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# DYNAMICS OF MICROCIRCULATION DISORDERS IN EXPERIMENTAL CIRCULATORY HYPOXIA /ISCHEMIA/

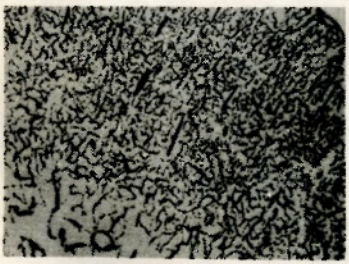
M.J. MOSSAKOWSKI, I.B. ZELMAN

Department of Neuropathology, Medical Research Centre,
Polish Academy of Sciences, Warsaw, Poland

Circulatory disorders, both generalized and circumscribed are known to accompany a great number of hypoxic conditions. The present study was undertaken to analyse the state of the cerebral vascular network during and after circulatory hypoxia /ischemia/ induced in rabbits according to the method of Mchedlishvili /1972/ and to confront the results with the histopathological abnormalities in the brain resulting from this procedure.

Cerebral ischemia was produced by bilateral ligation of carotid arteries, combined with simultaneous reduction of the systemic arterial blood pressure to 20 mg Hg for a period of 15 minutes by controlled exsanguination. After 15 min. of ischemia the systemic arterial pressure was restored to a normal level and one carotid artery was released. The animals were sacrificed at the 10th min. of ischemia, immediately after blood reinjection and then 15 min., 2, 4, 6, 12, 24 and 48 hrs following the experiment. Pickworth benzidine method and routine neuropathological techniques were used for microscopical examinations of the brains.

Contrary to the vascular picture seen in intact, control animals /Fig. 1/, the rabbits sacrificed at the 10th min. of ischemia revealed a significant reduction of the vascular network in the cerebral cortex, basal ganglia and in the white matter structures.



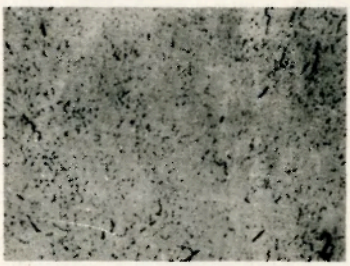
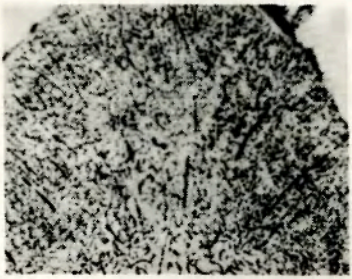


Fig. 1. Cortical vascular network in a control animal. Pickworth's meth. x 60
Fig. 2. Cortical vascular network during ischemia. Pickworth's meth. x 60

The angioarchitectonics typical for various parts of the brain was not visible /Fig. 2/. Cortical areas vascularized by the branches of posterior cerebral arteries showed a relatively better blood supply. Blood reinjection brought about an immediate amelioration of blood supply to all brain structures, except Ammon's horn and the border-line zones on the side of permanent carotid artery ligation. At the 15th min. after arterial blood pressure restoration widespread hyperemia involved all cerebral structures /Fig. 3/. Two hours later all parts of the brain were still hyperemic, but in most animals venous engorgement prevailed. The presence of widespread perivascular patches of reduced blood supply was very characteristic for the cortical picture /Fig. 4/. The same was true for animals sacrificed at the 6th hr.



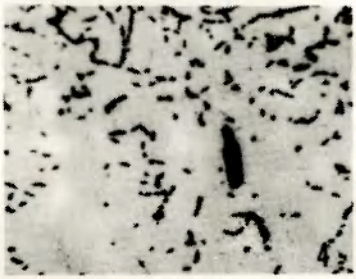
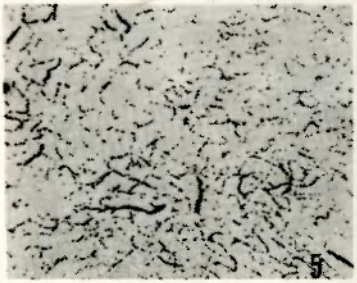


Fig. 3. Cortical hyperemia at 2nd hr of postischemic period. Pickworth's meth. x 60

Fig. 4. Perivaacular focus of reduced blood supply, 6 hrs following ischemic episode. Pickworth's meth. x 160

At the 12th hr the blood supply to the majority of cortical areas was again reduced as compared with normal animals. Normalization of the blood supply began at the 24th hr after the ischemic episode, however, even at that time, uneven distribution of blood content within the cortical blood vessels was still present /Fig. 5/.



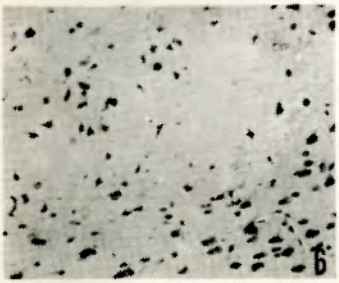
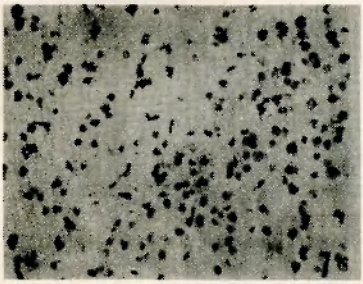


Fig. 5. Uneven distribution of the blood content in cortical vessels at 24 hr of postischemic period. Pickworth's meth. x 60

Fig. 6. Perivascular status spongiosus 12 hr of postischemic period. H-E. x 200

Full normalization of the morphological picture of the vascular network was observed not earlier than 48 hrs after the experiment.

The histopathological changes observed up to the 2nd hr of the postischemic period were not significant and consisted in generalized reduction of the staining ability of neurons, their tigrolysis and swelling as well as some perivascular pallor of the tissue. During the following hours, the features of diffuse, nonspecific nerve cell degeneration became more evident. Occurring in all grey structures, they were more significant in the lower layers of the frontal and parietal cortex, in the cerebellar cortex and in the thalami. However, against the background of this diffuse tissue impairment, focal structural lesions were visible, consisting in perivascular tissue rarefaction /Fig. 6/, small foci of tissue necrosis scattered in the cerebral cortex /Fig. 7/ laminar necroses of the Ammon's horn cortex /Fig. 8/ and large necrotic foci in the ventro-median part of the thalamus; the latter two changes occurring exclusively on the side of permanent carotid artery ligation. Glial reparative processes were of a very low intensity and extent.



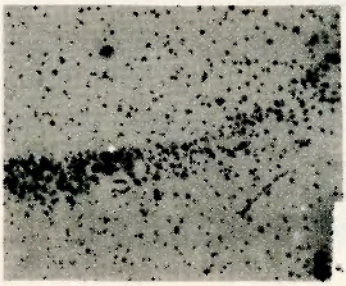


Fig. 7. Focal cortical necrosis 24 hr of postischemic period. Cresyl violet. x 200

Fig. 8. Laminar necrosis of ganglion cells in the Ammon's horn 48 hr of postischemic period. Cresyl violet. x 100

The results of our studies indicate that brain ischemia, induced by bilateral carotid artery ligation concomitant with reduction of the systemic blood pressure is followed by severe disturbances of cerebral circulation, occurring during the whole postischemic period from the 15th min. to the 24th hr after the experiment. The ischemic period is immediately followed by considerable hyperemia lasting 6 hrs. Initial involvement of all types of vessels and increased cerebral blood flow /Kapuściński, 1974/ are suggestive of an active nature of hyperemia in its early stages, while the prevalence of venous engorgement and subsequent decrease of the cerebral blood flow may indicate its passive type in later phases. The uneven distribution of the blood content within the vessels and presence of patchy foci of reduced blood supply in the cerebral cortex are very typical for the whole reco-

very period. Although the nature of these phenomena remains unclear, they seem to be related with functional abnormalities of the pial and cerebral arteries, found in circulatory hypoxia and attributed to the disturbances of their autoregulatory mechanisms /Mchedlishvili, Baramidze, 1971/. The distribution and topography of the histological tissue lesions strongly suggest that these postischemic circulatory disturbances, beside experimental ischemia itself, may be responsible for their occurrence. The lack of an immediate improvement of blood supply after restoration of normal systemic blood pressure, limited to the areas of the border-line zones and Ammon's horn on the side of permanent carotid artery ligation and manifesting local hemodynamic disturbances, has to be taken into consideration as a possible factor, leading to focal tissue lesions, localized in those areas. On the other hand the better blood supply to the areas vascularized by the branches of the posterior cerebral arteries during the ischemic episode indicates a relative efficiency of the vertebral circulation under these conditions. Preservation of the tissue integrity in those areas forms an additional argument for such an assumption.

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