a bright violet color with paraldehyde fuchsin. The epithelial cells of the pars intermedia stained variously with light green: for example, the homogeneous cytoplasm of the cells of the second type, like the delta-basophils of the anterior lobe, stained green, while the translucent cells took up the green dye only very feebly.

EXPERIMENTAL RESULTS

Dehydration of the experimental animals by means of hypertonic NaCl solution led to removal of all the hypothalamic neurosecretion from the posterior lobe of the hypophysis. Considerable hyperemia and hypertrophy of the



Posterior lobe and pars intermedia of the hypophysis of an albino rat after salt loading (stained by Halmi's method). p.n.) posterior lobe; p.i.) pars intermedia; p.a.) anterior lobe of the hypophysis. a) control: the posterior lobe is filled with neurosecretion, the cytoplasm of the cells of the pars intermedia is weakly basophilic; b) the posterior lobe of the experimental animal (20 days of salt loading) contains no neurosecretion, the cytoplasm of all the cells of the pars intermedia is filled with aldehyde-fuchsinophilic granules (900×); c) pars intermedia after salt loading for 5 days: clear differentiation of cells into two types, increased basophilia of the cytoplasm of the light cells of the first type (900×); d) pars intermedia after salt loading for 10 days: light, unstained cells predominant, branching cells of the second type are hypertrophied and intensively stained (900×); e) hypophysis after salt loading for 5 days: at the border between the pars intermedia and the posterior lobe is a lacuna filled with colloid K (900×).

organ were observed. The posterior lobe remained empty throughout the experiment – from the 5th to the 20th day – and did not stain with paraldehyde fuchsin. The parenchyma of the pars intermedia lost its characteristic normal affinity for light green and stained unusually brightly with paraldehyde fuchsin. This phenomenon was particularly conspicuous when the hypophyses of the control and experimental animals were compared (see figure, a, b).

Salt loading for 5 days, causing the total removal of neurosecretion from the posterior lobe, led to some degree of atrophy of the pars intermedia. The ability of the parenchyma of the pars intermedia of the hypophysis of the experimental animals to stain with aldehyde fuchsin intensified the differentiation, characteristic of its cells, into light cells with a loosely packed, chromophobic cytoplasm and "dark" cells with a homogeneous, chromophilic cytoplasm (see figure, c). However, in many of the light cells (first type) a condensation of the cytoplasm was observed, causing an improvement in their staining properties and the appearance of aldehydefuchsinophilic and PAS-positive granules (see figure, c). This process of condensation of the cytoplasm affected most cells of the first type and led to the formation of a number of hyperchromatic cells. These cells with hyperchromatic cytoplasm and oxyphilic nuclei were situated along the border between the pars intermedia and the posterior lobe. In places they lay close together and formed a continuous limiting layer.

The polysaccharide and ribonucleoprotein concentration in the cytoplasm of the cells of the second type increased, and they stained intensively with aldehyde fuchsin, but they remained small in size as before. The karyoplasm of the majority of the intermedial cells became oxyphilic on account of an increase in the number of structures of nucleolus type, staining with phloxin or orange. In the animals loaded with salt for 5 days, at the border between the pars intermedia and the anterior lobe we observed a distinctive lacuna, filled with colloid (see figure, e), whereas in the control animals no colloid was present in this region. The mass of colloid was thickened at the edges and appeared loosely packed at the center. In the marginal zone of the colloid individual groups of intermedial cells and pyknotic nuclei appeared to be immured. Sometimes large groups of small accessory droplets, staining with phloxin and orange, could be observed in the mass of colloid. It may be noted that the colloid, as a rule, did not take up aldehyde fuchsin and was an oxyphilic substance. Partial vacuolation of the colloid took place in the zone nearest to the anterior lobe.

At later periods of the experiment (10-15 days of salt loading) this colloid was almost entirely resorbed. The condensation and intensified staining of the cytoplasm observed in the cells of the first type were replaced on the 10th day of salt loading by signs of functional exhaustion. The cytoplasm of these cells appeared optically empty, for it was largely vacuolated and contained no granules (see figure, d). The intermedial cells of the second type attained considerable development: they were larger in size, and their processes were longer and ramified. The processes joined together to form syncytia, in the loops of which were situated the light cells we have described. The oxyphilia of the karyoplasm, characteristic of the early experimental periods, was absent.

On the 20th day of salt loading most of the light cells showed hyperchromia of their cytoplasm: they appeared condensed and granular, and stained brightly with aldehyde-fuchsin (see figure, b). The light cells with loose cytoplasm were, as a rule, absent. So far as the cells of the second type are concerned, at this period they showed no significant changes.

This marked hyperchromia of the cells of the pars intermedia during salt loading, when their cytoplasm stained unusually brightly with aldehyde fuchsin, suggests that diffusion of neurosecretion was taking place from the posterior lobe into the pars intermedia. Etkin [6] mentioned the possibility of the diffuse penetration of neurosecretion into the pars intermedia. In animals kept on a normal fluid intake, if this diffusion takes place, the neurosecretion in all probability penetrates into the pars intermedia chemically modified, and at the border between the lobes an apparent "filtration" of this hypothalamic substance takes place. Not by accident has it been reported by several writers that neurosecretory granules are absent from the pars intermedia [3, 7, 8]; the droplet formations observed in it at certain periods as a rule did not stain with aldehyde fuchsin or chrome hematoxylin by Gomori's method [3, 7]. It may be suggested that during a disturbance of the water and mineral metabolism, when a rapid disappearance of the neurosecretory substance takes place from the posterior lobe, it probably escapes along all possible channels. This conclusion is, of course, to some extent hypothetical, although it is obvious that the phenomenon of the opposite-of-normal relationship between the staining properties of the two lobes of the hypophysis, characteristic of the control animals and of the animals kept on a hypertonic solution, is in itself extremely interesting. The intensified basophilia of the intermedial cells at a time when the posterior lobe is free from neurosecretion may be regarded as proof that the function of the pars intermedia is dependent on the humoral influences of the neurosecretion.

SUMMARY

Albino rats were subjected to the action of hypertonic NaCl solution for 20 days. Complete loss of neurosecretion in the pars posterior of hypophysis was noted. Basophilia of the cytoplasm of the majority of the pars intermedia cells increased exceedingly; the latter stained intensely with paraldehyde-fuchsin by Schiff-iodic acid method. Differentiation of intermedial cells into two types (differing structurally and tinctorially) was intensified. Formation of oxyphilic colloid (which is later resorbed) at the border of pars intermedia and anterior is characteristic of the early experimental periods; at the same time cytoplasmic basophilia of the cells of the first type in the pars intermedia is reduced, whereas by the end of the experiment it is seen to increase markedly. The changes observed demonstrate the relationship between the pars intermedia function and the humoral effects of the neurohypophysis.

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