CEREBELLAR ARCHITECTONICS OF THE BLOOD VESSELS FOLLOWING EXPERIMENTAL LIGATION OF THE COMMON CAROTID ARTERIES IN RABBITS

V. V. Stenyk

From the Department of Anatomy of the L'vov Medical Institute

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The morphological alterations of the arterial stream which occur in various divisions of the brain following the exclusion of individual main cervico-cerebral vessels have not so far been studied very thoroughly, although there exist a number of studies in this field [1, 2, 3, 4, 6].

The present investigation had as its goal the study of the changes occurring in the cerebral arteries of the rabbit after a simultaneous bilateral ligation of the carotid arteries.

EXPERIMENTAL METHODS

Our studies were conducted upon 14 adult rabbits of both sexes. All the animals were operated under ether narcosis. Both the common carotid arteries were ligated. Externally, during the postoperative period the animals could not be distinguished from unoperated rabbits as no functional disturbances of any kind could be observed; they were all sacrificed from 7 to 265 days following the ligations. The arterial system of the head and neck of each animal was injected with a contrast medium (3 parts of lead white plus 1 part of carbon black stirred into turpentine to a creamy consistency), the thoracic aorta being the portal of entry, after which the brain was removed from the skull case and hardened first in 5% and then in 10% formalin solution. The hardened preparations were first examined for their external vessels with the aid of a binocular lens and then histological sections 200, 300 and 400 μ thick were made in the frontal, sagittal and horizontal planes so that the intraorgan arteries could be studied. The diameters of the principal arteries were determined with the aid of a micrometer objective and ocular. For a control comparison we studied the corresponding vessels of the region being examined utilizing the same technique in 10 adult rabbits.

EXPERIMENTAL RESULTS

Our observations indicate that simultaneous ligation of both common carotid arteries leads to a considerable reconstruction of the arteries to be found at the base of the brain. This last, in particular, expresses itself by an alteration of the angle at which the basilar artery terminates by dividing into the 2 caudal or posterior cerebral arteries, the normal acute angulation becoming blunted so that, as early as the 14th postoperative day, this obtuseness is evident while by the 128th day the angle reaches 180°. Simultaneously with this alteration the diameter of the indicated arteries increases; thus, the diameter of the basilar artery by the 30th postoperative day reaches 1.3 mm while by the 220th day it becomes 2 mm, i.e., twice the normal dimension.

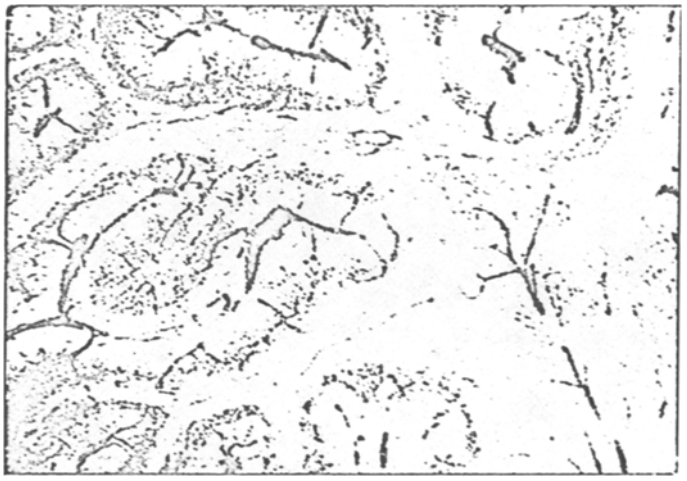
Along with the alterations of the individual components of the circulus arteriosus (Circle of Willys), analogous manifestations govern the compensatory reconstruction of the arterial bed of the cerebellum. Thus the nasal or superior cerebellar arteries which branch from the posterior cerebral arteries present the appearance of being direct continuations of the latter. This occurs because the angle of emergence of the superior cerebellar arteries is changed from the normal acute to a blunt angle; simultaneously, these arteries increase in diameter by 0.2-0.3 mm. The formation of tortuous collaterals upon the cerebellum must be considered as

rather rare. It was noted that the caliber of the branches leaving the superior cerebellar arteries to supply the midbrain also increased.

The caudal or inferior posterior cerebellar arteries increase their diameter in the initial period of compensatory widening of the vessel bed and maintain this later by exceeding the normal diameter of 0.2-0.3 mm by 0.1-0.15 mm. It should be noted that the cerebellum of rabbits is supplied only by two pairs of cerebellar arteries. The third pair, the inferior posterior cerebellar arteries, which is present in man, dog, cat and others is absent in the rabbit according to the data of A. Tschernyscheff and J. Grigorowsky [5] as well as our own observations.

The arterial net of previously existing cerebellar anastomoses seen in preparations made in animals sacrificed shortly after the operation is distinguished by considerable density; at later periods this net is less dense but the anastomoses of the individual collaterals are much more distinct.

The intracerebellar arteries react to the ligation of the carotid arteries in the same manner as do the external. The diameter of the sulcal arteries by the twenty-first lay postoperative day reaches 100 μ as against a normal of 60-70 μ. The long and short cortical branches arising from the sulcal arteries widen their diameter by 10-20 μ, the normal diameter within the short branches fluctuating between 25-30 μ, while within the long, the fluctuation is 35-45 μ. The increase in the diameters is to be seen mostly in those branches which go off at an acute angle.



Intracerebellar arteries on the 220th postoperative day following the exclusion of both common carotid arteries. Magnification 15x.

Finally, it should be noted the increase in the diameter of the collaterals and the greater density of the arterial net within the cortex of the cerebellum leads to the erasure of the usually well defined boundaries between the vessels of the individual layers. This is seen first in the vessels of the cerebellar cortical ganglionic layer. Within this layer normally the short cortical branches divide arc-wise forming a system of arterial anastomoses shaped like arcades. Under the conditions of the experiment the individual short cortical branches penetrate more deeply into the granular layer forming irregular branchings as a result of which the arcade-like system of anastomoses no longer exists. Similar findings were noted by N. A. Dzhavakhisvili-Komakhidze [1] who studied the vessels within the cruciate sulcus in the dog and by V. P. Kurkovskii [3] who investigated the cerebellar cortex of the white rat, this latter author taking the position that this is the cause of the special sensitivity displayed by the ganglionic layer of the cerebellar cortex to acute anoxemia.

Thus it can be seen that bilateral ligation of the common carotid arteries produces the development of collateral circulation in the cervical region and produces also considerable alterations in the angioarchitectonics of the brain as a whole and the cerebellum in particular.

SUMMARY

In order to study the architectonics of the cerebellum in conditions of collateral circulation, simultaneous bilateral ligation of the common carotid arteries was carried out in 14 rabbits. No functional disturbances were noted in animals during the postoperative period. External arteries were studied on injected preparations of the cerebellum, while the internal arteries were examined on the total histological sections. When the bloodflow is disturbed in these vessels, there is a morphological change in the arteries of the brain and cerebellum. With time these morphological changes develop further. The angles of division, origin and fusion of various blood vessels is changed, their diameter increases, and their course becomes tortuous. The same changes take place in the internal cerebellar arteries i.e., sulcal arteries and short and long cortical branches which originate from them. There is modification in the vascular structure of the separate layers in the cerebellar cortex, as a result of which the borders between them become indistinct.

LITERATURE CITED

[1] N. A. Dzhavakhishvili-Komakhidze, Transactions of the All-Union Congress of Anatomists, Histologists and Embryologists,* Leningrad, 1951, 148-149.

[2] E. N. Kosmarskaia, Volume, Conditions and Consequences of Collateral Circulation in the Brain Following Extra- and Intracranial Closure of the Basic Arteries Supplying the Brain,* Dissertation, Moscow, 1947.

[3] V. P. Kurkovskii, Collection, Symposium Dedicated to 50 Years of Scientific Work by V. N. Tonkova,* Leningrad, 1947, 90-100.

[4] A. P. Liubomudrov, The Morphology of the Collateral Vascular Cervical Circulation,* Dissertation, Leningrad-Ivanovo, 1938.

[5] A. Tschernyscheff and J. Grigorowsky, Arch. f. Psychiat. u. Nervenkrankheit, 1930, Bd. 89, H. 3-4, S. 482-569.

[6] R. Pfeifer, Die grundlegende Untersuchungen für die Angioarchitectonic des menschlichen Gehirns, Berlin, 1930.

* In Russian.