MORPHOLOGY AND PATHOMORPHOLOGY

MORPHOLOGICAL INVESTIGATIONOF THE SUBLINGUAL NERVE NUCLEUS IN PERSONS WITH NORMAL HEALTH AND WITH BRAIN TUMORS

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The nucleus of the sublingual nerve is a typical respresentative of specialized motor centers of the lower stages of the central nervous system. In man its role increases in connection with articulation movements. To understand the peculiarities of the functioning of this nucleus it is necessary to explain the plan of its structure. However, the data of morphological investigations available in the literature [2, 7, 13, 14 and others] do not answer this problem since they were obtained on a basis of single observations.

In this work an attempt was made to elucidate the topography and cellular composition of the sublingual nerve nucleus in persons with normal health with consideration of individual variations. To refine the functional significance of the various components of the nucleus it was investigated in the presence of brain tumors. Particular attention was devoted to the quantitative characteristics of the nucleus.

EXPERIMENTAL METHOD

The nucleus of the sublingual nerve was studied in 17 persons who had died as a result of trauma or as a consequence of somatic diseases and in whom a microscopic investigation did not reveal evident changes in the brain. This nucleus was also investigated in 7 persons with tumors of the brain stem, aged from 3 to 82 years. The brain stem was fixed 2-37 h after death in 10% solution of formalin and embedded in celloidin. We prepared a series of transverse sections 20 μ thick. Each 20th section was stained with thionine. Furthermore, some of the sections were treated with Spielmeyer's hematoxylin, Van Gieson's hematoxylin-picrofuchsin, and hematoxylin-eosin. The length and volume of the nucleus of the sublingual nerve, its arrangement along the axis, and diameter of the medulla oblongata were determined on a series of transverse sections without correction for wrinkling of the tissue. The number of nerve cells was counted with respect to their nucleoli with Abercrombie's correction [6]. The dimensions of the cell body, nucleus, and nucleolus of the neurons were characterized by the size of the profile field for which we took the product of the larger and smaller perpendicular diameters.

EXPERIMENTAL RESULTS

It was found that in the norm, the topography of the sublingual nerve nucleus is variable. Its situation on a transverse section and along the axis of the medulla oblongata varies, however, the latter varies more. As a rule, 55-95% of the long axis of the nucleus is under the floor of the fourth ventricle and only 5-45% at the level of the central canal. The length of the nucleus is 8.63±0.22 mm (coefficient of variability C is equal to 14%); volume 7.3±0.3 mm^3 (C = 18%); area of cross section in caudal third 0.42±0.02 mm^2 (C = 32%), in the middle third 0.99 ±0.03 mm^2 (C = 18%), and in the oral third at 1.15 ±0.03 mm^2 (C = 16%).

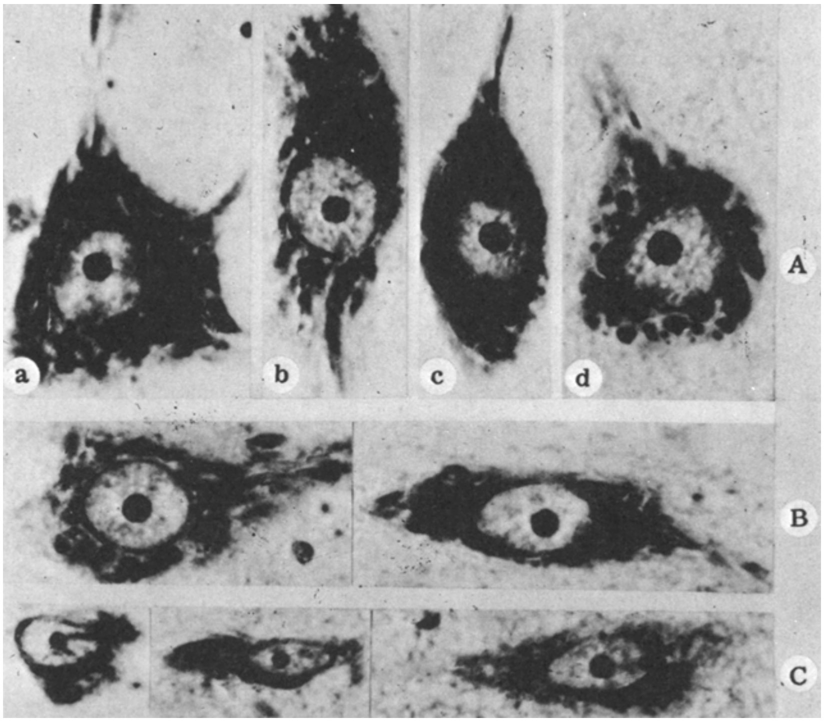

Fig. 1. Nerve cells of sublingual nerve nucleus. A) Typical motor; a) multipolar; b) elongated; c) fusiform; d) round shape; B) intermediate; C) nonmotor type. Thionine staining. Objective 60×, ocular 10×.

When the medulla oblongata is deformed as a result of tumor growth, the topography of the nucleus of the sublingual nerve changes in relation to the direction and degree of pressure of the tumor. An especially gross shift is observed when the tumor presses from the lateroventral side. The shift of the nucleus in 3-dimensional space (drop-like in the norm) changes somewhat even with negligible compression of the medulla oblongata. Pronounced deformation of the nucleus develops only with gross compression and does not extend to neighboring uncompressed areas. Compression and displacement of the nucleus do not cause pathological changes of its neurons or disturbances of the function of the sublingual nerve until circulatory disturbances develop. The volume and area of the cross section of the deformed nucleus diminish only in the case of atrophy of the neurons. The nucleus shortens only when compressed in the direction of the long axis.

The cell groups present in the sublingual nerve nucleus are extremely variable. Their number and arrangement are dissimilar even in the left and right nucleus at the same level of the medulla oblongata. In cases of compression or anatomical interruption of the root of the sublingual nerve because of unilateral destruction of a portion of the nucleus by extravasation, the neurons primarily of the medial, dorsal, and central region of the nucleus changed, which indicates the functional ambiguity of its various sections.

The results of the investigation of the cell composition of the nucleus of the sublingual nerve showed that from 4130 to 7450, on the average 5860±20 nerve cells (C = 17%) are counted in the nucleus. The density of their arrangement varies from 610 to 1430 cells in mm^3, being on the average 850±34 per 1 mm^3 (C = 22%). The number of glial cells per 1 mm^3 of nucleus tissue averages 48,200±3440 (C = 20%). The ratio of the number of glial cells to nerve cells per unit volume (glial index) averages 54±2.7 (C = 14%). In the presence of brain tumors the total number of neurons of the nucleus did not diminish with statistical significance in a single observation, however, in certain of the observations definite histopathological changes were noted.

The density of the neurons increased upon pronounced deformation of the nucleus only in the case of development of atrophic phenomena as a consequence of circulatory disorders. The number of glial cells per unit volume and the glial index of the sublingual nerve nucleus in the investigated cases did not substantially change.

The nerve cells of the sublingual nerve nucleus are divided by body shape into multipolar (up to 71% of all investigated neurons), elongated (up to 21%), round (up to 19%), and fusiform (up to 4%). They are all shown in Fig. 1A, a-d. Furthermore, we found neurons whose body shape is transitional between those enumerated above. They can be designated as cells of indeterminite shape. Their number did not exceed 21% of all neurons of the nucleus.

The shape of the body of neurons, depending on the size, number, and direction of their dendrites, is of considerable interest for the characteristics of nerve cells. Thus, during the normal activity of neurons as well as in various pathological states the shape of their body can change somewhat [4, 5, etc.]. In our examined cases, in the presence of brain tumors, changes in the shape of the body of the neurons of the sublingual nerve nucleus developed a relation to the direction of tumor pressure. The cells were elongated when the nucleus was compressed in a dorsoventral direction, the number of elongated neurons amounting to 52% of their total number. However, in the case of compression of nucleus from the lateral side, the shape of its neurons did not noticeably change.

The authors who have described the sublingual nerve nucleus usually note that it consists of typical motor neurons [9, 11, etc.]. Certain researchers [1, 10] indicate the presence in the nucleus of associative cells forming a commissure of the sublingual nerve nucleus. According to our data, typical motor neurons (Fig. 1A), comprise from 82.8 to 98.8% of all ganglion cells of the nucleus, averaging $93 \pm 0.8\%$ (C = 5%). They have primarily a multipolar body shape (Fig. 1A, a). The tigroid in most of these cells consists of brightly stained distinctly outlined large granules. Their nucleus is large, slightly oval, or round, and is situated most frequently centrally. The nucleoplasm is usually colorless with a small quantity of rather tiny granules. The nucleolus is distinguished by its large size and intense staining.

In addition to typical motor cells, the nucleus of the sublingual nerve constantly contains also small neurons similar in structure with cells of the reticular formation (Fig. 1C). They comprise from 0.7 to 14.3%, averaging $5 \pm 0.5\%$, of all neurons of the nucleus (C = 61%). Their body shape is multipolar, elongated, or round. The tigroid of these cells is fine-grained, individual granules are often seen in them. These neurons are appreciably inferior to typical motor cells with respect to the intensity of staining of the tigroid. Their nucleus is oval, light, with a few granules in the nucleoplasm, and occupies a larger part of the cell body so that the cytoplasm is sometimes represented only by a thin rim around the nucleus. The nucleolus is small, intensely stained. These cells we have tentatively designated as neurons of a nonmotor type.

In the sublingual nerve nucleus we also encountered neurons (Fig. 1B) similar in some morphological characters to typical motor cells and in other characters to neurons of the nonmotor type. On this basis the indicated cells were designated by the tentative name of neurons of an intermediate type. Their number did not exceed 12.3%, and on the average equal 2% of all neurons of the nucleus (C = 127%). Among the intermediate type neurons we could find with the same frequency all shapes of the cell body with the exception of the fusiform. The tigroid of these cells resembled the tigroid of typical motor neurons. They were similar to neurons of the nonmotor type with respect to the structure of the nucleus.

The three types of neurons of the sublingual nerve nucleus described above differ not only in structure of the cytoplasm, nucleus, and nucleolus, but also in such quantitative indices as the size of the profile field of the body, nucleus, and nucleolus and also by the value of the body-nucleus and nucleus-nucleolus ratio (see the table).

The results of studying all three isolated types of neurons of the sublingual nucleus in pathology showed that the character and degree of their changes can be different. The most expressed histopathological shifts, for example, tigrolysis, karyolysis, overloading with pigments, retrograde degeneration, are characteristic for typical motor cells (Fig. 2) and are not found in neurons of the nonmotor and intermediate types. In the presence of appreciable ischemia of the medulla oblongata which caused the development of gross disorders of the structure of typical motor cells even up to their destruction and lysis, only pronounced hypochromasia was observed in the neurons of the nonmotor and intermediate type. The boundaries of such cells are scarcely noticeable against the surrounding background, however, the contours of their nucleus and nucleolus remain distinct. The different reactions of the three types of cells of the sublingual nucleus in pathology evidently indicate their different functional value. We can assume that neurons of the intermediate type are elements regulating the flux of impulses which converge at the motor neuron of the nucleus from other brain formations. The neurons of the nonmotor type can be scattered reticular elements whose presence is demonstrated in sensory nuclei of the stem [3].

Size of Nerve Cells of the Sublingual Nerve Nucleus

Neurons	No. of measured cells	Average size of larger diameter (in μ)			Average size of profile field (in μ^2)			Ratio of profile fields	
		body	nucleus	nucleolus	body	nucleus	nucleolus	body/nucleus	nucleus /nucleolus
Typical motor	1225	36.4	14.3	4.8	800	164	21	5.1	8.5
Intermediate	62	24.7	15	3.4	392	141	11	2.7	13.5
Nonmotor type	191	17.6	12	2.4	214	97	6	2.1	19.8

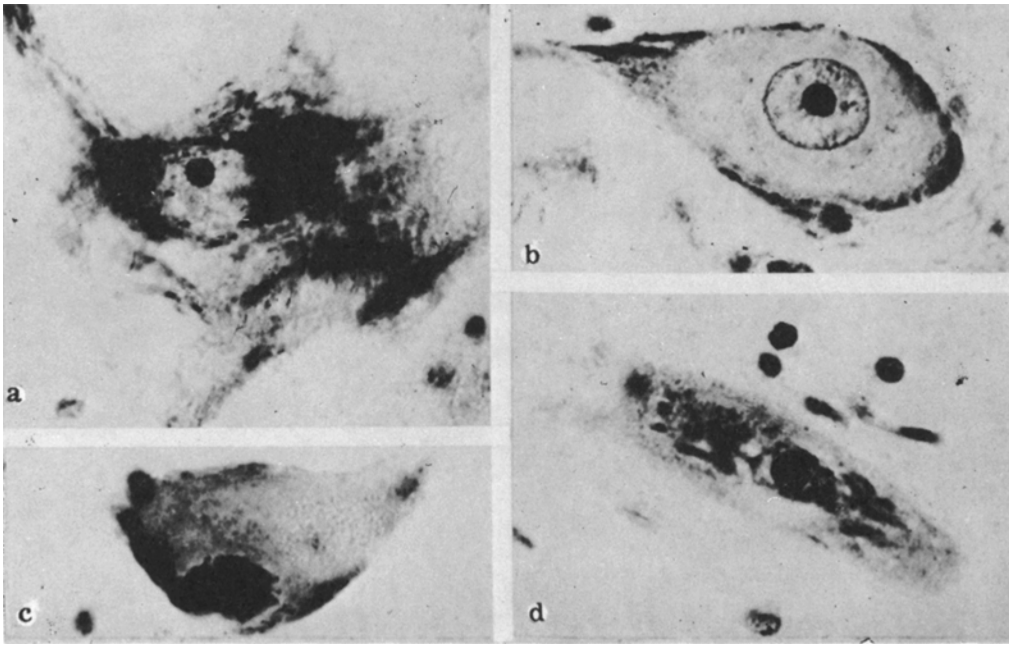

Fig. 2. Histopathological changes of motor neurons of the sublingual nerve nucleus. a) Partial tigrolysis with a blurred picture of the tigroid substance; b) total tigrolysis with swelling of the body; c) total tigrolysis with excess load of lipofuscin, with a scalloped hyperchromatic nucleus; d) cell in a state of karyolysis. Thionine staining. Objective 60×, ocular 10×.

When the structure of the neurons of the nucleus of the sublingual nerve is disturbed, for example, as a consequence of retrograde degeneration, the cells of the adjacent nuclei of Roller, Duval, interradicular, intercalated, nucleus of the raphe, dorsal paramedian, nucleus eminentiae teretis, and nucleus prepositus did not change and, on the contrary, in cases of gross histopathological changes of these nuclei the neurons of the sublingual nucleus proved to be better preserved. Hence, we can conclude that contrary to the opinion of certain authors [8, 12, and others] in man, the cellular formation surrounding the nucleus of the sublingual nerve do not send fibers to the sublingual nerve.

Thus, the data of this morphological investigation made it possible to establish a general plan of the structure and a number of characteristic features of the structure of the nucleus of the sublingual nerve as a typical representative of motor nuclei of the brain stem.

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