8. G. Rossi, M. Robecci, and M. Penna, Arkh. Anat., No. 8, 14 (1978).
9. C. A. Hamberger and H. Hyden, Acta Oto-Laryng., 61, Suppl., pp. 81-89 (1945).
10. R. S. Reynolds, J. Cell Biol., 17, 208 (1963).

ADRENERGIC INNERVATION OF VENOUS AND LYMPHATIC MICROVESSELS

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UDC 612.134+612.423]-06:612.899

KEY WORDS: microvessels; arteries, veins; lymphatics; adrenergic innervation; mesentery.

Venous and lymphatic microvessels, like arterial, are essential components of the structural and functional units of the microcirculation [1-3, 5, 6, 11]. Their integrative activity at tissue and organ levels is largely determined by neurotransmitter control mechanisms, especially sympathetic vasomotor and trophic influences [4, 7, 9, 10, 13]. This accounts for the interest shown by research workers in the adrenergic (sympathetic) innervation of vessels of the microcirculation. Numerous studies using the fluorescence-microscopic technique of Falck and Hillarp have substantially widened and clarified our present knowledge of the morphological substrate of the adrenergic component of autonomic vascular innervation. However, not all structural components of the microcirculatory syytem have been studied in equal measure. Definite preference has been shown for vessels of arterial type, as is shown by the quite complete description of their adrenergic innervation over their whole extent as far as the precapillary arterioles. Much less attention has been paid to venous microvessels. Usually it is stated as a fact that innervation structures in the arterial walls predominate quantitatively over those in the veins, and the sparseness of the adrenergic innervation of the veins is emphasized [8, 11]. So far as the lymphatic microvessels are concerned, the question of their adrenergic innervation still remains largely unexplored. There is nothing more than the simple mention, en passant, that adrenergic nerves make contact with the walls of lymphatic microvessels [8].

The writers have studied the adrenergic innervation of microvessels of the mesentery and have paid special attention to the innervation connections of venous and lymphatic microvessels.

EXPERIMENTAL METHOD

The mesentery of the small and large intestines of noninbred rats of both sexes weighing 180-220 g was studied. Immediately after decapitation (under ether anesthesia) laparotomy was performed, the mesentery removed and cut into separate areas, and stretched out on slides. After drying in a current of air from a room fan (3-5 min) the specimens were placed in a chamber containing paraform (humidity 50-51%) and kept there for 3 h in an incubator at 37°C. The specimens were examined and photographed on the LYUMAM-IZ luminescence microscope. In some cases the preparations were stained during microscopy with an aqueous solution of acridine orange to reveal the cell composition of the tissue substrate of the mesentery.

EXPERIMENTAL RESULTS

Microscopic examination of total preparations of the mesentery stained histochemically for catecholamines showed most clearly the presence of periarterial adrenergic plexuses accompanying all stages of the arterial system as far as precapillary arterioles. A conspicuous feature was the numerous side branches of the periarterial plexuses, which ran for a varied distance in the tissue of the membrane and joined the wall of the adjacent vessels. In some cases these vessels were tiny collecting veins and postcapillary venules, in others they were lymphatic microvessels. The latter were revealed sufficiently completely because

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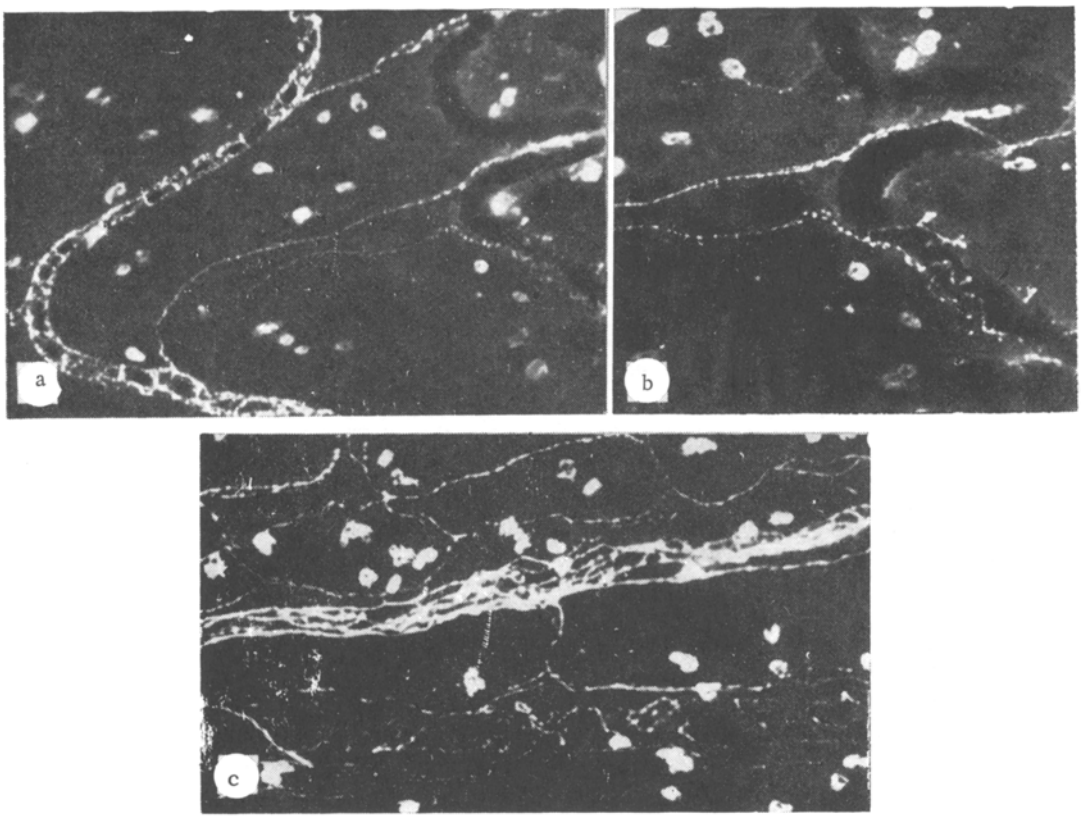

Fig. 1. Adrenergic innervation of venous microvessels of rat mesentery. a) Branches of periarterial plexus terminating on wall of a small vein (200 ×); b) the same, enlarged fragment (450 ×); c) passage of collateral of periarterial plexus into perivenous plexus (300 ×). Falck-Hillarp method.

of the nonspecific fluorescence of their walls.

In the zone of contacts between these adrenergic collaterals and the walls of the venous and lymphatic microvessels foci of ramifications of the nerve fibers covering these vessels appeared. In this way perivenous and perilymphatic adrenergic plexuses were formed in the region of the mesenteric microcirculation. They consisted basically of adrenergic nerve fibers of preterminal and terminal types. Similar neurovascular contacts could be repeated on comparatively short segments of veins and lymphatics, to form alternate foci of increased and reduced concentration of adrenergic innervation structures. A clear idea of the adrenergic innervation of venous and lymphatic microvessels of the rat mesentery is given in Figs. 1 and 2. They show adrenergic collaterals leaving periarterial plexuses and covering the walls of venous and lymphatic vessels with a system of their own terminal branches. Difference in the density of adrenergic structures on them can be observed — from areas with a dense distribution of adrenergic terminals to areas innervated very scantily or not at all. Adrenergic plexuses along the course of venous and lymphatic microvessels of larger caliber appeared independent. Meanwhile, consecutive microscopic examination of total preparations of the mesentery revealed separate adrenergic trunks leaving the periarterial plexuses and uniting directly with perivenous and perilymphatic adrenergic plexuses.

These observations show that in the region of the microcirculatory system of the mesentery the adrenergic innervation of veins and lymphatics is effected by innervation structures arising from periarterial adrenergic plexuses. The method of formation of the adrenergic innervation of venous and lymphatic microvessels described above allows a re-evaluation of the role of periarterial plexuses as sources of adrenergic innervation of venous and lymphatic microvessels. As we know, arterial vessels of varied caliber are accompanied by powerfully developed adrenergic plexuses. The number of axons composing these periarterial plexuses (especially on vessels of larger caliber) is so great that brightly luminescent sheaths can be seen all along the course of the arterial trunks, in which it is difficult to make out the axonal structure. At first glance this high concentration of adrenergic nerve struc-

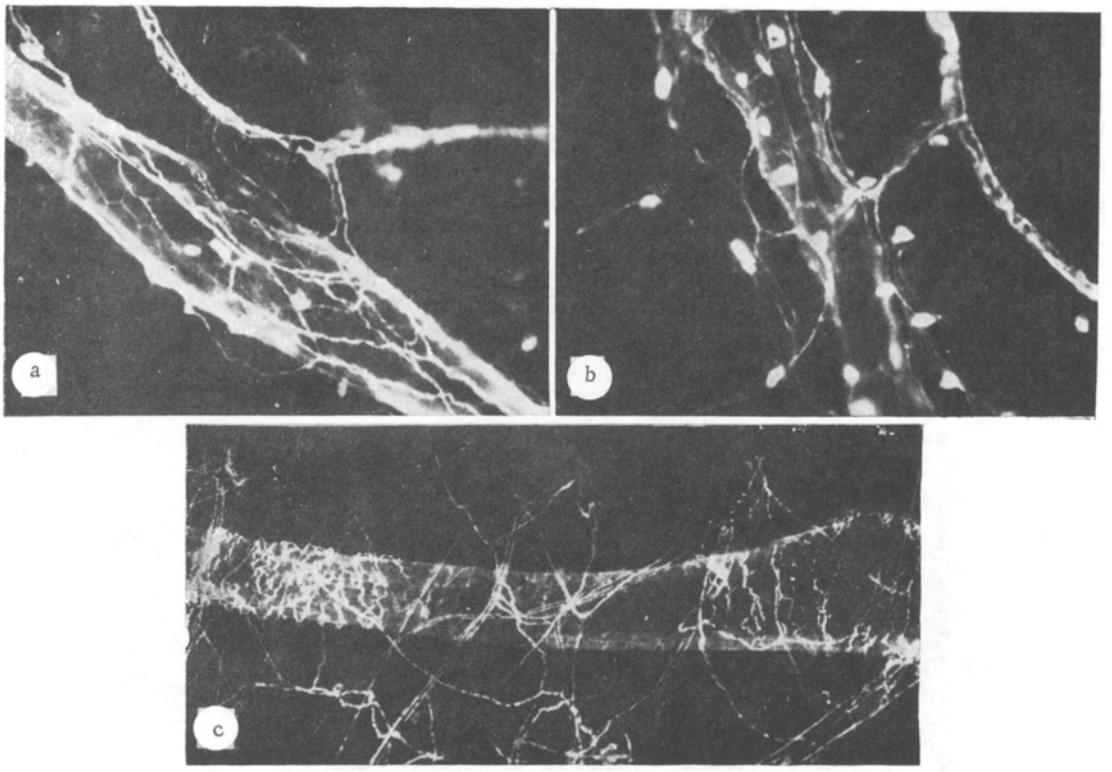

Fig. 2. Adrenergic innervation of lymphatic microvessels of rat mesentery. a, b) Passage of collaterals of periarterial plexuses into perilymphatic (300 ×); c) irregular (focal) character of adrenergic innervation of lymphatic vessel (200 ×). Falck-Hillarp method.

tures on a linear segment of an arterial vessel seems to be excessive and superfluous. However, in reality this can be regarded as a unique reserve of innervation material, which is utilized as the arterial vessels themselves ramify as far as their terminal portions, on the one hand, and through their participation in the innervation of venous and lymphatic microvessels on the other hand. It is only by taking this circumstance into account that a correct assessment can be made of the morphological and functional organization of both periarterial and, to the same extent, perivenous and perilymphatic adrenergic plexuses. Comparison of the architectonics of the adrenergic plexuses in the walls of arteries and veins of the same caliber is very demonstrative in this respect. Microscopic analysis of preparations of the mesentery shows that the predominant constituents of the periarterial plexuses are smoothly outlined axons of conducting type, whereas varicose fibers of terminal (synaptic) type are less richly represented. A different picture can be observed in the perivenous plexuses, which consists mainly of adrenergic fibers of preterminal and terminal type. Similar differences were found on comparative analysis of the structure of the periarterial and perilymphatic adrenergic plexuses. These differences in the structural organization of periarterial, perivenous, and perilymphatic plexuses in the region of the microcirculatory system of the mesentery are evidence of the relative value of a purely quantitative study of their characteristics.

The data described above are important from the standpoint not only of the actual existence of an adrenergic (sympathetic) innervation of venous and lymphatic microvessels, but also of its functional role. It is evident that a single innervation system, responsible not only for the independent (autonomous) mobility of all its vascular components, but also exerting the trophic influences necessary for their function, is represented in the zone of the microcirculatory module. In the writer's opinion this is the morphological equivalent of the integrative activity of neurovascular complexes at the microcirculatory level.

LITERATURE CITED

1. Yu. E. Vyrenkov, in: Current Problems in Biology and Medicine [in Russian], Tbilisi (1979), p. 58.

2. Ya. L. Karaganov and V. V. Banin, Arkh. Anat., No. 11, 5 (1978).
3. N. Ya. Kovalenko and A. M. Chernukh, Byull. Éksp. Biol. Med., No. 3, 367 (1981).
4. G. P. Konradi, Regulation of Vascular Tone [in Russian], Leningrad (1973).
5. V. V. Kupriyanov, Ya. L. Karaganov, and V. I. Kozlov, The Microcirculatory System [in Russian], Moscow (1975).
6. A. M. Chernukh, P. N. Aleksandrov, and O. V. Alekseev, The Microcirculation [in Russian], Moscow (1975).
7. B. Altura, Microvasc. Res., 16, 91 (1978).
8. B. Ehinger, B. Falck, and B. Sporrong, Bibl. Anat., 8, 33 (1966).
9. J. Gero and M. Gerova, Experientia, 24, 811 (1968).
10. G. Hauck, Angiologica, 8, 236 (1971).
11. J. Furness, J. Anat. (London), 115, 347 (1973).
12. J. Furness and M. Marshall, Br. J. Pharmacol., 45, 193 (1972).
13. J. Rusznyak, M. Földi, and G. Szabo, Lymphatics and Lymph Circulation, New York (1967).
14. B. Zweifach, Microvasc. Res., 5, 363 (1973).

MYOID CELLS OF THE THYMUS IN PATIENTS WITH MYOPATHY

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UDC 616.74-009.54-07:616.438-018.1-07

KEY WORDS: heteroorganic structures of the thymus; myoid cells; lymphoid tissue; thymus; muscle tissue.

A number of studies of heteroorganic antigens of the thymus, i.e., antigens of such highly specialized tissues as muscle tissue, the tegumentory and secretory epithelium of ectodermal origin, etc., represented in the thymus, have recently been published [1-3, 6-8]. It has been suggested that the possible function of these antigens is to inform the lymphocytes of the organ about the structure of their own antigens during the formation of a state of natural immunologic tolerance to them [1, 3, 4]. Among the heteroorganic structures of the thymus, those which have been studied the most are the myoid cells, whose cytoplasm contains antigens common with those of muscle tissue [2, 7, 13, 14]. A strong connection has been shown to exist between the state of the myoid cells and the lymphoid tissue of the thumus [7]. If muscle tissue is involved in a pathological process, such as in autoimmune diseases of myasthenia and rheumatic fever type, profound changes are observed in the myoid cells; these changes, moreover, have a specific character for the particular disease [9, 10]. More recently it has been suggested that yet another disease affecting muscle tissue, namely progressive muscular dystrophy, is autoimmune in nature and, by analogy with myasthenia, attempts have been made to treat this myopathy by thymectomy [11, 12]. Data on changes in the thymus in this disease could not be found in the accessible literature. Hence the interest of a comprehensive (including immunomorphologic) study of the thymus of patients with this disease.

The object of this investigation was to undertake an immunofluorescence study of the myoid cells of the thymus in patients with progressive muscular dystrophy.

EXPERIMENTAL METHOD

Sections of the thymus from children with Duchenne's myopathy (age 5-10 years, 15 cases) and Erb's myopathy (age 6-25 years, five cases) were studied. The thymus of children undergoing operations for congenital heart defects (seven cases) and of persons aged 8-23 years

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