MATERIAL ON THE PATHOMORPHOLOGY OF THE RETICULOENDOTHELIAL SYSTEM AND ARGYROPHIL SUBSTANCE AFTER DECORTICATION OF THE CEREBRAL HEMISPHERES

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Physiological observations, more or less fully presented in the literature, on animals after experimental damage to the cerebral hemispheres [1, 2, 3, 8, 12] have up to now not been sufficiently backed up by morphological data.

N. T. Shutova [15] in studying cholesterol metabolism in decerebrated dogs, gave a very brief description of the morphological changes in the liver, spleen, kidneys, heart, adrenals, lungs and thyroid gland in one dog and in the brain in 6 dogs. B. I. Bayandurov [2] by means of physiological observations presents data on the histostructural changes in the secretory glands, kidneys, bone marrow, and lymphatic nodes in baby rabbits and pups. E. A. Asratyan [1] stresses that after removal of the cerebral cortex, marked necrobiotic changes in the remaining parts of the cerebral hemispheres occur in dogs. He notes that as long term sequelae of the operation such "non-cortical" dogs become "non-hemispheric." A. O. Valdes [4] applying the method of decerebration and electro-coagulation of the brain studied the process of adiposity of the hepatic cells in rabbits and guinea pigs. V. A. Zhukhin [5, 6] and co-workers studied the morphological changes in various organs in dogs after decortication of both cerebral hemispheres. He points out that in the organs and tissues severe necrobiotic and atrophic changes are observed with signs of destruction of the parenchymal elements and subsequent sclerosis of the organs. I. D. Nasledova [11] refers to the quantitative and qualitative changes in the glia after extirpation of a small part of the cortex of the left cerebral hemisphere in rabbits.

N F. Popov [13] studied the morphological changes in the unimpaired parts of the brain in a dog and monkey after removal of the cortex of the large cerebral hemispheres. A. A. Kostenetsky [9] carried out similar investigations in rabbits, white rats and mice after removal of the central zone of the cerebral cortex. A. Ya. Khabarova [14] described the morphology of the nervous apparatus of the heart after removal of the cerebral cortex. C. J. Parhon, L. Laurian, M. Balacanu and S. Balacanu [16] carried out a morphological investigation of the endocrine glands in cats after decortication of the cerebral hemispheres.

Published findings on the pathological morphology of animal organs after decortication of the cerebral hemispheres are limited to the papers enumerated above and the literature at our disposal does not contain any special investigation devoted to study of the pathological morphology of the reticulo-endothelial system and the argyrophil substance in such experiments.

EXPERIMENTAL METHODS

Our experiments were conducted on 25 dogs including 6 controls. The animals, aged from 1 to 4 years weighed up to 6 kg; 5 dogs were subjected to decortication of only one cerebral hemisphere (they were observed for 58 to 201 days). 14 dogs were subjected to decortication of both cerebral hemispheres (observation period in

their case was from 45 to 173 days after the first operation until death, that is from 4 to 104 days after the second operation until death). We employed the method of decortication of the cerebral hemispheres devised by the school of Academician I. P. Pavlov and his followers. The dogs, subjected to decortication of only one cerebral hemisphere, were killed by intracardial introduction of 10 ml formalin 58, 65, 93 and 201 days post-operatively. Dogs with decortication of both cerebral hemispheres died merely as a result of severe tropic disturbances with signs of considerable exhaustion. Of the 6 control dogs three were subjected to trepanization of the skull and 3 dogs were not subjected to any surgical intervention.

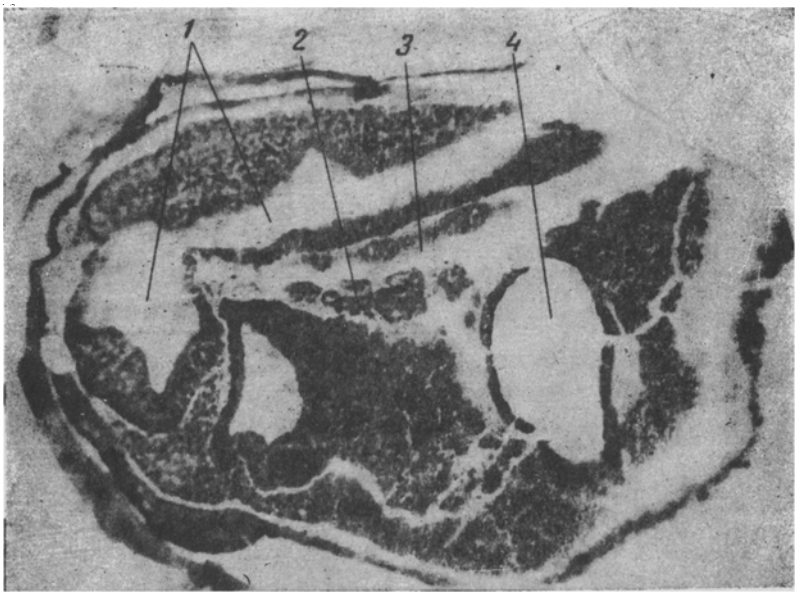

Fig. 1. Hepatic tissue. Focus of necrosis with signs of caryorrhexis, caryopicnosis and caryolysis. Stained with hematoxilin-eosin.

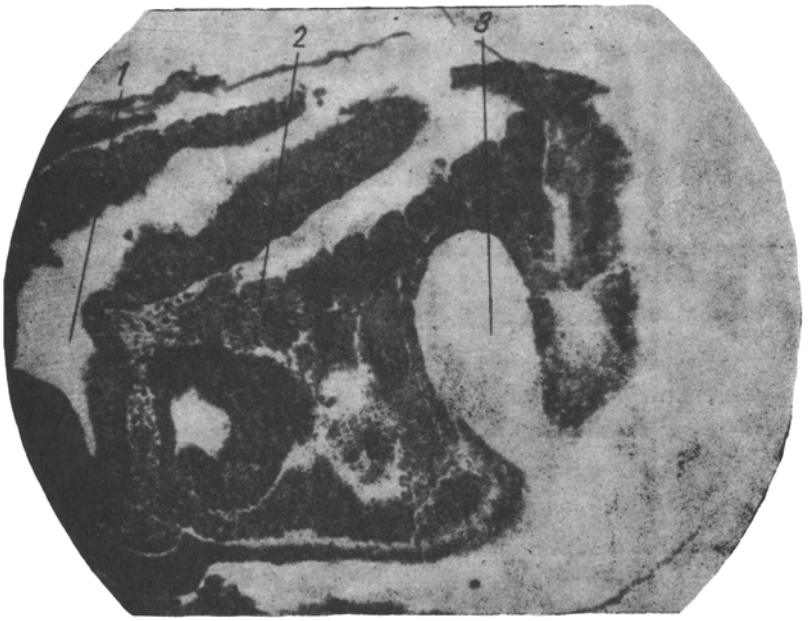

Fig. 2. Hepatic tissue. Necrobiosis, hypertrophy and decomposition of Kupfer cells. Impregnated with silver.

The corpses of the animals were usually dissected 10-15 minutes after death and, in the case of certain animals dying during the night and also some control animals killed for the purpose of comparison with the controls, were subjected to autopsy a few hours later. This made it possible to differentiate the post-mortem

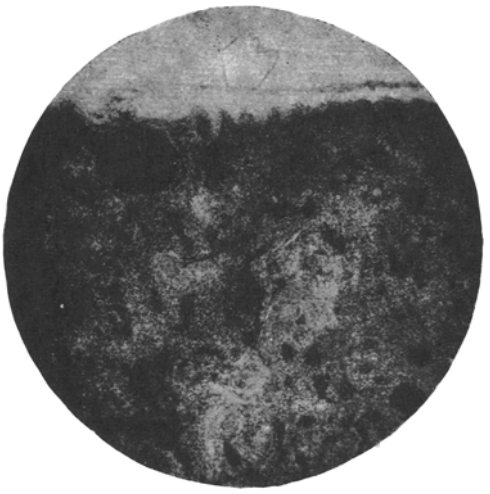

Fig. 3. Lymphatic nodule. Atrophy of lymphoid tissue and sclerosis of organ. Stained with hematoxylin-eosin.

structural changes from the changes during life associated with decortication. Specimens of the liver, spleen and lymphatic nodes taken from the root of the mesentery and also para-aortal and cervical specimens, were fixed in 10% neutral formalin solution. The solidified and celluloid microscopic sections were stained for elastic fibers with hematoxyline lin-eosin, and picrofuchsin according to Chart, for fat with sudan III, for iron according to Perls, the argyrophil fibers and cells of the reticulo-endothelial system were impregnated with silver according to the method of Zhukhin [6]. For the purpose of preventing possible artifacts both the experimental and control material was fixed and repeatedly stained in one and the same condition.

EXPERIMENTAL RESULTS

The clinical picture in our dogs after decortication of the cerebral hemispheres coincided with that described in the literature (I. P. Pavlov, B. N. Klosovsky, B. I. Bayandurov, N. T. Shutova, etc.) It should be noted that of the 19 experimental dogs left, bronchopneumonia developed in one dog 23 days after decortication of the second hemisphere and 2 days before death, confirmed on autopsy and by microscopic examination of the lungs. In another dog which died 3 days after decortication of the second hemisphere microscopic examination revealed a picture of fine focal aspiration bronchopneumonia.

On autopsy of the dogs which died after decortication of both cerebral hemispheres the macroscopic picture of the internal organs was one of pronounced dystrophic, atropic and sclerotic changes. The macroscopic findings on dissection of the dogs subjected to decortication of only one hemisphere in no way differed from those found on autopsy of the control dogs.

In the dogs subjected to decortication of both cerebral hemispheres, upon microscopic study of the liver, plethora of the organ and not infrequently hemorrhages were conspicuous. The structure of the lobules was eroded as a result of changes in complexity in the parenchymal cells. In certain cases in the hepatic lobules miliary necrotic foci were observed. The protoplasm of the parenchymal cells contained numerous fat droplets varying in size and a small amount of iron (Fig. 1). The epithelium of the interlobular bile ducts and the endothelium of the interlobular veins were in a swollen state with a considerable amount of fatty inclusion. In the adventitia of the veins a small accumulation of adventitial cells and histiocytes, intensely impregnated with silver, were encountered. In the protoplasm of certain cells there were inclusions varying in absorption of silver; some histiocytes located around the veins were disintegrated into clumps and granules. Elastic fibers in the vessels and the perivascular connective tissue were weakly stained, and in places were not discernible at all (elastolysis). Many Kupfer cells were hypertrophied, especially in the central sections of the lobules and their number

was increased. In some cases they formed granulomatous accumulations. The cell bodies were round, triangular or rod-shaped; star shaped cells with short stump-like outgrowths were found less frequently. Their protoplasm contained numerous inclusions with varying intensity of silver impregnation. In the protoplasm of many Kupfer cells fatty inclusions were found in large quantity in the form of fine and large drops, and there was also a considerable iron content. Cells were seen in a state of disintegration as a clump and granules (Fig. 2). The argyrophil fibers of the vascular walls were coarse, dilated and intertwined. In the perivascular zones they were impregnated to varying degrees with silver and some sections had become transformed into a uniform mass with the fibrils barely perceptible in it. The argyrophil fibers inside the hepatic lobules in many places did not show the proper mesh-like distribution, the argyrophil hull was thickened (pseudohyperplasia as a result of atrophy of the parenchyma), especially in the central parts of the lobules. The fibers were unequally impregnated with silver. In some places they displayed marked argyrophil properties, in others they were not impregnated with silver, swelling was seen along them, in places they were perceptibly attenuated to the point of separate fragments, granules and argyrophil dotted-lines.

Plethora of the spleen in the same dogs was evident and in some cases hemorrhages were encountered in the red pulp and a considerably marked sclerosis was observed. Here the follicles were greatly reduced in numbers and size and in many places were absent over a great area. In the endothelium of the central arteries in the trabecular vessels, in places in the histiocytes and polynuclear leucocytes, a large number of fatty inclusions were seen. The elastic fibers in the capsules, trabeculae, walls of the trabecular vessels, central arteries of the follicles and in the perivascular tissue were weakly stained, their structure was eroded, in places they were decomposed into separate fragments or were intertwined and in places were not evident at all. The argyrophil fibers of the capsule, trabeculae, the walls of the central arteries and the trabecular vessels were coarse, thickened in places, unequally impregnated with silver and intertwined. The argyrophil fibers in the red pulp were also unequally impregnated, in places they were not apparent or had the appearance of separate fragments, granules and argyrophil dotted lines, and in certain parts were indistinguishable from the uniform mass. Longitudinally they were of varying thickness; thickening and disorderly distribution were observed. The argyrophil hull of the unimpaired follicles consisted of coarse swollen fibers, unequally impregnated with silver, subject in places to decomposition. The number of reticular cells of the red pulp was reduced, they were unequally distributed. Sections with very small reticular cell content were observed. The shape of the latter was chiefly round, the cells had isolated pin-like or stump-like outgrowths or were completely devoid of them. Certain cells were hypertrophied. However much more often they were reduced in size, perceptibly thinned out and rod-like in shape. Many reticular and endothelial cells of the sinuses contained a considerable number of fatty drops and iron in the protoplasm. Some reticular cells were in a state of break-down into clumps and granules.

In the lymphatic nodes of the same dogs plethora and sclerosis of the organ was observed. A considerable reduction in the number and volume of the follicles and the pulpy cords was noted and in places for a considerable area they were completely indistinguishable or, in their place, small scattered accumulations of lymphocytes were seen rarely (Fig. 3). The centers of multiplication of the unimpaired follicles were scarcely perceptible or were completely indistinguishable. The walls of the blood vessels were sclerotized, their lumen contracted. The elastic fibers were weakly stained, not detected at all or with the appearance of separate fragments. The argyrophil fibers of the sinuses, follicles, pulpy cords, trabeculae and vessels were coarse, unequally swollen and unequally impregnated with silver. Not infrequently sections were found, particularly in the walls of the vessels, where the argyrophil fibrils were interlaced thereby losing their fibrillity. Thin fibers, staining weakly and decomposing into fragments were seen. The number of reticular cells was perceptibly increased. They were chiefly round in shape without outgrowths, less often elongated cells with outgrowths and depleted bodies were observed. The cells located at the site of the argyrophil follicles had an elongated shape with fine long outgrowths. The size of many reticular cells was reduced. Less often we came across large swollen cells containing many inclusions unequally impregnated with silver. Many cells were vacuolized, among them were cells having the appearance of mulberries. In some reticular cells a picture of caryorrhexis and caryopycnosis was found. In the majority of the reticular cells of the pulpy cords and sinuses fatty drops were present in very large amounts. Many cells disintegrated and in their place yellowish brown granules and clumps appeared. A considerable number of reticular cells of the pulpy cords and sinuses contained sometimes a larger and other times a smaller amount of iron. Iron was found only in some of the reticular cells of the follicles.

Thus, in the organs studied by us we observed severe necrobiotic, atrophic changes up to the point of disintegration of the parenchymal elements, leading to destruction and sclerosis of the organs. The severe necrobiotic and atrophic changes were found on the part of the reticulo-endothelium and the argyrophil substance and

the changes were greater the later the time of observation after decortication.

As a result of removal of the hemispheres, tissue dystrophy occurs which can subsequently be detected in macro and microscopical histo-structural changes. In particular, the reticulo-endothelial system and the fundamental argyrophil substance undergo severe histo-structural changes. The argyrophil fibers are subjected to decomposition and fusion, especially in the vascular walls and cellular membranes, as a result of which their permeability is disturbed. If one takes into account the significant role of the reticulo-endothelial system and the fundamental argyrophil substance in the defense reactions of the organism it becomes clear why such animals become exceptionally unstable to the influence of various harmful factors, in particular to infection.

After decortication of only one cerebral hemisphere we did not find any perceptible histo-structural changes in the organs of the dogs. This is due, in the words of I. P. Pavlov, to the fact that "absence (extirpation in experimental animals) of one hemisphere with the passage of time is almost or even completely replaced by the work of the remaining one", the unimpaired cerebral hemisphere so to speak levels out the functional defect arising after decortication.

Severe operational trauma with its profound "repercussion of the operational blow on the whole mass of the hemispheres" (I. P. Pavlov) and complications arising under the influence of the gashes aggravate the effect of decortication. Such a role is played by intoxication of the organism as a result of resorption of the varied products of decomposition of the brain tissue (neurotoxins) and the development of more or less marked internal hydrocephalus [8]. Despite all these possible factors one should nevertheless consider as the basic cause of the changes detected by us the fact of exclusion of the tropic influence of the cerebral cortex on metabolism in the organs and tissues. Bronchopneumonia in two of the above mentioned dogs, being an acute disease, could not produce atropic and sclerotic changes in the organs and they must pathogenetically be associated with decortication of the cerebral hemispheres.

The patho-morphological changes found by us in the cellular elements of the reticulo-endothelial system and the fundamental argyrophil substance, to a certain degree reflect, morphologically the severe tropic disturbances arising in the tissues and organs after decortication of the cerebral hemispheres.

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