

# Parameters of Neurocytes in Vagal Caudal Ganglia Innervating Various Organs of the Gastrointestinal Tract in Rats

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We studied projections of various organs on afferent neurons of vagal caudal ganglia in mature albino rats. The morphometric parameters of labeled neurocytes were determined using computer-assisted image analysis system. It is established that somato- and viscerosensory neurocytes of vagal caudal ganglia in albino rats are characterized by specific shape and morphometric parameters.

**Key Words:** *vagal caudal nodes; afferent neurocytes; retrograde transport*

Studies with various tracers confirmed innervation of various organs of the gastrointestinal tract [1,5,10,11], respiratory system [6,7], and cardiovascular system [2,8] by neurocytes of vagal caudal ganglia (VCG). Labeled neurocytes in VCG were detected after introduction of markers into the glossopharyngeal nerve [3], superior laryngeal nerve [4], and inferior laryngeal nerve [9]. The researchers usually localized sensory neurocytes in VCG, but did not measure their morphometric parameters.

## MATERIALS AND METHODS

Regional specificity of VCG neurocytes was studied in experiments on random-bred male rats ( $n=273$ , 250-300 g). The animals were narcotized with nembutal (40 mg/kg intraperitoneally) and tracers (10-15  $\mu$ l per rat) were injected into various organs with a MSh-10 microsyringe. We used the following tracers: highly purified horse radish peroxidase or wheat germ agglutinin-horseradish peroxidase conjugate. After 24-72 h narcotized rats were perfused via the left ventricle with isotonic NaCl (200 ml) and then with a fixative mixture consisting of 0.4% paraformaldehyde, 1.25% glutaraldehyde in 0.1 M phosphate buffer (pH 7.4). Labeled neurocytes were revealed in isolated left and

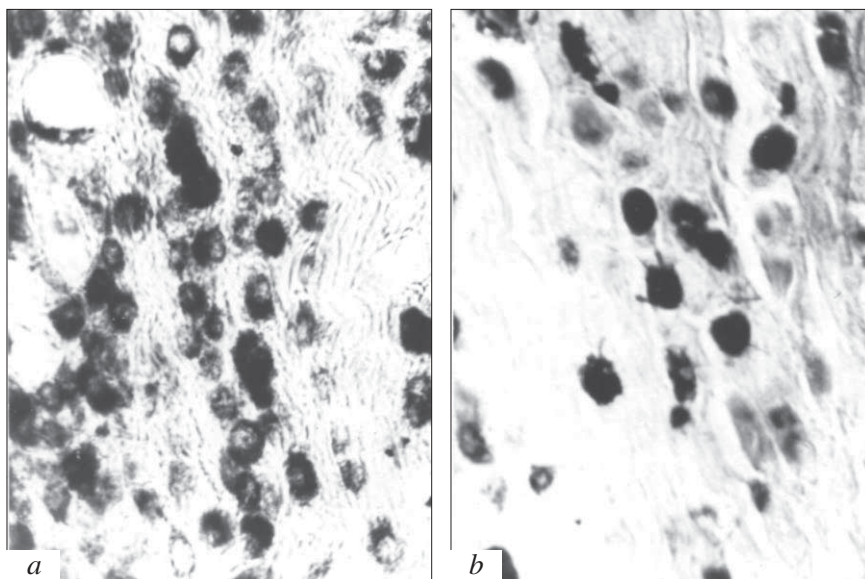
right VCG. The specimens were immersed into fixative for 12 h at 4°C and then transferred into 30% sucrose in 0.1 M phosphate buffer for 24 h at the same temperature. Serial cryostat sections (40  $\mu$ ) were mounted on gelatinized slides. Histochemical detection of the markers was performed with benzidine dihydrochloride. Computer analysis of morphological specimens was carried out with a Bioscan image analysis system (Konako). Two morphometric parameters were analyzed: equivalent circle diameter (ECD) and round shape factor (RSF).

## RESULTS

The target cells were found after injection of the tracers into the external acoustic meatus, root of the tongue, cervical and abdominal subdivisions of esophagus, stomach, duodenum, pancreas, liver, ileocecal area, solar plexus ganglia as well as after application of the tracers onto vagal trunks.

Analysis of morphometric parameters of labeled neurocytes revealed their regional specificity depending on the innervation targets. Most VCG neurocytes with long dendrites had greater linear size. It follows from the fact that application of horse radish peroxidase onto cervical part of the vagus nerve visualized relatively small VCG cells ( $ECD=21.380\pm0.988 \mu$ ,  $RSF=0.650\pm0.082 \mu$ ), while application of this tracer

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**Fig. 1.** Labeled neurocytes in vagal caudal ganglion of albino rat, which innervate duodenum (a) cervical part of esophagus (b). Staining with horse radish peroxidase.

onto ventral and dorsal vagal trunks labeled larger neurocytes ( $ECD=23.41\pm1.67\ \mu$ ,  $RSF=0.540\pm0.091\ \mu$ ,  $p<0.05$ ). At first look, these data confirm the axiom saying that the size of a neuron directly correlates with the distance to innervated target. However, we found that this relationship is not universal. The largest VCG neurocytes participate in innervation of the root of the tongue and duodenum ( $ECD=24.330\pm1.183\ \mu$  and  $24.21\pm1.06\ \mu$ , correspondingly; Fig. 1, a). The smallest VCG neurocytes ( $ECD=20.460\pm1.994\ \mu$ ) are involved in innervation of the cervical part of esophagus (Fig. 1, b). Morphometric parameters of the latter group of neurocytes are significantly smaller than those of the former group ( $p<0.05$ ).

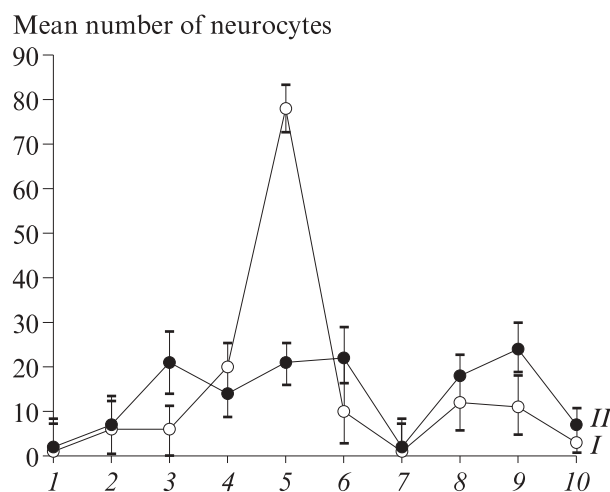
The size of neurocyte can depend not only on the distance from the target organ, but also on its role in various reflex arches including somatic or vegetative effector neurons. Correspondingly, the velocities of the reflexes triggered by stimulation of visceral or somatic vagal afferents are different.

Analysis of the shape factor of various populations of VCG neurocytes also revealed heterogeneity of these cells. According to the degree of circularity, all labeled VCG neurocytes were subdivided into 3 groups. The first group comprised cells where circularity was most pronounced. These neurocytes innervated external acoustic meatus and abdominal part of the esophagus ( $RSF=0.680\pm0.017$  and  $0.620\pm0.062$ , respectively). The second group comprised cells with moderate circularity innervating the root of the tongue, duodenum, pancreas, liver, and ileocecal area ( $RSF$  in this group varied from  $0.407\pm0.043$  to  $0.590\pm0.041$ ). Circularity of neurocytes of the third group was minimum. These cells are involved in innervation of the cervical part of esophagus and the stomach ( $RSF=0.350\pm0.085$  and  $0.390\pm0.035$ , respectively). The dif-

ferences in circularity of all groups were significant ( $p<0.05$ ).

The clear-cut proportion in the numbers of detected neurocytes in the right and left VCG (which is characteristic of all tracers used in this study) was observed in some organs, but was absent in others (Fig. 2). Afferent neurons of the left VCG predominantly innervate the abdominal part of the esophagus and curvatura minor ( $p<0.05$ ), while neurocytes of the right VCG predominantly innervate the cervical part of the esophagus, liver, and ileocecal area ( $p<0.05$ ).

Injection of tracers into other organs revealed no significant differences in the number of labeled neurocytes in both VCG. No clear-cut regularities were found in the distribution of labeled neurocytes within



**Fig. 2.** Mean number of labeled afferent neurocytes in left (I) and right (II) vagal caudal ganglia of albino rats depending on tracers injection site. Abscise: sites of tracer injection: 1) external acoustic meatus; 2) root of tongue; 3) cervical subdivision of esophagus; 4) abdominal part of esophagus, 5) stomach; 6) duodenum; 7) pancreas; 8) liver; 9) ileocecal area; 10) solar plexus.

the left and right VCG. The neurocytes innervating gastrointestinal organs are situated predominantly near the caudal pole of VCG, while the cells innervating external acoustic meatus are grouped near the cranial pole of VCG.

Thus, the sensory VCG neurocytes that innervate organs of the gastrointestinal tract are characterized by individual peculiarities of the shape and morphometric parameters, which depend on their localization and specificity of structural and functional organization.

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