ROLE OF THE VARIOUS PARTS OF THE BRAIN STEM IN THE DEVELOPMENT OF ACUTE PROLAPSE OF THE BRAIN

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Acute experiments were carried out on cats by a stereotaxic method to identify the morphological formations stimulation of which leads to the development of acute prolapse of the brain. These formations were found to be the lateral hypothalamic area, the zona incerta, zones H_1 and H_2, the parafascicular, interstitial, and interpeduncular nuclei, and the nucleus of Darkshevich. In response to stimulation of the lateral hypothalamic area, zona incerta, and zones H_1 and H_2, besides the characteristic histological changes of acute prolapse, signs of edema and swelling of the brain also were found.

KEY WORDS: *acute prolapse of the brain; stimulation of nuclei of the hypothalamus and mesencephalon.*

During operations on the basal regions of the brain a not infrequent complication is a rapid increase in the volume of the brain. This phenomenon was initially called acute cerebral edema [2, 12]. It has been observed after manipulations in the region of the hypothalamus, the cerebral peduncles, and the intrabulbar enlargement. According to Burdenko [2], the phenomenon of acute edema is reflex in origin and the regions of the brain mentioned above are reflexogenic zones of a special type. Further investigations in this field showed that this phenomenon has little in common with cerebral edema. The term "acute prolapse" has been suggested [1, 3, 4, 6]. It has been shown that acute prolapse is based, not on a disturbance of water metabolism, but on vascular changes; cerebral edema only rarely accompanies this phenomenon.

Acute prolapse has been obtained experimentally by gross mechanical stimulation of the hypothalamus and mesencephalon [5, 8, 9, 12], but these investigations have not yielded the answer to the question of which formations in the hypothalamus and mesencephalon participate in the development of acute prolapse of the brain. Only some more recent authors have attempted to determine their localization [7, 11], but further clarification of the problem is required.

The object of this investigation was to identify the formations of the hypothalamus and mesencephalon which participate in the development of acute prolapse of the brain.

EXPERIMENTAL METHOD

Acute experiments were carried out on 31 adult cats of which five were controls. Under hexobarbital anesthesia two burr-holes measuring 3 × 2.5 cm were drilled in the parietal regions and the dura was opened. A unipolar electrode 0.2 mm in diameter was inserted through one burr-hole in accordance with the stereotaxic atlas of Reinoso-Suarez [10]. Only one point in the brain stem beneath the electrode was investigated in each experiment. A current of 50 Hz, 5-8 V was used for stimulation. Stimulation began with a current of 100-200 μA. After a series of stimulations (6-10 stimulations, each lasting 10-30 sec) there followed an interval of up to 1 h in order to observe changes in the brain volume, after which the same series of stimulations was given with a current of 300-500 μA. The stimulated re-

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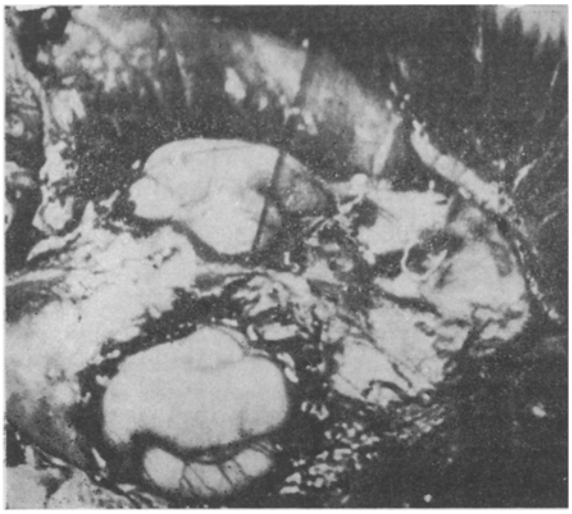

Fig. 1. Increase in volume of cat brain after stimulation of parafascicular nucleus.

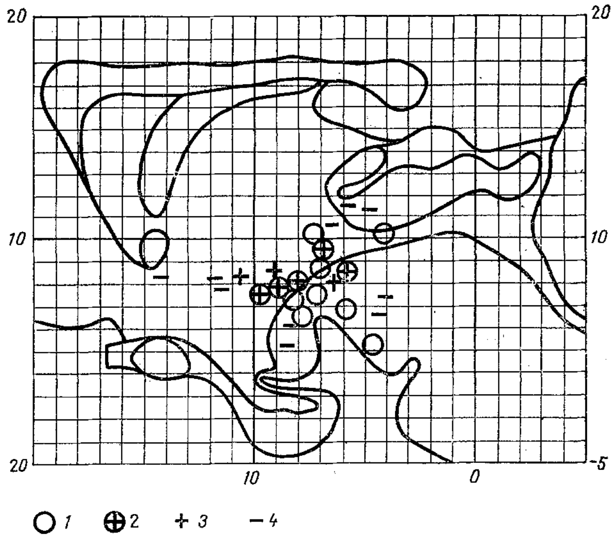

Fig. 2. Localization in cat brain stem of regions whose stimulation caused an increase in brain volume (1), an increase in the brain volume and the development of a morphological picture of edema and swelling (2), the development of a morphological picture of edema and swelling without any marked increase in brain volume (3), or had no effect (4).

Fig. 3. White matter of suprasylvian gyrus of cat brain after stimulation of lateral hypothalamic area. Stained with thionine by Nissl's method, 135 ×.

gion was coagulated by a current of 2 mA for 1.5-2 min 1-1.5 h after the end of stimulation and the animal was killed by decapitation. In the course of the experiment the blood pressure was recorded continuously by means of an electromanometer. All the manipulations described above except stimulation were carried out on the control animals. The brain was fixed in 5 and 10% formalin. Pathomorphological changes in the brain were studied in frontal celloidin sections 20 μ thick, stained with thionine by Nissl's method and with gallocyanin and chrome alum by Einarson's method, in cytoarchitectonic areas 4, 5, 6, 7, 17, and 22 of the cortex and underlying white matter. The location of the electrodes was determined in frontal celloidin sections through the brain stem stained with thionine by Nissl's method.

EXPERIMENTAL RESULTS

An increase in the volume of the brain accompanied by its protrusion into the burr-holes (Fig. 1) was observed in response to stimulation of the lateral hypothalamic area, the zona incerta, zones H_1 and H_2, the nucleus of Darkshevich, and the parafascicular, interpeduncular, and interstitial nuclei (Fig. 2). Swelling developed at once or within a few seconds after the beginning of stimulation. Dilatation of the pial vessels of the swollen part of the brain was observed. In most cases swelling of the contralateral hemisphere was more pronounced, and only occasionally was this process predominant in the ipsilateral hemisphere or equally marked in both hemispheres. In response to a single stimulation the height of the prolapse did not exceed 5-7 mm. As a rule 2-5 min after stopping the current, the protrusion completely or partly disappeared.

Protrusion of the brain was accompanied in all cases by the development of arterial hypertension. In individual cases the blood pressure rose by 80-100% but, as a rule, it returned to normal within 2-5 min after the end of stimulation.

By the end of series I or during series II of stimulation the protrusion usually became stable, and by the end of the experiment it reached a height of 10-15 mm. Against this background the fluctuations in brain volume with starting and stopping the current were less marked. The changes in blood pressure remained as before under these circumstances, i.e., it rose sharply during stimulation and then gradually returned to its original level.

Histological examination of the brain of these animals showed a number of small hemorrhages in the cortex and on the boundary between the cortex and white matter. Sometimes dilatation of the capillary network was observed. The combination of macroscopic and microscopic changes observed thus gives a picture similar to that of acute prolapse of the brain.

Microscopic changes in the brain in response to stimulation of the lateral hypothalamic area, the zona incerta, and zones H_1 and H_2 showed certain special features. Besides the changes already described above, in these cases evidence of edema and swelling of the brain was found. A diffuse loosening of the structure of the white matter (Fig. 3), widening of the perivascular spaces in the cortex, and changes in the neurons – swelling and vacuolation or, less frequently, shrinking – were observed. In some cases these changes were observed without any marked increase in brain volume in the course of the experiment.

A less clear picture of edema and swelling was observed in some cases after stimulation of the nucleus of Darkshevich and the parafascicular nucleus.

In response to stimulation of other brain-stem formations (the supramammillary nucleus, the anterior and posterior hypothalamic areas, the nucleus of the posterior commissure, the ventral thalamic nucleus, central gray matter, mesencephalic reticular formation, nuclei of the 3rd pair of cranial nerves) no increase in brain volume was found and the microscopic picture of acute prolapse or of edema and swelling of the brain did not develop.

The results of this investigation suggest that acute prolapse of the brain can develop as a result of stimulation of the lateral hypothalamic area, zona incerta, zones H_1 and H_2, the parafascicular, interstitial, and interpeduncular nuclei, and the nucleus of Darkshevich. It is impossible to compare these results with those obtained by Ischii et al. [7] and by Terara and Meuer [11]. In the first of these investigations the effect of point stimulation of the brain stem was assessed only by an increase in CSF pressure and it is therefore difficult to say whether prolapse or edema of the brain in fact occurred. The second paper cited above mentions an increase in brain volume in response to stimulation of nuclei of the brain stem, but because of the large number of points of stimulation in each experiment it is impossible to judge with confidence the role of the individual nuclei.

It can tentatively be suggested that arterial hypertension plays an important role in the development of acute prolapse, but it is impossible to account for all the changes observed in this way. The fact that the arterial pressure always returned to normal outside the times of stimulation and that protrusion of the brain in some cases remained permanent indicates that the above-mentioned brain centers may be capable of influencing the blood vessels of the brain, causing lasting dilatation of them. In response to stimulation of the lateral hypothalamic area, zona incerta, and zones H_1 and H_2, the phenomena of edema and swelling of the brain observed against the background of the other changes described above play an important role.

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EFFECT OF CATIONIC DYES ON BLOOD COAGULATION

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Experiments on rabbits showed that intravenous injection of dyes of the thionine series (toluidine blue, azure A, 1,9-dimethylmethylene blue) causes hypofibrinogenemia, a decrease in the concentration of factors of the prothrombin complex, thrombocytopenia, and a decrease in the index of platelet adhesion against the background of slowing of the time of thrombus formation. The blood heparin tolerance and the free heparin concentration were sharply reduced. It is suggested that the hypocoagulation effect of the cationic dyes on the blood is due to thrombocytopenia and to a decrease in the aggregating activity of the platelets.

KEY WORDS: *cationic dyes; coagulation; platelets.*

Toluidine blue and azure are known to form a complex with the heparin of the blood and they are responsible for its metachromatic staining [4, 5, 8, 14, 15]. Most methods of determining free heparin in the blood are based on this property [4, 5, 11]. There are indications of changes in blood coagulation under the influence of metachromatic dyes [10, 12], although the character of these changes differed in investigations by different workers.

The object of this investigation was to study the effect of various cationic dyes, giving a metachromatic effect, on the coagulating activity of the blood and functional properties of the blood cells.

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