CORRELATION BETWEEN NERVE CELLS AND CAPILLARIES IN THE MESENCEPHALIC RETICULAR FORMATION

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Nerve cells of the nucleus cuneatus of the cat's reticular formation with different morphological characteristics possess a different blood supply. The most highly developed vascular network is formed near the body of the large multidendritic neurons of the reticular formation resembling motoneurons, and it is poorest in the case of small neurons described in the literature as interneurons.

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Variations in the activity of different groups of neurons of similar morphological structure have not yet been adequately explained. It is known, however, that the blood supply of nerve cells reflects the level of metabolism characteristic of their different functions [1-3]. A more highly developed network of blood vessels is formed around the bodies of motoneurons than around those of sensory neurons. It has also been found that those motoneurons which function for longer periods and at high intensity have a particularly good blood supply.

For these reasons, in the present investigation the intimate blood supply of nerve cells of the mesencephalic reticular formation was studied.

EXPERIMENTAL METHOD

The correlation between nerve cells and capillaries was studied in the nucleus cuneatus of the mesencephalic reticular formation in continuous series of paraffin sections through the mesencephalon of 10 adult cats. Histological sections containing cerebral vessels injected intravitally with 4% solution of gelatin in ink and nerve cells stained by Nissl's method side by side were used for this purpose. The blood supply of the nerve cells was studied in a volume of brain substance surrounding a nerve cell for a distance of 25 μ from its surface. Since the cells investigated varied in size from 7 to 60 μ, the thickness of the sections was 60, 70, 80, 90, 100, and 110 μ. A drawing apparatus was used to draw all the nerve cells and surrounding capillaries in the middle plane of the section. The correlation between nerve cells and capillaries was studied on the basis of five criteria: length of the capillary network in the above-mentioned volume of brain substance; presence or absence of contact between the capillary and nerve cell body; length of contact of the capillary with the nerve cell body; arrangement of the capillary in contact with the body of nerve cell; shape of segments of the capillaries taking part in supplying blood to the nerve cell.

We studied the blood supply of three types of somatochromic nerve cells found in the nucleus cuneatus of the mesencephalic reticular formation. Group 1 consisted of small cells with thin, short processes, a large nucleus occupying a considerable part of its body, and a gryochromic type of tigroid structure. Group 2 consisted of middle-sized neurons with long, thin processes and tigroid of archiochromic structure. Group 3 consisted of large, multidendritic nerve cells with a large nucleus occupying a comparatively small part of their body, and tigroid of archiostriochromic type present in small quantities in the dendrites also.

EXPERIMENTAL RESULTS

The length of the capillaries taking part in supplying blood to the nerve cells of group 1 varied from 160 to 230 μ (mean 187 μ), while for the group 2 cells the limits of variations were 180-250 μ (mean 200 μ), and for the group 3 cells 180-330 μ (mean 240 μ). The frequency of contact between capillaries and group 1

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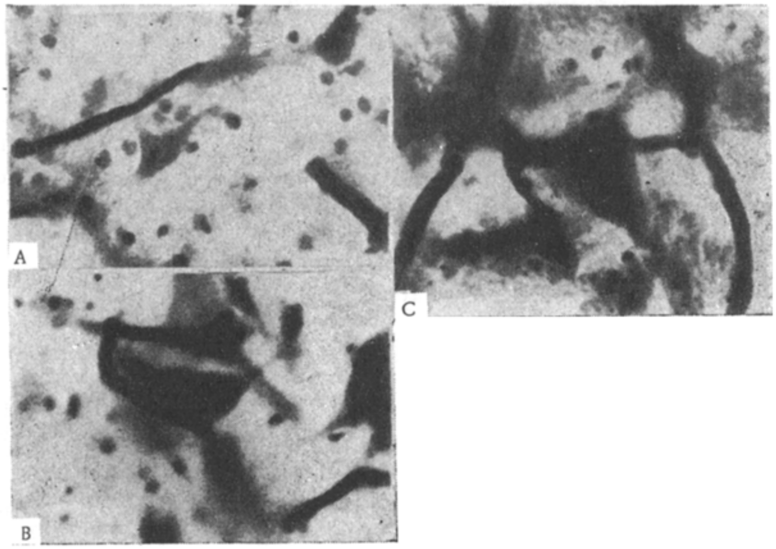

Fig. 1. Blood supply of neurons of different sizes in nucleus cuneatus of mesencephalic reticular formation. A) Small nerve cell (cells of group 1); B) medium-size nerve cells (cells of group 2); C) large nerve cell (cells of group 3). Blood vessels of brain injected with gelatin solution in ink, neurons stained by Nissl's method. 400×.

nerve cells was in the ratio of 1 : 3, i.e., the number of cells in contact with the capillaries was 37%, and one-third of these was in contact with capillaries only by their processes. Of the group 2 cells, 65% were in contact with capillaries, while nearly all the group 3 nerve cells were in contact with the surrounding capillaries. The length of the capillary segments on the body of the group 1 nerve cells averaged 7-9 μ, compared with 12-15 μ for the group 2 cells and a mean value of 25-28 μ for the group 3 cells, reaching in some cases 50 μ. Capillaries supplying blood of the group 1 nerve cells had segments which were straight lines. When only one capillary made contact with the cell it did so for only a short distance or it crossed one of its corners (see Fig. 1, A). Capillaries lying on the body of the neuron appeared as short segments of straight lines. The pattern of the capillaries surrounding the cells was more complex in the next two groups. The capillaries wound around the nerve cells to form arches around their corners (Fig. 1, B). Near the body of the large nerve cells, loops, spirals, and semicircles could be seen. Often the cells lay with one side along a capillary or they were enclosed in the angle formed by two capillaries (see Fig. 1,C). The shape of the capillary segments lying on the bodies of the nerve cells likewise was more complex: often they pursued a long and twisting course from one corner of the cell to another; sometimes several capillaries could be seen touching a nerve cell in various places.

The relations between the capillaries and processes of the neurons also varied: Thin processes of small cells, free from chromatin, were not in contact with capillaries or crossed them in only one place, i.e., their surface of contact was very small. This was also true of the relations between capillaries and processes of the group 2 nerve cells. In contrast to this, the powerful dendrites of large neurons of group 3 containing chromatin were surrounded by loops of capillaries which accompanied them for some distance from the cell body.

Hence, comparison of differences between the blood supply of nerve cells of the various groups in the nucleus cuneatus of the mesencephalic reticular formation clearly showed that morphologically different neurons possess different blood supplies; the most highly developed capillary network was found near large, multidendritic nerve cells rich in chromatin. Nearly all of these were in contact with capillaries. Since the twisting capillaries seen on their bodies often lay along the length of the cell or were in contact with it at several places, the length of contact between cell and capillary was considerably increased. The greatest differences were observed in the shape of the capillaries surrounding the large and small nerve cells. Whereas the capillaries near the group 1 cells appeared as segments of straight lines which did not wind around the cell but simply touched it at one place, the capillaries around the group 3 cells formed complex loops and turns, thus creating more intimate contact between cell and capillaries supplying it with blood. These variations in the degree of vascularization of the nerve cells may reflect differences in intensity of metabolic processes associated with different forms of functional activity. In other words, the large neurons of the nucleus cuneatus of the mesencephalic reticular formation resemble motoneurons not only in their morphological characteristics, but also in their blood supply. In the same way, the small cells of this nucleus, so far as their blood supply is concerned, are similar to sensory or internuncial neurons.

LITERATURE CITED

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