INNERVATION OF BLOOD VESSELS IN THE RABBIT

THESIS

Submitted By

Mona Mohamed Gamal El-Deen Galal

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Supervised by

Dr. Esmat Zaky Ghieth

Assist. Prof. of Histology

Dr. Olfat Sayed Ahmed

Lecturer of Histology

Histology Department

Faculty of Medicine

Ain Shams University

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C O N T E N T S

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INTRODUCTION

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The innervation of the blood vessels is a subject still opened for more investigations. There is great controversy about the distribution of nerve fibres in the three layers of the artery. Some authors claime that nerve fibres permeate the whole media (Woollard, 1962; Millen, 1948; Copenhaver & Johnson, 1964), while others deny completely the presence of nerve fibres in the media of the artery (Pease & Molinarie, 1960; Pease and Paule, 1960; SoSato, 1966). In this work we tried to reach a settlement for this problem. The rabbit was the animal chosen for this study because of its suitable size both for applying vital staining method and for obtaining blood vessels of considerable size.

Different categories of arteries were represented in this study:

1. Aorta (elastic artery).
2. Femoral artery (muscular distributing artery).
3. Renal artery (muscular artery receiving large amount of blood delivered under high pressure).
4. Basilar artery (special artery).

REVIEW OF LITERATURE

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Lapinsky (1905) described five types for the endings of the medullated nerves of the blood vessels which were; terminal brush, small knobby thickening, large oval swelling, fine granule-like ending and freely branching termination after loss of medullary sheath. These endings were not intraprotoplasmic.

Eugling (1908) described and figured in the tunica media of the blood vessels of the rabbit's ear large branching cells which differed morphologically from nerve cells and no Nissel granules could be seen in them. They could not be the source of nerve fibres as after denervation, the nerve fibres disappeared in spite of the persistance of these cells.

Berglas (1925) with the aid of a binocular micro-scope dissected the periarterial plexus around the iliac arteries, where he found at the union of the adventitia and the muscular coat large nerve strands, he believed that they were extending along the whole vascular tree.

Woollard (1926) by intravital staining with methy-lene blue studied the innervations of blood vessels in rats, guinea pigs, cats, dogs and rabbits. He observed the presence of an adventitial plexus and another intra-muscular nerve plexus all over the vascular tree.

The adventitial nerve plexus was described as bundles of nerve fibres which crossed, divided and rejoined with each other forming a plexus occupying all layers of the adventitia. The nerve fibres forming this plexus were of two types according to the type of the artery; those in the aorta were non medullated fibres (sympathetic) coming from adjacent ganglia of sympathetic trunk and the plexus formed by them descended allover the vascular tree till the distal part of the femoral artery where these descending fibres diminished gradually and vanished. In the more distal arteries the adventitial plexus was made by small twigs from the adjacent nerve trunks. These twigs were mostly medullated nerve fibres with few number of non medullated fibres (for each 3 or 4 medullated fibres one were non medullated). The non-medullated fibres did not share in the adventitial plexus and were seen to pass to the tunica media and share in the intramuscular plexus.

The intramuscular plexus was described as abundant mesh of the finest fibres which usually presented a beaded form and occasionally slight oval expansions could be seen along its course. They ramified widely all through of the media and in the aorta there were two plexuses; one superficial and another deep plexus. The intramuscular nerve plexus was continuous allover the vascular tree although its constituting fibres reached it by two ways; some coming down from the aortic plexus of the media while others arriving by the way of the adjacent peripheral nerves.

Regarding the mode of termination of the non-medullated fibres (sympathetic) of the media, the author noticed that the individual strand in the network gave off tiny side branches which ended in small pericellular swellings. These terminal expansions where in relation to large branching cells which varied in form and was observed to give off complicated processes which entwined with the axis cylinder. They seemed sometimes to be in apposition with the axis cylinder as though this was inserted into the cell.

The medullated nerves ended by collaterals which might pass along the vessel wall, loop and rejoin other collaterals, form encapsulated organised termination or end as axis cylinder with lateral terminal enlargements They might end outside the vessel wall in the form of paccinian corpuscle or subdividing in the adjacent tissues and wide spreading in it.

Konidez (1935) using the reduced silver nitrate method of Cajal to demonstrate the aortic pressoreceptors in the rabbit, found that the terminal arborization of aortic nerve fibres laid in the externa, between externa and media or in the media, mainly in its outer half and ended as small club-shaped dilatation or as delicate rings. The thinner afferent aortic fibres also ended as diffuse or dense arborizations in the externa or outer media. No encapsulated nerve endings as those in chicken were seen. There were swellings or reticulated enlargments placed along the course of the branches of the arborization, terminally or subterminally. In the media these reticulated enlargements were seen to lie between the fenestrated layers of elastic membranes.

Although no ganglion cells were observed near by the arborizations, yet there were oval or rounded nuclei in the vicinity of the terminal branches; whether they represented an extension of the sheathes enveloping the nerve fibres or belonged to the surrounding tissues was not easy to say.

Nonidez (1941) in a study on different nerve endings in the aorta of 6-week-old puppies found that the pressoreceptor fibres reaching the aorta through two nerves; the superior cardiosympathetic branch and the left cardiovagal nerve. They composed of sympathetic postganglionic, preganglionics for the ganglia of the plexus between the aorta and the pulmonary artery and pressoreceptor fibres.

The pressoreceptor fibres branched in the outer third of the tunica media forming a plexus supplying the smooth muscles of the media. The pressoreceptor fibres could be identified by the presence of massive reticulated swellings along their branching nerve endings which were not noticed in other vascular endings.

The thick axons within the aortic wall often had a beaded appearance due to postmortem contraction of the wall, exaggerated by shrinkage incidental to the preparation of the section. The thin deeply stained fibres had smooth outlines and thickenings only present at points where branches were given off.

The aortic nerve endings were variable according to the diameters of the nerve fibres; the large and medium sized fibres ended as reticulated swellings, compact club shaped swellings or as single or double rings of various sizes while the thin fibres lacked reticulated swellings.

The author noticed in close proximity to the pressoreceptor endings abundance of nuclei. The nature of the cells to which they belonged was uncertain. They may be fibrocytes or more highly specialized cells migrated along the nerve fibres during growth of the latter. They might release substances related to the metabolism of the neurons.

Bakay (1942) studied frozen sections of the ascending aorta of the cat. He found regular plexus of fine intraprotoplasmic nerve fibres (ground plexus) The fine fibres ended with terminal spirals or as network on the smooth muscle cells. Other coarser fibres, interpreted as sensory elements formed glomerular endings in nucleated syncytium. The author removed each of the stellate ganglion, the nodose vagus ganglion and vertebral nerves, and he noticed the result in each case. He concluded that the postganglionic sympathetic fibres (ground plexus) of the ascending aorta chiefly originated in the left stellate ganglion, and that the sensory fibres ran partly in the vagus and partly in the vertebral nerves. The corresponding sensory ganglion cells were in the nodose ganglion and cervical spinal ganglia.

Millen (1948) studied the innervation of blood vessels of the ear and stomach of rabbit using intravenous methylene blue staining technique. He described three nerve plexuses in the medium-sized arteries which were:

1. In the adventitia, the nerve fibres ran longitudinally in rough parallel direction to the vessel wall, they branched and sent fibres to deeper plexuses, but there was no indication of a true plexus. The diameter of fibres were uniform and nodes of Ranvier could sometime be seen. They were formed mainly of non-medullated nerve fibres and less numerous medullated nerves.

2. Between tunica adventitia and tunica media there was a meshwork of non-medullated communicating fibres which were irregular in diameter and showed many varicosities. It was suggested that this plexus might subserve the sensation of pain and provide a mechanism for the production of active vasodilatation.

3. In tunica media, there were very fine beaded fibres branching in a regular zigzag pattern between the smooth muscle cells.

The non-medullated fibres ended as knobs in close relation to the nuclei of the smooth muscle cells, or freely terminated between these nuclei. The sensory nerves (medullated) might end in an organized ending in the adventitia formed of short thick branches or might leave the artery and disappear among adjacent fat cells.

Pease and Molinari (1960) reported on the presence of unmyelinated fibres in the adventitia and the total absence of nerves within the tunica media of pial vessels of the cat and monkey.

Pease and Paule (1960) by electron-microscopic examination stated that there were no nervous elements within tunica media of elastic arteries.

Copenhaver and Johnson (1964) described the presence of an adventitial plexus giving off secondary plexus permeating the entire media where the fibres branched extensively and ended on the muscle cells with delicate knob-like termination. The fibres forming these plexuses