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The Arterioles and Capillaries of the Brain Stem and Cerebellum: A Microangiographic Study*

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Summary. A schema of the vascular supply of the brain stem in sagittal sections and of the vascular supply of cerebellum is presented.

The subject of this communication is the morphology of the arterioles and capillaries of the brain stem and of the cerebellum. The respective distributing arteries will not be considered in detail.

Technique

Although our technique derives ultimately from methods elaborated by numerous anatomists, such as Foix and Hillemand (1925), Lazorthes (1961) and Mouchet (1911), it resembles more closely that used at the present time by Hassler (1966) and by Saunders (1960).

Because of the extreme fragility of cerebral tissue, the brains used are removed from the body as soon after death as possible; the interval ranges from six to 24 h. They are perfused with a radio-opaque substance which is introduced through cannulae placed in the internal carotid and vertebral arteries in the case of general perfusion, and through a catheter inserted into an individual artery (cerebellar, basilar, or other) in the case of selective injection. After careful fixation, a limited area of injected brain tissue, measuring 2 cm^2, is selected for microradiographic study and sectioned on a freezing microtome ("Tassnie" type, modified by addition of a "Peelcool" freezing attachment with adjustable temperature). Sections of 500 μ, 1 mm, and 2 mm thickmess, cut at a temperature slightly above freezing, are radiographed with the aid of a fine-focus tube having a beryllium window, of water-cooled Tubix G.M.U.L. (1×1) type, permitting very long exposure times. They are mounted directly on fine-grain Halioguil film or on Kodak plates, and should be placed on a suspended antivibration stage. The resulting negatives are enlarged photographically 10 or 20 $\times$ at the time of printing.

Results

The *vascular supply of the brain stem*

A scheme of the vascular supply territories of the brain stem, differing in some respects from that classically taught by Stopford (1915) and by Foix and Hillemand (1925), has recently been proposed by Lazorthes, Zadeh, and Lazorthes (1968). While accepting the validity of a division into anterior, anterolateral, and posterior territories corresponding to the perforating arteries and to the short and long circumferential arteries, these workers believe that this scheme requires adjustment for successive levels in the brain stem.

The vascular pattern in the lower part of the medulla oblongata is strikingly similar to that at the upper end of the spinal cord; in the upper medulla oblongata the anterior arteries run between the pyramids and end in the nuclei of the twelfth cranial nerve. The lateral medullary territory is extensive and includes

Fig. 1. Sagittal section of brain stem (1 mm thick). Microradiography

arteries to the olive and to the retro-olivary region. The posterior group disappears at the level of nucleus gracilis and nucleus cuneatus.

In the pons the anterior arteries run a markedly oblique course between the pyramidal fibres and give off many branches. The lateral arteries penetrate

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Fig. 2. Sagittal section of cerebellum (1 mm thick)

Fig. 3. Horizontal section of cerebellum (1 mm thick)

between the nuclei of the fifth, seventh, and eight cranial nerves. An avascular zone is believed to be present between the areas supplied by the anterior and lateral groups; the posterior group is apparently not represented at this level.

In the lower part of the midbrain numerous median and anterior arteries run to the nucleus of the fourth cranial nerve. The lateral group of arteries pass to the substantia nigra, and the posterior group to the colliculi. The cerebral peduncles themselves have a relatively poor blood supply.

These data were obtained from semi-horizontal sections after diaphanization. Our work consisted in studying, on microangiographic sagittal sections of the brain stem, the arrangement and morphology of the median group of arteries (Fig. 1).

The initial results suggest that three distinct angioarchitectonic territories can be distinguished. The most anterior of these contains the pyramids and is composed of a loose network of vessels lying roughly parallel to each other. Behind it is a more highly vascularized zone whose vascular pattern, with its multitude of bifurcating vessels, recalls that of the lentiform nucleus or the thalamus; this zone appears to correspond to the brain stem reticular formation. The third and most posteriorly situated zone, less richly supplied, corresponds apparently to the nuclei of the cranial nerves.

The *vascular supply of the cerebellum*

The cerebellum is supplied by the posterior inferior, anterior inferior, and superior cerebellar arteries. These vessels and their variations have been studied by Lazorthes, Poulhès, and Espagno (1950).

Microradiographic study of the arterioles and capillaries of the cerebellum reveals a characteristic vascular arrangement, differing from that in other structures of the central nervous system (Figs. 2 and 3). The arterioles lie at the level of the cerebellar cortex, where they bifurcate and ramify, forming festoons of vessels corresponding to the different cell layers. Good correlation was found between the microangiograms and histological preparations. The disposition of the various layers of the cerebellar cortex and white substance can be identified through the capillary network. These findings are comparable to those of Lazorthes and of Marini de Aranjo (1969).

In conclusion, exploration of the arteries and capillaries of the brain stem and cerebellum both offers a fruitful field of research in vertebral angiography and reveals the limitations of this procedure. The disposition of the capillary network confirms the hypothesis that every segment of the neuraxis may have a specific vascular supply pattern. Absence, or abundance, of anastomoses explains the contrast between the brain stem, with an end-arterial type of supply in its median zone, and the cerebellum with its highly anastomotic vascular network. The rich vasculature of the brain stem and cerebellum suggests that their pathology cannot be described solely in terms of cell damage; as in the case of other parts of the brain, a knowledge of their arterial distribution and of its pathology will promote understanding of certain lesions affecting them.

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