DIFFERENTIATION OF PITUICYTES OF THE NEUROHYPOPHYSIS AND THEIR RESPONSE TO WHOLE-BODY IRRADIATION

A. A. Voitkevich and V. I. Dedov

UDC 612.434.018.014.482

Details are described of the differentiation of the pituicytes of the rat neurohypophysis and their response to whole-body γ-ray irradiation. Differentiation of the pituicytes is complete by the age of 2 weeks. Ionizing radiation induces the accumulation of lipid inclusions in the cytoplasm of the pituicytes and the formation of characteristic cilia (with the formula $9 \times 2 + 2$) by the differentiating pituicytes.

Opinions still differ even today as regards the function of the pituicytes of the neurohypophysis. According to Thomas [6] the pituicytes separate the active principle from the neurosecretory glycolipid complex and liberate neurohormones into the blood stream. Kurosumi [5] regarded the accumulation of lipid inclusions by the pituicytes as the result of phagocytosis of the lipid membranes of elementary granules after liberation of the hormonal principles into the blood stream. Irradiation induces the formation of unusual ultrastructures (cilia or microvilli, for example), which are absent under normal conditions [2].

The object of the investigation described below was to study differentiation of the pituicytes and their response to the action of an extremal factor (ionizing radiation) in young Wistar rats during postnatal development.

EXPERIMENTAL METHOD

The experimental material consists of 50 rats in different stages of postnatal development – 1, 3, 5, 7, 10, 14, 30, 45, and 60 days after birth; sexually mature animals were used for comparison. The rats were irradiated on a "Luch" apparatus: dose 200 R, dose rate 32.8 R/min. Acute radiation sickness was diagnosed in all the experimental animals and they died on the 16th-18th day. The neurohypophyses of the control and irradiated rats were investigated with the electron microscope. Material was fixed in 1% buffered osmium tetroxide solution and embedded in Araldite. Ultrathin sections, stained with lead citrate, were examined in the JEM-54 electron microscope.

EXPERIMENTAL RESULTS

Ultrathin sections through the neurohypophysis of newborn rats revealed a pattern of slight differentiation of the pituicytes. Multivesicular particles and lipid inclusions were seen in the cytoplasm of the pituicytes of the newborn rats. The inclusions differed in shape and their edges were uneven. Lipid inclusions were found in the perikaryon of the pituicytes and in their numerous processes.

With age, the number of lipid inclusions in the pituicytes rose sharply (Fig. 1), so that they frequently deformed the organoids, which appeared compressed between the enlarged lipid drops. The most significant

Laboratory of Radiation Neuroendocrinology, Research Institute of Medical Radiology, Academy of Medical Sciences of the USSR, Obninsk. (Presented by Academician of the Academy of Medical Sciences of the USSR, G. A. Zedgenidze.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 72, No. 11, pp. 107-109, November, 1971. Original article submitted February 8, 1971.

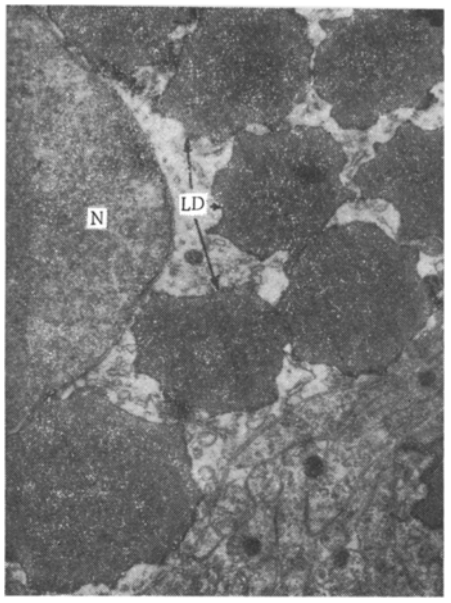

Fig. 1. Area of pituicyte (1 week after irradiation). Numerous lipid drops can be seen in the cytoplasm. N) Nucleus; LD) lipid drops (inclusions), 18,000 ×.

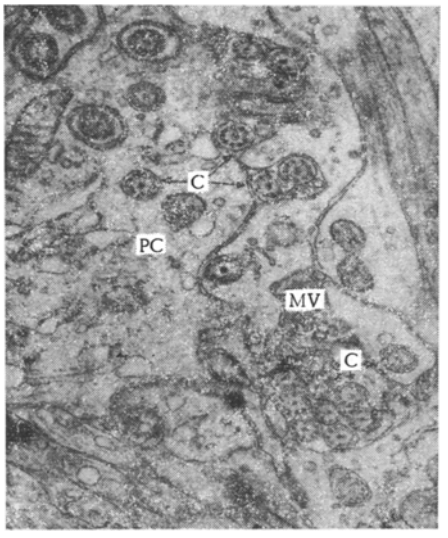

Fig. 2. Transverse section passing through several pituicytes in the cytoplasm, in the intervals between cells, and in the cavity of a "follicle." C) Cilia; PC) pituicyte; MV) microvilli, 23,000 ×.

changes were observed 2 weeks after irradiation. The tubules of the granular recticulum were greatly dilated. Their membranes for the most part had no fixed ribosomes. Free ribosomes, on the other hand, were located near these "cavities" formed as a result of excessive swelling of the tubules.

The cytoplasm of some pituicytes in rats aged 2 weeks forms multiple cilia (Fig. 2). In transverse sections, the cilia are elliptical in shape and have a characteristic structure: 9 pairs of tubules at the periphery and 1 pair in the center. Most of the cilia are arranged in groups both in the cytoplasm of the pituicytes and in the intervals between neighboring pituicytes or secretory terminals. In certain cases the cilia are arranged in groups, forming geometrically regular 3-6-sided figures. Small groups of cilia are found in the cavities of the intercellular "follicles" formed by adjacent pituicytes (Fig. 2). Besides cilia, these cavities as a rule contain typical multiple microvilli.

The sharp increase in size of the lipid inclusions in the cytoplasm of the pituicytes of irradiated animals coincides with the forced liberation of neurosecretion into the blood stream. This phenomenon has been observed by the writers previously. The same sort of relationship between the number of lipid inclusions in the processes of the pituicytes and the rate of liberation of neurohormones was also observed by Kurosumi [5] in experiments to study the action of dehydration and of chronic stressors (formalin and mechanical trauma). An identical phenomenon was found in experiments in which hypertonic saline was injected [1]. Bennett and Fox [4] kept animals for long periods exposed to cold and demonstrated a functional link between the pituicytes and nerve endings liberating hypothalamic hormones, especially vasopressin.

The existence of close contacts between the pituicytes of the neurohypophysis, the secretory nerve endings, and blood capillaries, and also the relationship between the number of lipid inclusions in the pituicytes and liberation of neurohormones from the endings are evidence of the tropic function of the neurohypophyseal pituicytes.

In the present experiments, irradiation of the newborn rats with γ-rays evidently induced derepression of one of the genes or a group of genes responsible for cilia formation. This also explains the latent period between the time of irradiation and the time of cilia formation. It must also be noted that not all pituicytes are capable of forming cilia, i.e., the distinctive effect of radiation was observed only in relation to a certain cell population. Another explanation of the appearance of cilia in the pituicytes of the neurohyophysis likewise cannot be ruled out. Ziegler [7], and Bargmann et al. [3] described the appearance of individual cilia between glandular cells in the pars intermedia of the pituitary. Voitkevich and Soboleva [2] first observed the formation of multiple cilia in the intermedial cells of rats under the influence of whole-body irradiation in a dose of 600 R. Cells forming cilia were found to occur mainly in the zone adjacent to the residual cavity of the pituitary. Cells in which cilia are formed are also found in various parts of the parenchyma of the pars intermedia.

The possibility likewise cannot be ruled out that the intermedial cells on the boundary with the neurohypophysis form cilia facing the posterior lobe of the pituitary. The cilia may insinuate themselves into

the intercellular spaces or into the cytoplasm of the pituicytes. In both cases the integrity of the cytoplasmic membrane is undisturbed, and it surrounds the cilium like the finger of a glove. This may explain the regular occurrence of a membrane surrounding the cilia in cases when they project into the cytoplasm of a pituicyte.

LITERATURE CITED

1. A. A. Voitkevich, Neurosecretion [in Russian], Moscow (1967).
2. A. A. Voitkevich and É. L. Soboleva, Izvest. Akad. Nauk SSSR, Seriya Biol., No. 6, 881 (1969).
3. N. Bargmann, E. Linder, and K. Andres, Z. Zellforsch., 77, 282 (1967).
4. M. V. Bennett and S. Fox, Gen. Comp. Endocrinol., 2, 11 (1962).
5. K. Kurosumi, Internat. Rev. Cytol., 11, 1 (1961).
6. O. L. Thomas, J. Comp. Neurol., 95, 73 (1951).
7. B. Ziegler, Z. Zellforsch., 59, 496 (1963).