FURTHER ON THE EFFERENT INNERVATION OF THE ARCH OF THE AORTA IN THE RABBIT

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Each blood vessel has a proper nerve apparatus — afferent and efferent — providing for the reflex relationships of the vascular system with the organism as a whole. The presence of nerve elements within the vascular wall, penetrating into its various layers, is reported by a great number of authors. Brasche (18) postulated a hypothesis for the innervation of the cerebral vessels. Obersteiner (30) supports the idea of Brasche. There are numerous publications claiming the presence of nerve fibers within the vascular wall (24, 29, 25, 14, 20, 21). The afferent innervation of the vascular system has been the objective of many morphologic investigations (33, 8, 6, 34, 12, 13, 3, 27, 16). Data are also available about the efferent innervation of vessels. Boecke (19) reports that the motor innervation of the vessels is accomplished by virtue of a sympathetic basic plexus. Stöhr (31), in most of his works, emphasizes the presence of amyelinc nerve fibers within the vascular wall. Motor vegetative fibers and ganglionic cells are in addition described by a great number of authors (26, 5, 2, 10, 1, 9, 11, 22, 28, 17 etc.).

We proposed to investigate the problem of efferent innervation of the arch of the aorta — penetrance of nerve fibers, their course, presence of interneural junctures and ganglionic cells and relationship between vegetative nerve fibers and intramural vascular flow. There are noticeable gaps and discrepancy in the data reported by various authors in the pertinent literature.

Material and method

The data reported and the entire work are based on the investigations carried out on 5 inbred male rabbits. Impregnation of the aortic wall is performed with osmic acid — zinc iodide mixture, according to the method of Maillet (1959), as modified by Stach W. (31). Following impregnation, the material is treated on freezing microtome, with thickness of the sections ranging from 20 to 40 microns. Different regions of the wall of the aortic arch were investigated.

Results

Numerous amyelinc nerve fibers, anostomosing between each other, are observed in the outer connective tissue layer of the adventitia of the arch of the aorta. The orientation of the nerve fibers is undetermined —
Fig. 1. Wall segment of aortic arch. Flat section. Network of vegetative nerve fibers in the adventitia of the arch of the aorta. Impregnation.
Microphotograph: oc. 10, ob. 63

Fig. 2. Wall segment of the aortic arch. Flat section. Ramification of myelinic nerve fibers. Impregnation.
Microphotograph: oc. 10, ob. 10
mainly longitudinal, oblique and transverse nerve fibers are likewise observed (fig. 1). They are undulated in a spiral-like fashion, forming loops of various order and form—triangular, quadrangular and polygonal. Often, the fibers pierce the deep strata of the adventitia, reaching down to the media. After penetrating deeply into the media, the nerve fibers become rarefied, terminating in smooth-muscular cells. The amyelinic nerve fibers which are doubtlessly postganglionic (i.e., efferent), differ from the myelinic (afferent) fibers inasmuch the latter display a wavy course, ramifying very similar to arborisation (fig. 2). Their end-terminations reach various depths into the media. A major part of these fibers appear to be accumulated within the area surrounding the orifice of the vessels, originating from the arch of the aorta, where connective tissue elements prevail. There, they form a dense network (fig. 3).

Along with numerous nerve fibers, intramural vessels are likewise detected in the adventitia and media of the aortic arch. Their caliber is of the order of arterioles, precapillaries, capillaries, postcapillaries and venules (fig. 4). They penetrate in varying depth and are accompanied by single or numerous nerve fibers, which appear to be parallel to the intramural vessels (fig. 5). At fixed points, their terminations end in the smooth-muscular cells of the arterioles or capillary pericytes (fig. 6).

Comparatively large quantities of nerve-ganglionic cells are found within the deep adventitial layers and in the media (fig. 7). They exhibit cobweb-
Fig. 4. Wall segment of the arch of the aorta. Flat section. Capillary network accompanied by nerve fibers. Impregnation
Microphotograph: oc. 10, ob. 6,3

Fig. 5. Wall segment of the arch of the aorta. Flat section. Intramural blood vessel, accompanied by amyelinic nerve fibers. Impregnation
Microphotograph: oc. 10, ob. 16
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Fig. 6. Wall segment of the arch of the aorta. Flat section. Capillary with amyelinic nerve fibers terminating in the pericytes. Impregnation

Microphotograph: oc. 10, ob. 100

Fig. 7. Wall segment of the arch of the aorta. Flat section. Intramural ganglionic cell with pericellular outgrowths. Impregnation

Microphotograph: oc. 10, ob. 40
like outgrowths of various length. Around them, the typical piricellular apparatus is formed of preganglionic vegetative fibers (myelinic), running a spiral course. They differ from the connective tissue cells insofar the latter display smaller sizes.

Discussion and results

The results of investigating the efferent innervation of the arch of the aorta conform with the principal concepts, postulated by most of the authors (31, 26, 6, 13, 11, 22, 20, 21). We share the conception of Dolgo-Saburov B. A., as regards the venous wall, Lev I. D. — the wall of the renal artery and Eremenko V. I. — for the walls of the superficial veins of the brain in man, according to which the vascular wall disposes of a common innervation system. The distinction of adventitial plexus on one hand, and plexus of the media and intima, on the other (24, 2, 13) constitutes an artificial division of a common nerve plexus, forming a widely spread nerve network.

The facts established insofar the proper vessels of the arch of the aortic wall are concerned are in conformity with the results, published by Vankov, Gjurov and Madjarov (4), obtained in the course of analogous studies in dog. Coming across amyelinic nerve fibers along the course of the vasa-vasorum proves the presence of a proper nerve apparatus. Here is the only site where orientation of nerve fibers, up to a certain degree, is detectable. Their course is coincident with the orientation of intramural vascular flow. It is evident that part of the fibers terminate within the smooth muscle cells of the arterioles and venules and within capillary pericytes. The general course of nerve fibers and intramural vessels demonstrates that there exist common ways for penetration of nerve elements and vessels within the depth of the wall.

The investigations herein reported support the findings of B. Dolgo-Saburov, Lev I. D. and Agarkov G. B. insofar the presence of nerve-ganglionic cells in the vascular wall is concerned. The survey of literature proves that similar cells are discovered in the arterial vessels of muscular type and in venous vessels alike (22, 6, 11, 1). We found them also in arterial vessels of elastic type. The observation of nerve-ganglionic cells in association with pericellular preganglionic nerve fibers, formed about them, elucidate up to a certain extent the interneuron junctions in this area.

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Об ЭФФЕРЕНТНОЙ ИННЕРВАЦИИ ДУГИ АОРТЫ У КРОЛИКА

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РЕЗЮМЕ

Сообщаются данные об эфферентной иннервации стенки аорты. Изучались разные участки в области дуги. Устанавливается наличие единого нервного сплетения в стенке аорты, расположенное пространственно. Конечные окончания проникают в разную глубину в адвентицию и медию, создавая сеть с разными по форме и величине петли из безмиелиновых нервных волокон. В адвентиции и меди интрамуральные сосуды сопровождаются нервными волокнами. Они проходят параллельно и сориентированы одинаково с интрамуральным сосудистым руслом. В определенных местах их окончания заканчиваются в гладких мышечных клетках артериол или капиллярных периваскулярных клеток. Среди глубоких слоев адвентиции наблюдаются и нервно-ганглийные клетки с характерным аппаратом.