STATE OF NERVE CELLS OF THE PROSTATIC PLEXUS AFTER CASTRATION

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UDC 616.681-089.87-07:616.65-009-091-07

Castration of male rats causes atrophic changes in the gangliar autonomic neurons of the prostate, a characteristic feature of these disturbances being severe impoverishment of the neuronal cytoplasm in ribonucleoproteins, which is accompanied by a change in the structure of the tigroid body. These changes are specific to the neural apparatus of the prostate of castrated animals.

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The purpose of studying mechanisms of neurohumoral regulation of a physiological function is to determine the character of interaction between the nervous and endocrine systems when functioning under different conditions. Few investigations have yet been made of structural changes in different parts of the autonomic system when function of the endocrine glands is disturbed.

The object of this investigation was to make a morphological study of nerve cells of the prostatic ganglia of rats after extirpation of the gonads.

EXPERIMENTAL METHOD

Experiments were carried out on sexually mature noninbred male rats weighing 160-180 g. Gonadectomy was performed by the standard method [3]. Two parallel series of experiments were performed. In series I hormonal deficiency was compensated by giving the animals daily injections of 0.2 ml of a 1% solution of testosterone propionate in peach oil, starting from the first day after operation. In series II, castrated animals received only peach oil in the same dose. The animals were sacrificed by decapitation 3, 5, 10, 14, 21, 30, and 60 days after the operation. Nerve cells of the prostatic ganglia were stained with hematoxylin-eosin, with Einarson's gallocyanin to reveal nucleoproteins at pH 1.64, and with toluidine blue by Nissl's method to reveal tigroid. As a control in both series of experiments, nerve cells of the inferior cervical sympathetic ganglion were stained by the same methods. The size of the neurons and of their nuclei was measured.

EXPERIMENTAL RESULTS

Castrated animals not receiving testosterone propionate developed marked changes in the autonomic nerve cells of the prostatic ganglia, following a course parallel to that of involution of the secretory apparatus of the glands. A gradual decrease in the nucleoprotein concentration in the cytoplasm of the neurons was first observed, and was particularly marked 60 days after the operation (Fig. 1, I). Investigation of sections preliminarily treated with ribonuclease revealed no distinct qualitative differences in the DNP content at all stages of the experiment. This suggests that the decrease in intensity of staining of the nerve cells with gallocyanin was connected with a decrease in the RNP content. Staining by Nissl's method revealed changes in the structure and character of distribution of tigroid granules at various times after castration. A distinctive redistribution of tigroid was observed after 3-7 days in the cytoplasm of most nerve cells composing the prostatic ganglia. Tigroid was mainly located in the perinuclear zone, the peripheral part of the cytoplasm being in part free from tigroid granules (Fig. 1, II). After 60 days most neurons had a uniform distribution of tigroid throughout their cytoplasm, in the form of tiny and palely stained dust-like particles (Fig. 1, III). Cytometric and karyometric studies revealed a statistically significant decrease in the size of

Institute of Human Morphology, Academy of Medical Sciences of the USSR, Moscow (Presented by Academician of the AMN SSSR A. P. Avtsyn). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 67, No. 5, pp. 107-110, May, 1969. Original article submitted September 16, 1968.

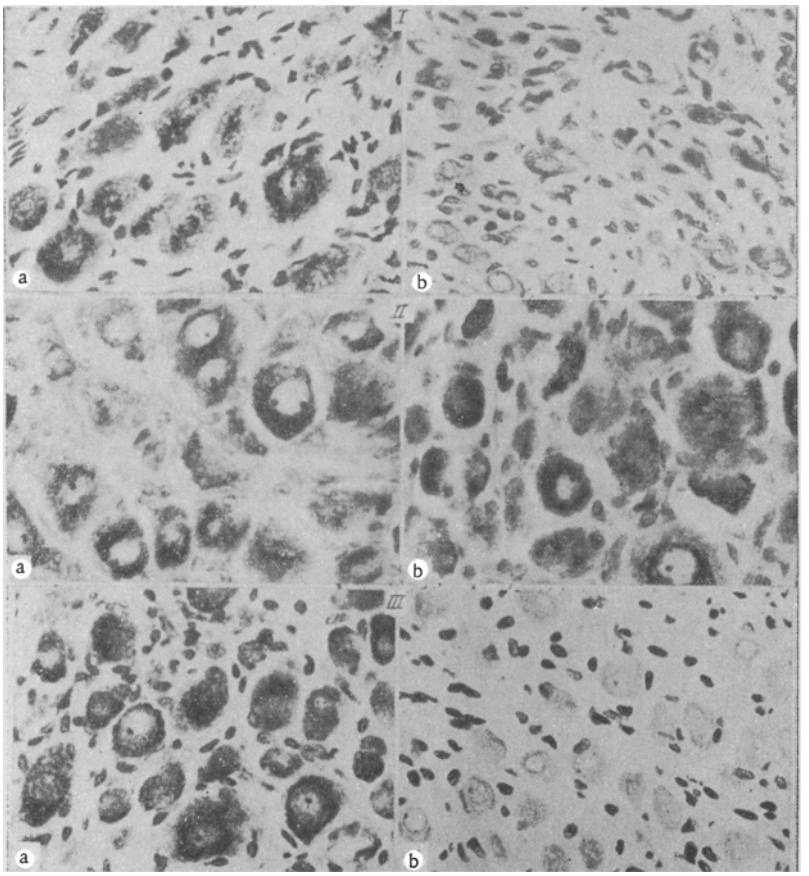

Fig. 1. Nerve cells of prostatic ganglia of rats of series I (a) and II (b) of the experiments. I) Sixty days after operation. Einarson's method, 520 ×. II) Five days after operation. Nissl's method, 520 ×. III) Sixty days after operation. Nissl's method, 520 ×.

the nerve cells and their nuclei. For instance, by the third day after the operation the mean diameter of the neurons was 18 μ, decreasing to 15 μ on the 21st day and 14 μ on the 60th day. The diameter of their nuclei was 10, 9, and 8 μ, respectively. Besides the general decrease in size of the neurons at the end of the first month after operation, some groups of neurons could be seen in the prostatic ganglia with evidence of marked degeneration (pericellular edema, marked vacuolation of the cytoplasm, shrinking of the cytoplasm, and pycnosis of the nuclei). After 60 days, some parts of the ganglia were completely without nerve cells.

In the experiments of series II, in which the animals received testosterone propionate after the operation, no marked structural changes were observed in the nerve cells of the prostatic ganglia. In most cases the neurons were large (25-35 μ) with a large, pale nucleus, and their cytoplasm extremely rich in tigroid. As a rule the tigroid consisted of large granules, frequently forming clusters in various parts of the cytoplasm, especially at its periphery. Staining with gallocyanin revealed a high nucleoprotein content in the cytoplasm of these cells. The shape, size, and staining properties of the neurons remained unchanged 60 days after operation. In this series of experiments, among the cells of the prostatic ganglia were some showing signs of degeneration. However, these cells were very few in number. According to published reports [1, 6], the presence of a few degenerative forms is a characteristic feature of every normally functioning autonomic ganglion.

Investigation of cells of the inferior cervical sympathetic ganglion of the castrated animals showed no essential changes in their structure in both series of experiments. In every case large neurons (20 μ) were observed, their cytoplasm containing numerous uniformly distributed tigroid granules. The cells had large vesicular nuclei with one or two nucleoli.

The results indicate that castration causes structural changes in the nervous system and, in particular, in the nerve cells of the prostatic plexus. The existence of a highly differentiated system of incretory organs in the vertebrates is one of the more important factors providing the particular conditions required for functioning of the autonomic nervous system [2]. Recent investigations [4, 5, 7, 8] indicate that endocrine factors have a considerable influence on the formation of the autonomic nervous system in ontogenesis and on the character of its function in adult animals and man. According to the concepts of Champi and Coujard [7, 8], the autonomic nervous system plays the principal role in regulation of tissue sensitivity to the action of hormones. There is still no general agreement in the literature regarding the character of structural reactions of nerve cells to disturbances of hormonal regulation. Some workers [7, 8] consider that castration leads to the development of marked degenerative changes in neurons concerned with the innervation of the genital apparatus. Meanwhile some experimental results [9] indicate the absence of marked structural changes in neurons composing the autonomic ganglia of the prostate in rats 14 days after castration.

The results of the present investigation confirm the basic principles of the concept of Champi and Coujard concerning the effect of the hormonal factor on structure and function of prostatic autonomic ganglia. Postcastration changes observed in the nerve cells of these ganglia can be considered to be the manifestation of a special form of atrophy, caused by blocking of hormonal influences from the gonads. A characteristic feature of the changes observed is a sharp decrease in the ribonucleoprotein content of the cytoplasm of the nerve cells, accompanied by changes in tigroid structure.

Signs of the marked atrophy of the nerve cells forming the prostatic ganglia are the considerable decrease in their size and the death of some neurons in the late stages after castration. Comparison of the severity of the structural changes in nerve cells of the prostatic ganglia and corresponding cells of the inferior cervical sympathetic ganglion in rats not receiving testosterone propionate after the operation points to definite specificity of the reaction of the prostatic nervous apparatus to elimination of the influence of this hormone.

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