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Morphological Features of the Structure of the Nervous Structures of the Muscular Membrane of Various Parts of the Esophagus

Khamraev Akbar Khairulloevich

Samarkand State Medical University, Uzbekistan

Abstract The esophagus has its own structural features as the initial part of the digestive tract, especially the structure of the muscular membrane of its various departments and the distinctive signs of innervation differ from other departments of the digestive canal. **Material and methods.** The esophagus of adult rabbits served as the material for the study. After killing animals according to the rules of bioethics, the taken organ was divided into three parts: cervical, thoracic and abdominal. Each department was divided into two more parts. The first part is placed in a cryostat for taking frozen sections, in order to study adrenergic nerve structures by treating the material with 2% glyoxylic acid. The second part was fixed in a 12% solution of neutral formalin. The **results** of the study showed that in the intermuscular and submucosal nerve nodes there are mainly long-axon and equidistant Dogel neurons and in a small number of neurons of the third type. In all cases, the number of long-axon neurons in the intermuscular nerve nodes is relatively greater. All nerve fibers and bundles of the esophageal wall are strongly writhing. **Conclusions.** This structure of nerve fibers and bundles creates a reserve length and prevents strong stretching of the fibers during the expansion of the esophageal wall during the passage of the food lump.

Keywords Esophagus, Intramural nerve structures, Neurocytes, Muscle fibers

1. Relevance

The esophagus is the initial part of the digestive canal, where striated muscle tissue turns into smooth, there is a joint arrangement and gradual combination of somatic nerve structures with vegetative ones. In recent years, the work devoted to the general innervation of the esophagus, especially the nervous structures of the muscular membrane of the organ has a special place. The reason for this is, firstly, the features of the structure of the muscular membrane of various parts of the esophagus, and secondly, the distinctive signs of innervation of the striated muscle tissue of the proximal esophagus from the innervation of the striated muscle tissue of other parts of the digestive canal. There are problems concerning the study of the structure of the esophageal wall, especially its muscular membrane and its innervation. Solving these problems will make it possible to determine the mechanism of pathogenesis of diseases of this part of the digestive canal, their prevention, as well as treatment. In this regard, we have set ourselves the task of studying the morphology of nerve fibers and nerve endings involved in the innervation of smooth and striated muscle tissue of the upper, middle and lower esophagus of rabbits, which has both theoretical and practical significance.

* Corresponding author:
sammi-xirurgiya@yandex.com (Khamraev Akbar Khairulloevich)
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2. The Purpose of the Study

Study of the nervous structures of various parts of the esophagus in rabbits.

3. Material and Methods

The esophagus of adult rabbits served as the material for the study. After killing animals according to the rules of bioethics, the taken organ (esophagus) was divided into three parts: cervical, thoracic and abdominal. Each department was divided into two more parts. The first part is placed in a cryostat for taking frozen sections, in order to study adrenergic nerve structures by treating the material with 2% glyoxylic acid. The second part was fixed in a 12% solution of neutral formalin. Formalin was neutralized with sodium tetraborate salts and the PH of formalin was controlled by an RCS indicator. When the medium changed to the acidic side, sections were taken from the fixed material on the cryostat and impregnated with nitric acid silver by the Bilshovsky-Gross and Campos methods. Another part of the material fixed in formalin was filled with paraffin and sections were obtained using a microtome. These sections

were stained with hematoxylin-eosin and according to Van Gieson. Preparations treated with glyoxylic acid were studied using a luminescent microscope LUMAM 1-2 (Specialized microscope) using filters FS-1-4 and FS-1-6.

4. The Results of the Study

Nerve nodes consisting of neurons are located in the muscle membrane. Between the nerve cells are located the nuclei of many gliocytes and connective tissue cells. The shape of the nerve nodes and the number of neurons in it to a certain extent depends on the thickness of the micropreparation, and the morphometric parameters of the nerve nodes depend on the caliber of the overlapping nerve fibers. As can be seen in the figure, the degree of impregnation of neurons located in the node is not the same. Because the intake of silver nitrate salts is associated with the functional state of neurons at the time of exposure to the drug. The size of the intermuscular nerve nodes and the number of neurons in them are diverse and the density of the location is high compared to submucosal nerve nodes (Figure 1).

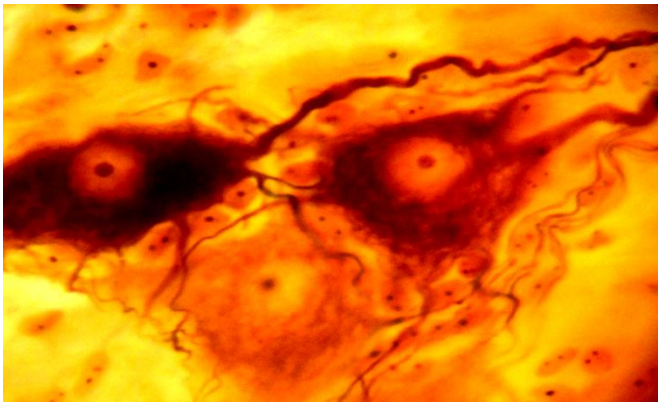


Figure 1. Long-axon neurocytes in the intermuscular nerve plexuses of the rabbit esophagus. Coloring according to Bilshovsky–Gross. Vol. 40, approx.7

Both in the intermuscular and submucosal nodes, there are mainly long-axon and equidistant Dogel neurons and in a small number of neurons of the third type. However, in all cases, the number of long-axon neurons in the intermuscular nerve nodes is relatively greater. If we take into account the fact that long-axon neurocytes are motor nerve cells of the autonomic nervous system, then this condition becomes understandable. The caliber of bundles of nerve fibers varies depending on the number of nerve fibers in them. It should be noted that the long-axonal neurocytes are always darker (Fig. 2).

Do not forget that neurons in the body are large cells in size, and therefore it is impossible to see them with all the processes at the same time in the same field of view of the microscope at the same time. With the help of a special drawing apparatus (DA-1), we sketched their drawing with all the processes and from these drawings it became possible to determine the type of these neurons. Thus, we have established that in the esophagus of rabbits, if equidistant nerve cells are more common in submucosal nerve nodes, then long-branched neurocytes are more common in intermuscular nerve nodes. The shape of all equidistant neurocytes is mostly rounded and evenly impregnated and looks lighter than long-axonal neurocytes. The body of long-axon neurocytes has a pyramidal shape, and the axon is located on the elongated side of the pyramid. Dendrites extend from the lateral parts of the neuron.

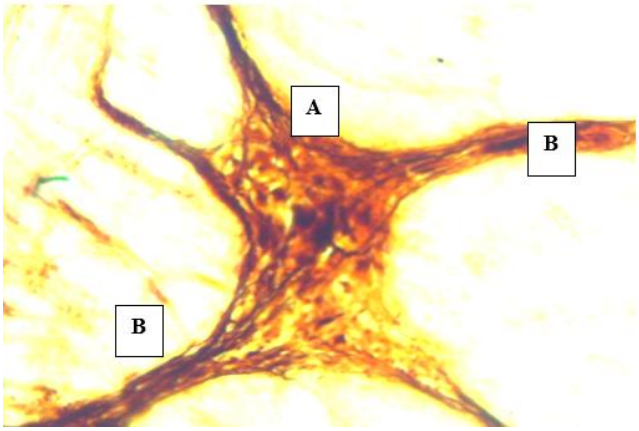


Figure 2. The nerve node (A) of the intermuscular nerve plexus and bundles of nerve fibers (B) of the rabbit esophagus. The Bilshovsky method –Gross. Vol.20, approx 10

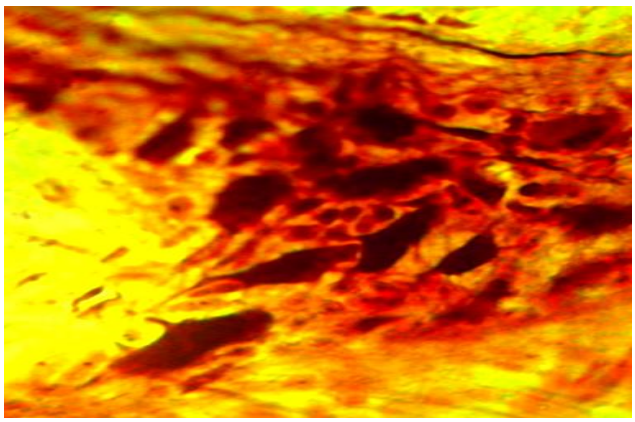
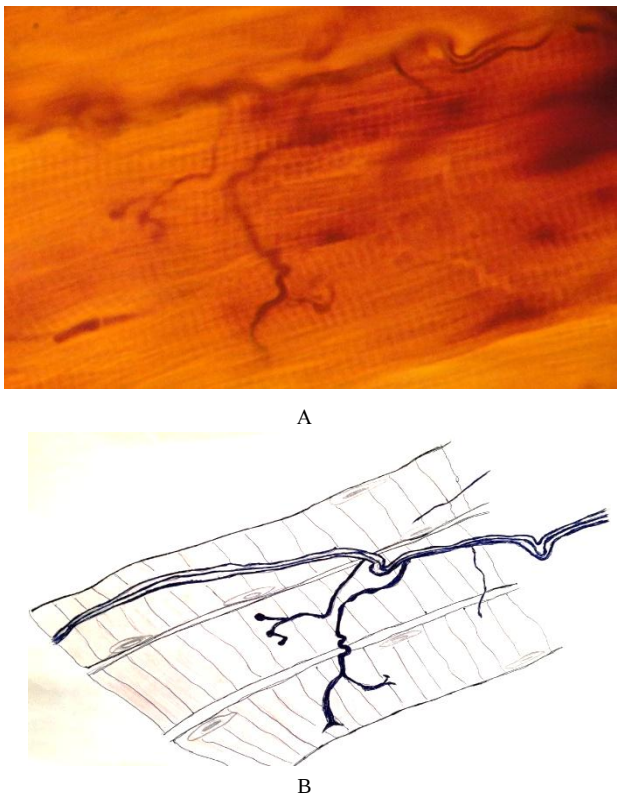


Figure 3. An intramural nerve node located between the muscular and submucosal membranes of the rabbit esophagus. Dark-impregnated long-axon neurocytes. The Bilshovsky method-Gross Volume 20, approx. 10

Both nerve plexuses of the rabbit esophagus consist of different caliber bundles of nerve fibers located in different directions. These nerve bundles mainly consist of myelin-free nerve fibers, between which you can see the nuclei of oligodendrogliocytes. Relatively large bundles of nerve fibers are located in the submucosal nerve plexuses, and relatively large intramural nerve nodes can also be seen in the places of their intersection. At the node level, these bundles are joined by processes of nerve cells. As part of the nerve nodes, these processes look thicker and darker than the rest of the fibers, but then they have the same tinctorial pattern with other fibers. This means that as a result of connecting the processes in the nerve nodes to the bundles, they become increasingly thick. It should be noted that

individual hyperimpregnated nerve fibers as part of nerve bundles in the thickness of nodes and between nerve cells form polyvalent receptors and effectors (Fig. 3).

In our research, we paid attention to a relatively little–studied side - the morphology of the motor (motor, effector) nerve endings of the muscular membrane. It should be noted that nerve cells are one of the largest cells in the body. Therefore, their processes and nerve endings can be examined and analyzed under a conventional light microscope. In our studies, we were able to detect various forms of motor nerve endings in the muscular lining of the esophagus. In this shell, bundles of nerve fibers are located parallel to bundles of muscle fibers. The separated individual nerve fibers from the bundles fit tightly to the muscle fibers and form short branches of various shapes. Depending on the location of these branches, we have found several forms of motor nerve endings. In the first case, it has the shape of a bunch of grapes (Fig. 4).



A

B

Figure 4. Motor nerve ending in the wall of the rabbit esophagus (A). Bilshovsky method – Gross. Volume 40, approx.7. Drawing of the cluster-shaped nerve ending sketched using the drawing apparatus DA-1 (B)

The figure shows that the hyperimpregnated preterminal nerve fiber separated from the nerve bundle located above the striated muscle fiber formed an effector nerve ending on the second muscle fiber. The preterminal nerve fiber, approaching the muscle fiber, forms several branches (the phenomenon of Langley animation) and typical button terminals are visible at the end of some of them. The second preterminal separated from the nerve bundle further on the muscle fiber will form an effector nerve ending in the form of a plate. We also found intensely impregnated nerve fibers with dichotomous branches in all the membranes of the rabbit esophagus. These morphological signs indicate their predilection for sensitive nerve fibers.

It should be noted separately that many bundles of nerve fibers in the wall of the esophagus have a spiral shape. In our opinion, this creates a reserve length to prevent stretching during functional expansion of the esophageal wall during the passage of food (Fig. 5).

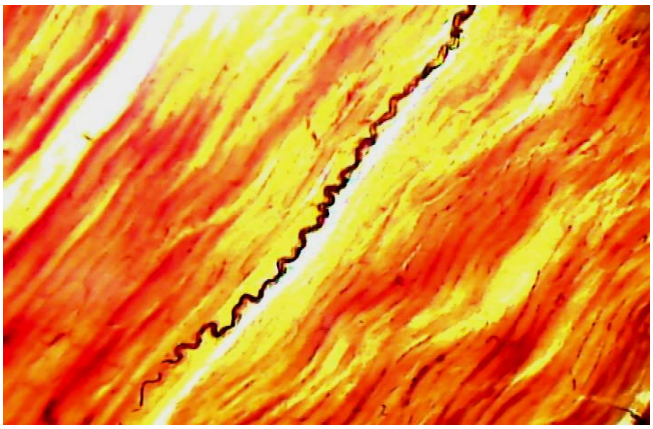


Figure 5. Spiral nerve bundle of the longitudinal layer of the muscular membrane of the middle part of the rabbit esophagus. The Bilshovsky-Gros method. Pre-coloring with Carmine. Vol.10, ok 7

The same spiral-shaped nerve fibers of various calibers were found at the border of the muscular and submucosal membranes in the distal part of the rabbit esophagus (Fig. 6). In the figure, a thick nerve bundle has a spiral shape. Smaller in caliber, nerve bundles and even individual nerve fibers also have a spiral shape. The figure shows individual nerve fibers between bundles of striated muscle fibers. It is characteristic that even small individual nerve fibers also have a spiral shape.

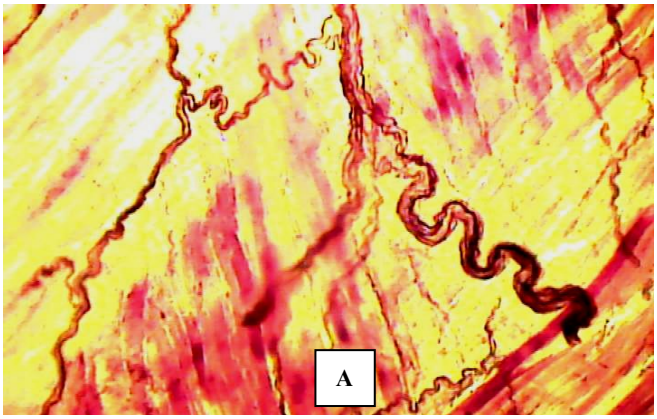


Figure 6. Spiral-shaped nerve bundles of various calibers and fibers separated from them at the border of the submucosal and muscular membranes of the rabbit esophagus. The Bilshovsky method-Gross Volume 10, approx.7. A – fibers of muscle tissue

5. Conclusions

The activity of muscle tissue is regulated by nerve structures, in particular by long-axon neurocytes (Dogel type

1) of the intramural nervous apparatus, as well as by the vagus nerve and the somatic nervous system. Submucosal (Meissner) and intermuscular (Auerbach) nerve plexuses were found in the wall of the rabbit esophagus and between the layers of muscle fibers. These plexuses consist of bundles of nerve fibers and there are intramural nerve nodes at the intersection of the bundles. The nodes contain all three types of Dogel nerve cells (long-axon, equi-process and interneurons) and the quantitative ratio of these neurons varies in the direction of the distal part of the digestive tube. Our studies have shown that submucosal intramural nerve nodes are larger than intermuscular ones and there are more nerve cells in their composition. Naturally, there are more long-axon neurocytes (Dogel type 1) in the nerve nodes of the intermuscular plexuses. For the nervous apparatus of the esophagus, it is characteristic that all nerve fibers and their bundles located in the nerve plexuses strongly twist and they are located in all layers of the esophageal wall. In our opinion, such a structure of nerve fibers and bundles creates a reserve length to prevent strong stretching of the fibers during the expansion of the esophageal wall during the passage of a food lump.

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