THE SENSORY INNERVATION OF THE SUPERIOR MESENTERIC ARTERY

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(Received March 26, 1956. Presented by Academician A. D. Speransky)

The aim of the present research has been to uncover the origin of the sensory innervation of the superior mesenteric artery.

In studies conducted by means of anatomical preparations, N. A. Kukover [7], T. V. Strukgof [8] and others have demonstrated an association of the gastric plexus with the superior mesenteric one. Also, there has been proven the association of the right vagus nerve in the formation of the superior mesenteric plexus [1, 3, 8].

The data in animals bearing on the innervation of the superior mesenteric artery is most scanty. V. M. Godinov [4] was the first to describe the sensory nerve endings within the adventitial and muscular layers of the mesenteric vessels. He indicated that these receptors lie mainly at places of branchings from the main arterial stem. T. A. Grigorieva [5] noted the presence in the arterial wall of receptors constructed, "on the general plan analogous to the one seen in the abdominal aorta" and she observed an especial plentitude of sensory receptors within the media of the artery.

By means of physiological studies, V. N. Chernigovsky [9] showed that the gastric plexus contains the main mass of the sensory fibers of the small intestine; the removal of this plexus leads to a disappearance of those reflex phenomena which are mediated by the visceral interoceptors.

V. A. Ivanov [6] found that the receptors in the walls of the mesenteric vessels carrying the afferent fibers of the depressor reflex from the superior mesenteric artery pass through the gastric plexus being incorporated in the gastric nerves.

EXPERIMENTAL METHODS

We made anatomical dissections, using histological methods of study and experiments on cats and dogs. The anatomical studies were conducted on human cadavera as well as on cats and dogs. The histological studies of the nerve fibers and their ultimate ramifications in the human superior mesenteric artery were conducted on bodies of persons dying of trauma, similar observations being made on the walls of the cat and dog superior mesenteric arteries, the method of Bielschowsky-Gross-Lavrentiev being employed as well as the Kampos procedure.

The sources of the sensory innervation of the superior mesenteric artery we determined by experimental histological procedures. The following operations were performed: removal of spinal cord ganglia in the chest and lumbar divisions; sectioning of the gastric nerves within the abdomen; excision of the ganglia of the recurrent nerve. To determine the sources of the sensory innervation of the superior mesenteric artery, we severed in cats and dogs in sequence from each side either one or two adjoining thoracic and lumber spinal cord ganglia.

The animals were sacrificed in 6 days.

The data from the anatomical preparations indicates that in man the superior mesenteric plexus is formed by branches from the gastric plexus, splenic plexus and branches from the right vagus. The nerves around the

superior mesenteric artery form a rich periarterial network from which fibers direct themselves to the vessel sheath. From this periarterial network of the main stem fibers go to the intestinal arteries as they form loops and go also to the numerous branches entering the intestinal walls. In dogs and cats the basic construction is similar but the branches are smaller and the architecture of the nerve ramifications is more simple.

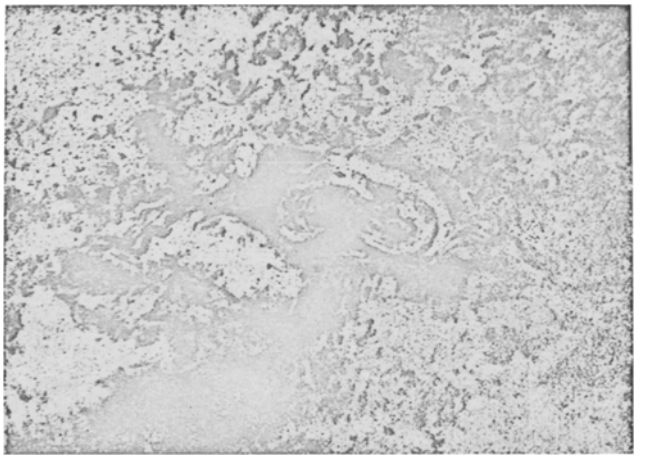

Fig. 1. Typical Krause corpuscle on an arteriole in the outer sheath of the human superior mesenteric artery. Microphotograph. Magnification 600x.

The human superior mesenteric artery has numerous free nerve endings in the adventitial and muscular layers as well as special end-organs of the sensory type such as the Vater-Pacini laminated corpuscles and the Krause bodies (Fig. 1) lying in the outer sheath and in the perivascular connective tissues. We were able to demonstrate similar structures in the superior artery walls of a cat but only the free nerve endings in dogs.

EXPERIMENTAL RESULTS

Study of our histological preparations demonstrated that the nerve trunks and the nerve fibers enter the wall of the superior mesenteric artery from the side of its external sheath. Both superficially and in depth, the adventitia of the superior mesenteric artery has free nerve endings forming bushy clusters of branching nerve fibers. In addition, the outer sheath of the vessel has bush-like sensory nerve endings served by specialized cells.

Even within 48 hours following the removal of spinal cord ganglia, the nerve fiber and its sensory ending can be seen to be in the initial stage of degeneration. After 72 hours the disintegration of the nerve fiber is easy to see (Fig. 2). After 5-6 days, within the adventitial wall of the vessel the fragmentation of the fibers of the receptor nerves is sharply defined.

Our data is in agreement with that of T. A. Grigorieva [5] and they demonstrate that the media of the superior mesenteric artery has a rich supply of sensory nerve endings. In the muscular layer are bush-like free sensory nerve endings and also free nerve endings associated with the collagen fibers. At the boundary between the outer and inner vessel sheaths lie the receptor field whose endings are in the muscular layer and which are supplied with special cells. Some fields are occupied by fibers having a step-ladder appearance, their nerve fibers being associated with bundles of elastic collagen fibers. T. A. Grigorieva [5] speculates that these receptors of the muscular layer associated with the collagen fibers or lying immediately upon them serve the purpose of registering the tone of the blood vessels and the degree of blood filling.

Degeneration of the receptor endings within the outer and middle sheath of the superior mesenteric artery is caused by removal of spinal cord segments from the 5th to the 13th. It follows that the source of the sensory innervation of the superior mesenteric artery are nerve cells lying in the spinal cord at those levels.

Removal of the spinal cord ganglia in cats by us, as with other investigators [2, 11], led to degeneration of the myelinated fibers going to the sensory plates of the Vater-Pacini bodies. Bilateral section of the large

gastric nerves in the cat led to fragmentation of the myelinated nerve fibers going to the Vater-Pacini bodies which is a confirmation of previously published work [2, 10].

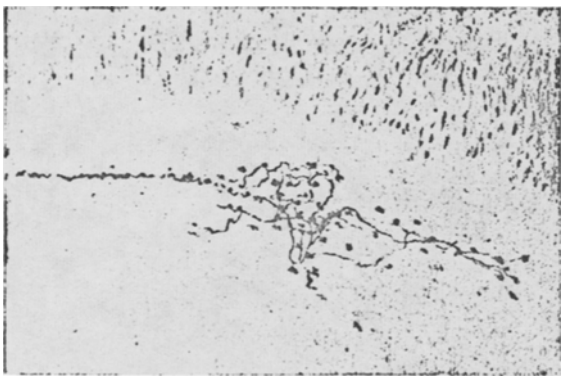

Fig. 2. Bush-like receptor ending having its own reenforcing cells lying within the outer layer of a dog superior mesenteric artery. The disintegration of the nerve fiber supplying the receptor (first stage of fragmentation). Bilateral removal of thoracic segments 6-7, 72 hours after the operation. Microphotograph. Magnification 600 ×.

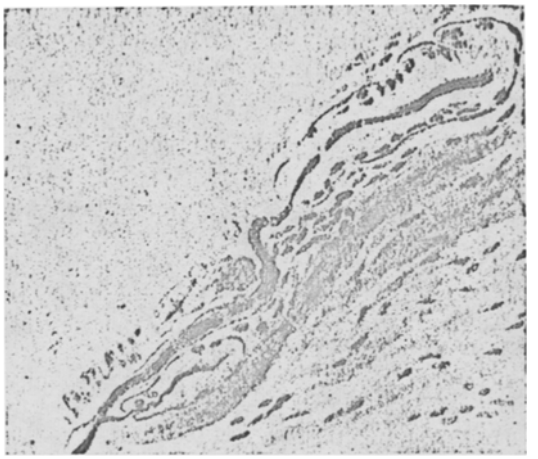

Fig. 3. Laminated bodies of the Krause corpuscle type in the outer covering of the superior mesenteric artery near a blood capillary. Nerve fiber is fragmenting. Removal of right fascicle o cat. 72 hours after operation. Microphotograph. Magnification 600 ×.

Removal of the right as well as the left gastric ganglia of the vagus nerves in dogs and cats (the animals being sacrificed 3-6 days after surgery) caused degeneration of nerve fibers and free nerve endings within the wall of the superior mesenteric artery. After the removal of the ganglionic bundles in cats, degeneration of the axes of the myelinated nerve fibers could be observed at their entrance to the laminated bodies of the Krause type as seen within the outer sheath of the superior mesenteric artery (Fig. 3). We, just as V. M. Godinov [4], observed in the deeper layer of the external sheath of the superior mesenteric artery sensory nerve endings at places where branches left the main stem.

In the adventitia of the dog superior mesenteric artery, we uncovered polyvalent nerve endings, terminatin fibrils of which lay on the vasa vasorum and in the surrounding connective tissue. Such receptors T. A.Grigorie [5] designated as tissue-vascular and deemed them to be regulators of the metabolic intra-tissue exchanges. In the perivascular connective tissues, along the course of the nerve fibers and in the adventitia of the superior mesenteric artery we saw nerve cells lying singly or in groups.

SUMMARY

Experimental studies demonstrated that spinal ganglia from the fifth to thirteenth thoracic segments as well as both the vagi nerves partake in the sensory innervation of the superior mesenteric artery. Laminated medullary corpuscles surrounding the sheaths of the superior mesenteric artery derive their nerve fibers from the above ganglia. Krause-type corpuscles in the perivascular connective tissues have their innervation from similar sources.

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