HISTOTOPOGRAPHY OF CATECHOLAMINES IN THE MAMMALIAN THYMUS

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The thymus of 80 cats and 50 albino rats were studied by the method of Falck and Hillarp in E. M. Krokhina's modification. Catecholamines were localized in the thymus chiefly in adrenergic nerve fibers penetrating into the thymus along blood vessels of varied caliber, in which they are distributed in the adventitia. Nerve fibers accompany the smallest blood vessels into the parenchyma and innervate it directly. Hassall's corpuscles are closely connected with varicose adrenergic nerve fibers and exhibit adrenoreceptive properties. Autoluminescent structures, consisting of reticular cells of the cortical substance of the lubules, granules of the medullary substance, and elastic elements of the connective tissue also are described.

Interest in the catecholamines and their localization in the tissues has increased considerably in recent years [1, 3, 4, 6, 7]. However, as yet no investigations of catecholamines in the thymus have been carried out.

The object of this investigation was to detect and describe the sympathetic innervation of the thymus and also of other tissue structures serving as carriers and assimilators of catecholamines.

EXPERIMENTAL METHOD

The thymus of 130 animals (80 cats weighing 1.5 kg and 50 albino rats of both sexes weighing 150-350 g) was investigated. The animals were killed with ether. Autoluminescence was studied in some sections and other were treated by the method of Falck and Hillarp [10] in Krokhina's modification [4]. Sections treated by this method were studied in the ML-2 luminescence microscope in light of wavelength 380-420 nm. The observations were described in note form and recorded photographically.

EXPERIMENTAL RESULTS

The special test for catecholamines showed a rich adrenergic innervation in the stroma and parenchyma of the thymus and also a system of mast cells. Catecholamine-containing nerve fibers penetrated into the thymus chiefly along blood vessels of varied caliber in the form of perivascular plexuses. The neurovascular plexuses were distributed in the capsule, along the interlobular septa, and also among the autoluminescent cells of the thymus.

Among the nerve fibers some could be distinguished which were very thin, with emerald green luminescence, and with frequent varicose swellings, and others which were thick, with less frequent varicose swellings. Parallel supravital staining with methylene blue solution confirmed that these types of nerve fibers are present in the thymus.

A typical picture of the terminal portion of an autonomic plexus could be seen in longitudinal sections through the blood vessels. Adrenergic nerve fibers with varicose swellings interwove with each other in

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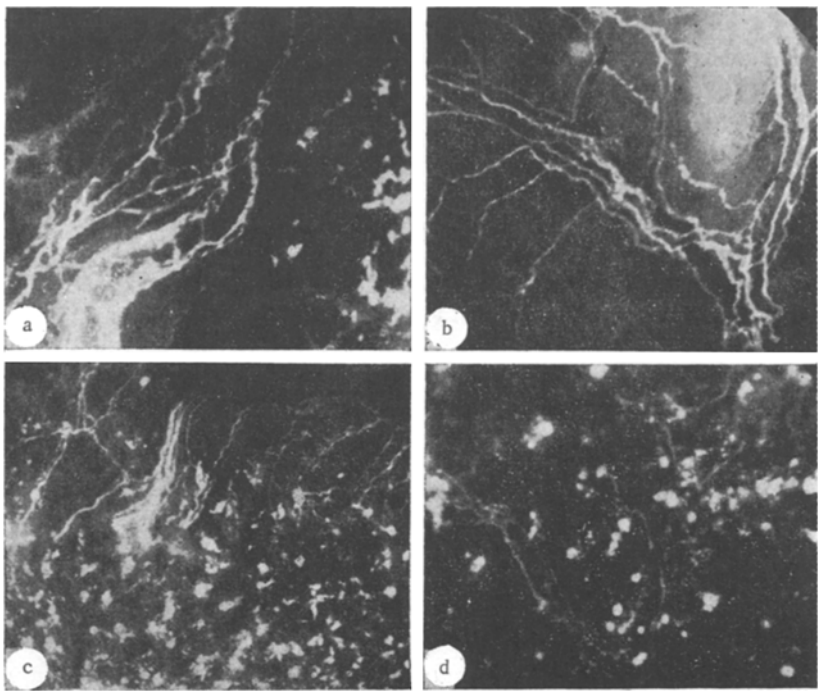

Fig. 1. Catecholamine-containing nerve fibers in the thymus: a) in an interlobular septum; b) in the capsule; c) fibers with varicose swellings penetrate the cortical substance of the lobules of the thymus like a palisade; d) terminal nerve plexuses among luminescent thymus cells. Method of Falck and Hillarp, ML-microscope, objective 40, ocular 10, Homal 1.7.

different directions and some of them ran parallel to the length of the vessel. Dense plexuses of these unmyelinated nerve fibers occupied a large area of the vessel (Fig. 1a). Where the vessels pass into the thickness of the parenchyma as a rule there were no luminescent cells, which are very numerous in the parenchyma. Nerve twigs branching from the adventitial nerve plexuses frequently formed rings and loops in the cortex and medulla of the thymus. As a rule the rings were formed only by thin varicose nerve fibers and they were arranged in several layers. Vessels of small caliber, cut across transversely, were evidently present in this region and their walls themselves were not outlined because of the absence of autoluminescent elastic fibers.

It must be emphasized that adrenergic nerve fibers in the blood vessels of the thymus were visible only in the adventitia and they were far less numerous in the walls of the veins than of the arteries. Terminal branches of the nerves were not seen to penetrate into the muscle coat of the vessels, in agreement with observations by other workers [1, 3].

Catecholamine-containing nerve fibers regularly ran into the parenchyma with the smallest blood vessels, where they formed a terminal plexus distributed directly among the cellular structures. In these sections adrenergic nerve fibers distributed among the cortical cells sometimes occupied 3 or 4 fields of vision under the high power of the ML-2 microscope. These observations do not agree completely with those of workers who used classical methods and who state that the cortex is less richly innervated than the medulla [2, 11].

Some nerve fibers entered the parenchyma of the thymus from the perivascular plexuses of the capsule not along the course of the blood vessels (Fig. 1b). Solitary terminals with varicose swellings of this type perforated the cortex of the thymus with parallel fibers. They approached close to the cortical cells (Fig. 1c) and reached the granules of the medulla. Sometimes the same nerve fiber approached many luminescent cells.

A dense plexus of adrenergic nerve fibers also was revealed by the luminescence-histochemical method in the medulla of the lobules of the thymus. Very often nerve twigs, penetrating into the medulla along a blood vessel, broke up there to form single nerve fibers.

Investigation of the luminescence of the thymus revealed a specific greenish luminescence, not hitherto described, of the Hassall's corpuscles, the connection of which with the catecholamines has been demonstrated experimentally [8].

The innervation of the Hassall's corpuscles is particularly interesting. Many workers [2, 9, 11] have pointed out that they were never able to observe nerve fibers dividing actually in Hassall's corpuscles. Only Kornilova [5] found nerve endings, consisting of "boutons" and triangular end-plates on the cells of Hassall's corpuscles. Nerve endings could also be seen on the corpuscles in the present experiments in sections stained with methylene blue. The luminescence-histochemical investigation showed that the Hassall's corpuscles are closely connected with the varicose adrenergic nerve fibers but are not penetrated by them. This apparent contradiction can only be explained by assuming that methylene blue and silver impregnation reveal nerve fibers of nonadrenergic nature.

Sometimes brightly fluorescent varicose swellings could be seen near the corpuscles along a nerve fiber and the segments between the swellings were not visible because of the diffuse greenish luminescence around the corpuscles in that region. In that situation the Hassall's corpuscles were probably actively adsorbing neuromediators from the segments between the varices.

In old animals the parenchyma of the thymus is replaced by adipose tissue. Despite this fact, a network of adrenergic nerve fibers could still be observed in the thymus after involution. The fibers entered the adipose tissue along the walls of the fat cells and interwove around nearly every cell.

These observations showed that the thymus contains several autoluminescent structures. Polygonal cells in the cortex (Fig. 1d), forming its delicate stroma, and granules of the medulla which are never revealed by other staining methods, gave the brightest luminescence. The Hassall's corpuscles, elastic elements of the connective tissue, membranes of the fat cells, and platelets along the course of the blood vessels all exhibit autoluminescence. The platelets of rats are not luminescent, evidently because of specific differences in serotonin metabolism in these animals.

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