http://dx.doi.org/10.35630/2199-885X/2021/11/4.11

NEURON STRUCTURE OF THE GANGLION PLEXUSES IN THE LARGE INTESTINE

Received 12 July 2021;
Received in revised form 12 August 2021;
Accepted 17 August 2021

Ramilya Babaeva

Department of Human Anatomy and Medical Terminology, Azerbaijan Medical University, Baku, Azerbaijan

ramilababayeva@mail.ru

ABSTRACT — AIM OF THE STUDY: The aim of the work: to study the syncytial connections in the ganglia of the nerve plexuses of the large intestine.
MATERIAL AND RESEARCH METHODS: The work was carried out on 30 sexually mature Wistar rats at the age of 3–4 months, having a mass of 180–320 g by the beginning of the experiment. The study used a universal method of impregnation, based on classical impregnation methods: intravascular — Rannier–Goyer and immersion — Bilshovsky–Gros. The study was conducted in 2019–2020.
RESULTS: According to our data, the large intestine has intraorgan ganglia located in the intermuscular and submucosal plexuses. The intermuscular plexus (Auerbach) of the large intestine has the form of a network with cells of various shapes and consists of nerve nodes containing cells of types I and II of Dogiel, however, the latter are numerically significantly predominant (20–25 cells or more). Syncytial connections of neurons in the autonomic ganglia of the intestine were constantly detected. These were syncytial connections of processes and bodies of two neurocytes. Protoplasmic processes of nerve cells diverge in different directions, go to meet similar branches, joining them, form a narrow or wide-looped network. Syncytial connections between the bodies of neurons and peripheral processes form closed annular anastomoses. Interfiber cytoplasmic bonds are formed by membrane syncytial fusion.
CONCLUSION. The large intestine has intraorgan ganglia located in the intermuscular and submucosal plexuses. Syncytial connections of neurons in the autonomic ganglia of the intestine were constantly detected. Interfiber cytoplasmic bonds are formed by membrane syncytial fusion.

KEYWORDS — ganglia, plexuses, large intestine, Syncytial connection, neurons, protoplasmic processes of nerve-cells, Dogiel cells.

INTRODUCTION

The study of the mechanisms for transmission of excitation in synaptic structures is one of the most urgent and rapidly developing areas in modern neurophysiology.

The human nervous system has chemical and electrical synapses (syncytial connections). The secretion of a mediator in chemical synapses is based on the process of exo-endocytosis of synaptic vesicles in the active zones of active zones [1]. Compared to chemical synapses, electrical synapses conduct nerve impulses As a rule, electrical synapses are bidirectional, that is, a nerve impulse can travel along them in both directions [2].

Electrical synapse is a place of highly specialized contacts (gap junctions) between neurons, where there is a direct flow of electrical currents from one neuron to another [3]. In gap junctions, the membranes of neighboring cells are at a distance of about 3.8 nm, while in a chemical synapse, the distance between two neurons is from 20 to 40 nm [4]. In the area of each gap contact there are many special channels that cross the membranes of both cells [5]. Ions and molecules of medium size can pass through them from one cell to another, due to which the cytoplasms of two neighboring cells are connected. A particular case of an electrical synapse is an autapse, in the formation of which an axon and a dendrite of the same neuron take part [6]. Electrical synapses (syncytial connections) are predominantly observed in the central nervous system. The basic mechanisms of this process are well understood. So, they have been studied in detail in the striatum, cerebellum and suprachiasmatic nucleus [7, 8]. However, ideas about the peculiarities of the formation of these mechanisms in various organs have significant gaps. In this respect, the ganglia of the intestinal plexuses are of particular interest.

The aim of this study

to study the syncytial connections in the ganglia of the nerve plexuses of the large intestine.

MATERIAL AND METHODS

The work was carried out on 30 sexually mature Wistar rats at the age of 3–4 months, having a mass of 180–320 g by the beginning of the experiment. Rats were chosen as a biomodel, given their physiological adequacy and simplicity of keeping. The keeping of animals and their euthanasia was carried out in accordance with the EC Directive "On the protection of animals used for experimental and scientific purposes" (86/609 CE). Universal method of impregnation was used, based on classical impregnation methods: intravascular — Rannier–Goyer and immersion — Bilshovsky–Gros [9].

The abdominal aorta was calulated to the animals under ether anesthesia and the portal vein was transected. A 5% glucose solution was first perfused through the abdominal aorta until a pure perfusate appeared in the portal vein. Then, a solution of barium hydroxide [$Ba(OH)_2$] was perfused, which is a physiological tracer passing from the bloodstream through the interstitial space into the lymphatic microvessels. Argiphilia of tissue structures is determined by the pH level of precipitation of silver hydroxide from a solution of its nitrate salt. Complete precipitation occurs at pH 11–13.Microphotography was performed from preparations of different parts of the large intestine on a Leica-DM 1000 microscope with a video system (Germany).

RESULTS

The results of the study showed that the large intestine has intraorgan ganglia located in the intermuscular and submucosal plexuses. The intermuscular plexus (Auerbach) of the large intestine has the form of a network with cells of various shapes and consists of nerve nodes containing cells of types I and II of Dogel. In the intramural nodes of the colon, there are a large number of sensitive nerve endings. At the same time, a significant number of these endings in the nodes are formed by the processes of Dogiel type 2 cells. Most of the processes of these neurons are very long, which extend beyond the node, pass as part of the internodal strands. Along the periphery of the node, these neurons have a unipolar, pseudo-unipolar, or bipolar shape, while in the center there are multipolar cells. The number of processes in these cells ranges from 2 to 6.

Syncytial connections of neurons in the autonomic ganglia of the intestine were constantly observed. These were syncytial connections of processes and bodies of two neurocytes. Based on our observations, the protoplasmic processes of nerve cells diverge in different directions, go to meet similar branches, joining them, form a narrow or wide-looped network (Fig. 1). Syncytial connections between the bodies of neurons and peripheral processes form closed annular anastomoses.

Interfiber cytoplasmic bonds are formed by membrane syncytial fusion, as reproduced in our experiments. Our preparations support the fact of independent existence of single neurons.

DISCUSSION

According to our data, modulation of synaptic transmission can occur not only at the cellular level, but also in the synaptic cleft. The synaptic cleft is filled with a loose electron-dense substance oriented parallel to the contacting surfaces.

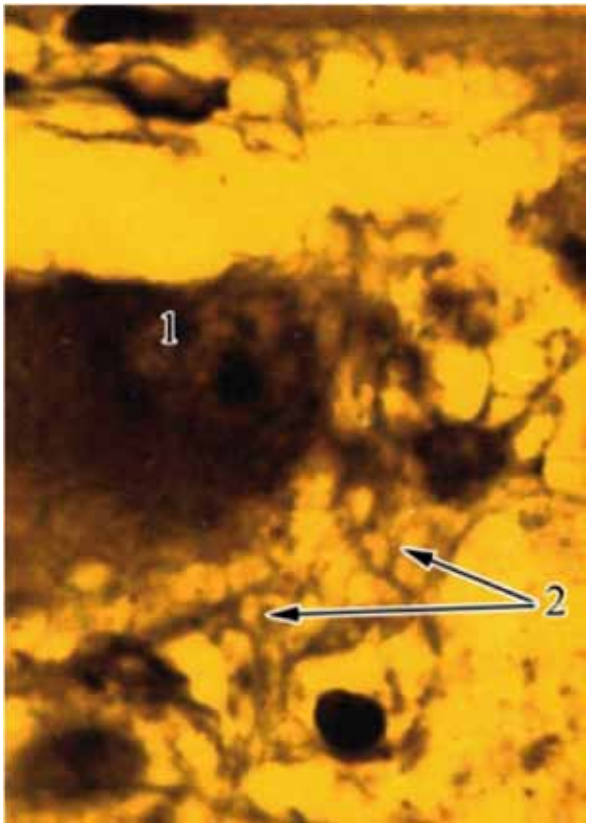

Fig. 1. *Broad-mesh network between protoplasmic processes of nerve cells. 1 — Dogel's cell of the 2nd type in the frontal plane. 2 — A wide-mesh network between the processes of nerve cells. A universal method of impregnation. Sw. ×900*

The cytoplasmic fusion of nerve processes into one neurite is a kind of *alligator's law*. Along with the great neural theory, this fact confirms and requires recognition of the validity of Dogel's reticularism and many other researchers [11]. The literature describes the reverse interaction between the postsynaptic and presynaptic parts of the membrane, carried out by various chemical agents. Currently, retrograde signals in the synapse are divided into three groups, which are related according to the principle of the release of chemical agents and their transfer from the postsynaptic part of the neuron to the presynaptic part. The first group of retrograde signals includes substances that freely penetrate the postsynaptic membrane. The second group includes substances that are secreted from the postsynaptic membrane by secretion [12].

Thus, on the set in the work by O.S. Sotnikov's question: *Is it possible with the help of light microscopy to present absolute evidence of the presence of interneuronal syncytium*, it is necessary to answer: yes, it is possible. There is no doubt that syncytial interneuronal connec-

tions make the structural organization of the nervous system more reliable. Obviously, instead of the current representation of *either — or* or synapses, or epaps, it is necessary to represent *and — and*, i.e. and synapses and epaps [12].

CONCLUSION

1. The large intestine has intraorgan ganglia located in the intermuscular and submucosal plexuses. 2. Syncytial connections of neurons in the autonomic ganglia of the intestine were constantly found. These were syncytial connections of processes and bodies of two neurocytes. Syncytial connections between the bodies of neurons and peripheral processes form closed annular anastomoses. 3. Interfiber cytoplasmic bonds are formed by membrane syncytial fusion.

REFERENCES

1. **Zefirov A.L., Petrov A.M.** Synaptic vesicle and neurotransmitter release mechanisms. Kazan: Publishing House "Art Cafe". 2010.324 s.
2. **Purves Dale, George J. Augustine, David Fitzpatrick, et al.** Neuroscience. 42nd ed. Sinauer Associates, 2008; 88 p.
3. **Balezina OP, Gaidukov AE, Sergeev I.Yu.** Physiology: biopotentials and electrical activity of cells. M .: Yurayt, 2017.165 p.
4. **Sheriar G Hormuzdi, Mikhail A Filippov, Georgia Mitropoulou, et al.** Electrical synapses: a dynamic signaling system that shapes the activity of neuronal networks. Biochim Biophys Acta. 2004; 1662 (1–2): 113-37. DOI: 10.1016 / j.bbamem.2003.10.023.
5. **Gibson J. R., Beierlein M., Connors B. W.** Functional properties of electrical synapses between inhibitory interneurons of neocortical layer. Journal of Neurophysiology. 2005; 93 (1): 467–480. DOI: 10.1152 / jn.00520.2004.
6. **Haas J. S., Zavala B., Landisman C. E.** Activity-dependent long-term depression of electrical synapses. Science (New York). 2011; 334 (6054): 389–393. DOI: 10.1126 / science.1207502. – PMID 22021860.
7. **Eugenin E. A., Basilio D., Sáez J. C., et al.** The role of gap junction channels during physiologic and pathologic conditions of the human central nervous system. Journal Of Neuroimmune Pharmacology. 2012; 7 (3): 499–518. DOI: 10.1007 / s11481-012-9352-5.
8. **Pereda A. E., Curti S., Hoge G., Cachope R., et al.** Gap junction-mediated electrical transmission: regulatory mechanisms and plasticity. Biochimica Et Biophysica Acta. 2013; 1828 (1): 134–146. DOI: 10.1016 / j.bbamem.2012.05.026
9. **Markov I.I. Petrov E.S., Markova V.I.** A universal method for the selective detection of argyrophilic structures. Morphological statements. 2016; 1: 116–119.
10. **Borovikov V.P.** A popular introduction to modern data analysis in STATISTICA. M .: Telekom, 2015.288 p.
11. **Fitzsimonds R.M. Poo M.M.** Retrograde signaling in the development and modification of synapses. Physiological Reviews. 1998; 78: 143–170
12. **Sotnikov O.S., Markov I.I.** The concept of reticular organization of the nervous tissue by Alexander Dogel. Morphological statements 2018; 26 (1): 8–15