ENCAPSULATED RECEPTORS OF ARTERIES OF THE MEDULLA AND SPINAL CHORD

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Investigation of the innervation of the anterior spinal artery and its branches to the anterior median fissure throughout the length of the human medulla and spinal cord revealed encapsulated receptors of the Krause's end-bulb type. They are located at the origin of the arteries supplying the fissure. The structure of the receptors is described and their polyvalent function postulated: regulation of the blood pressure, temperature, and chemical composition of the blood.

* * *

Encapsulated receptors are found in the overwhelming majority of organs and they are most closely related to the blood vessels [3]. They have been described by many investigators in the large intracranial arteries [4, 6-8, 14].

In this investigation the innervation of the anterior spinal artery and its branches to the anterior median fissure was studied throughout the length of the medulla and spinal cord.

EXPERIMENTAL METHOD AND RESULTS

The impregnation method of Cajal and Bielschowsky were used. Arteries of 32 persons aged 20-60 years were investigated.

The sensory corpuscles which were observed were spherical or oval in shape and their largest diameter varied from 120 to 200 μ (Figs. 1 and 2). The capsule is composed of long, flattened cells, arranged in 3-6 layers. Its inner bulb contains large, irregularly shaped nuclei, belonging to special cells on which the endings of the sensory fiber are arranged. These terminal fibers divide, interweave, and diminish in thickness to form a compact or looser nerve glomerulus.

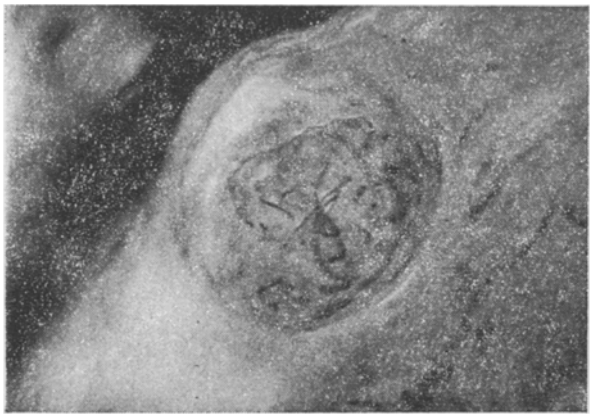

Fig. 1. Anterior spinal artery of the medulla. Encapsulated spherical corpuscle. 200 × (impregnation).

In the dense glomeruli the outer plexus is formed by thicker fibers than the inner network. Its fibrils, frequently without endings of any special shape, decrease rapidly in thickness and disappear imperceptibly in the tissues.

Endings of ring or loop type or consisting of small homogeneous segments are present only in some encapsulated receptors. Perhaps they are not always detectable or are not present in a particular section.

The terminal glomerulus is evidently formed by several fibers of different diameters. In some cases fibers of different caliber could be seen alongside the corpuscle and within it. The encapsulated receptor illustrated in Fig. 3 is demonstrative in this respect. This corpuscle is long and partly irregular in shape, and contains a dense, compact glomerulus formed of thin fibers. The fact that at least three fibers of different diameters participate in the formation of this

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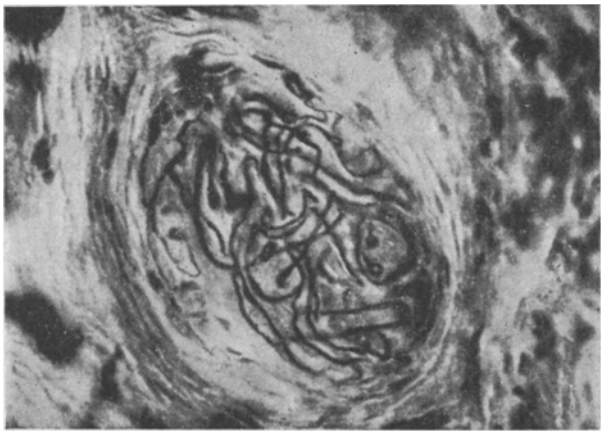

Fig. 2. Anterior spinal artery of the medulla. Encapsulated oval corpuscles. Layers of the capsule and terminal rings are clearly visible. 400 × (impregnation).

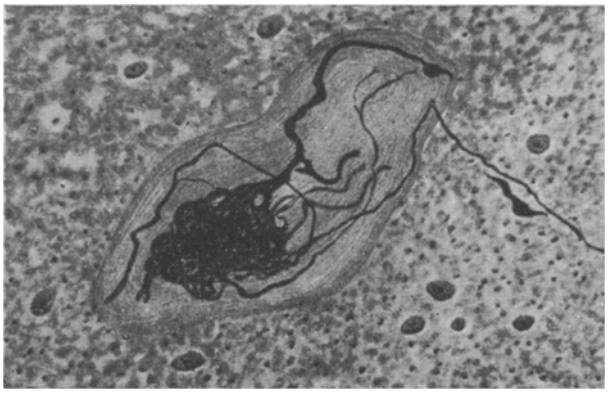

Fig. 3. Encapsulated receptor of the anterior spinal artery. Description in text. 630 × (impregnation).

glomerulus is clearly visible. One of them, lying above and on the right, is the thickest. Division of this fiber is clearly visible in the figure. A thinner fiber participating in the formation of the glomerulus enters it on the left side and gives off a thin lateral branch along its course.

Finally, the third and thinnest fiber enters the receptor from its right and lower side.

The encapsulated endings as described above resemble most closely in their structure the corpuscles first described by Krause [13] and named after him. They lie at the origin of the arteries entering the fissure, the distal parts of which sink into the tissues of the medulla and spinal cord. Usually one pole of the Krause's corpuscle is compressed into the angle formed by the walls of the anterior spinal artery and the artery to the fissure, while the other lies in the pia in immediate proximity to small blood vessels such as capillaries and postcapillary venules.

This fact, which has been observed by many morphologists, has led to the opinion that these encapsulated endings are baroreceptors [2, 3, 14, 16, 17]. Physiological investigations have shown that encapsulated corpuscles respond to pulsation of blood vessels [10].

To be precise, electrophysiological data on the function of encapsulated structures have been concerned mainly with Vater-Pacini corpuscles. In their morphology Krause's end-bulbs differ from the latter by being smaller in size and having a less well developed capsule. Current physiological opinion is that both have the same function. They are regarded as organs maintaining the blood pressure at a stipulated level [11]. The encapsulated receptors discovered in the arteries supplying the spinal cord and medulla can evidently be regarded as true baroreceptors, more especially because the existence of apparatuses with this function have been demonstrated experimentally [5, 15].

The terminal neural apparatus in Krause's end-bulbs, as measurements have shown, is formed of fibers not exceeding 5 μ in thickness. These fibers respond actively to cooling [9]. Accordingly, Krause's end-bulbs are regarded as receptors responding to a fall in temperature [12].

The presence of Krause's bulbs in the blood vessels of the brain, where metabolic processes run at a high level and the tissue temperature is higher than the blood temperature [1], is absolutely essential.

These structures, concentrated on the pathways of the blood, evidently control the constancy of its temperature and determine the limits below which it may not fall.

Consequently, as well as their baroreceptor function, the encapsulated structures resembling Krause's end-bulbs can also be regarded as thermoregulatory structures responding to cooling.

The presence of glial cells in the encapsulated corpuscles and their close contact with the capillary and venous networks suggest that these structures may also act as chemoreceptors.

Hence, encapsulated corpuscles of the Krause's end-bulb type as described above in the arteries of the medulla and spinal cord are evidently polyvalent from the functional point of view, a conclusion which is compatible with current physiological findings [18]. They work simultaneously as baro-, thermo-, and chemoreceptors.

Bearing in mind that encapsulated corpuscles lie at the boundary between the extramedullary and intramedullary arterial systems, at the origin of the arterial branches entering the anterior median fissure, their importance in regulation of the blood flow to the medulla and spinal cord is difficult to overestimate. By maintaining the pressure, optimal temperature, and chemical composition of the blood, these encapsulated structures ensure a normal hemodynamics and create the essential physiological conditions for the functioning of nerve tissue.

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