THE EFFECT OF TRAINING ON THE RESISTANCE OF CHILLED RATS TO ANEMIA OF THE BRAIN

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It is known that, under conditions of artificial hypothermia, the organism is markedly more resistant to disturbances in the general or regional blood circulation, and, in particular, to anemia of the brain. However, in a number of cases an increase is necessary in the resistance of the chilled organism to deep hypothermia and hypoxia. In previous investigations, performed on rats, it was shown that this can be accomplished by training the animals for hypoxia, hypercapnia, and chilling [2, 3], as well as by preliminary maintenance of the animals with a low temperature of the ambient air [1].

We considered it of theoretical and practical interest to elucidate the possibility of increasing the animal's resistance to lethal blood deprivation of the brain.

EXPERIMENTAL METHOD

Anemia of the brain was caused by occluding 4 cervico – spinal arteries (two carotids, right subclavicular and left vertebral), ensuring practically complete stoppage of the inflow of blood into the brain. The skin incision, isolation of the arteries, and application of the ligatures was carried out under superficial ether-oxygen narcosis in the control experiments, while in the experimental group it was done with artificial hypothermia, at a body temperature of 13-16°. Rats weighing 150 - 200 g were chilled in a hermetically sealed vessel inside a refrigerator to 22-20°, under conditions of increasing hypoxia and hypercapnia, and subsequently, down to 15-16° (using ice). At 15-20 min before applying the ligatures, 1 ml of 40% glucose was injected subcutaneously. Artificial respiration with oxygen was accomplished in the chilled rats by the use of an apparatus for resuscitation of newborns. When the animals were withdrawn from the artificial hypothermia, we applied local warmth to the thoracic cage.

In order to elevate the resistance of the rats to deep hypothermia and hypoxia, a portion of the animals were subjected to a preliminary treatment: 1) training for hypoxia, hypercapnea, and chilling, accomplished by 2-3 previous chillings under the conditions indicated above, and 2) maintenance at a temperature of from – 5° to 10°, over a period of 1-1½ months.

EXPERIMENTAL RESULTS

Occlusion of 4 cervico-spinal arteries at normal body temperature led to the death of the animals in minutes in all the experiments [15]. Even at 3-10 sec after application of the last ligature, the ophthalmic and flexor reflexes disappeared in the rats, and spasms and marked panting were seen. The initial period, characterized by the development of excitation of the central nervous system, was quickly replaced by increasing inhibition. After 1½ - 6 min (an average of 3 min), respiration disappeared completely, and, almost in all cases, normal cardiac activity also ceased simultaneously. The bioelectric activity of the heart disappeared completely 6-13 min after occlusion of the vessels.

Removal of the ligatures in the rats 5 min after occlusion of the vessels, with subsequent artificial respiration with oxygen, did not restore complete cardiac activity and blood circulation.

With occlusion of 4 cervico-spinal arteries in the rats that were chilled to 1-14°, the initial period of excitation was absent in the majority of cases. Brief motor unrest, following application of the ligatures, was noted in only 7 experiments out of the 20. The ophthalmic reflexes and reflexor reflexes of the anterior extremities disappeared after 2-5 min, but respiration stopped considerably later – after 5-20 min. The changes in the EKG were analogous to those normally observed with chilling of rats to 14-15°, under conditions of hypoxia and hypercapnia.

In the experiments involving stoppage of the blood supply to the brain for 60-90 min, 1 hypothermic rat survived out of 6, while with occlusion of the vessels for 30-40 min, 8 out of 14 rats survived. It must be noted that in the latter group, out of the 6 that died, 2 rats died 12-20 h after the operative procedure, and 2 – after 2 days. Apparently, the application of supplementary therapeutic measures in this period would decrease the number of deaths.

In the rats with elevated resistance to chilling, after application of the ligatures to 4 cervico-spinal arteries, no spasms were noted in a single one of the experiments; a weak motor unrest was observed in only one rat out of 29. Thus, in the rats of this group, nervous system inhibition was the most absolute, and their resistance to anemia of the brain was elevated. While in the previous series of experiments, after 30-40 min of anemia of the brain, almost 50% of the animals died, in this group all the rats survived after 40-90 min of complete anemia of the brain.

Thus, the resistance of rats to lethal anemia of the brain, produced under conditions of artificial hypothermia, can be elevated markedly by training for hypoxia, hypercapnia and chilling, as well as by preliminary maintenance of the animals under cold conditions for 1-1½ months.

SUMMARY

Occlusion of two carotid, right subclavicular and left vertebral arteries at normal body temperature leads to the death of albino rats in 3-5 min. Application of deep artificial hypothermia (13-15°C) prolongs the possible periods of arterial occlusion. However, arrest of cerebral blood supply for 30-40 min in these conditions is also incompatible with the life of almost half of the animals. Resistance of rats to cerebral anemia may be raised by preliminary training to hypoxia, hypercapnia and chilling, as well as by placing the animals in conditions of cold for 1-1½ months. Complete restoration of the viability of such rats was observed after the arrest of cerebral circulation at a temperature of 13-15°C for 60-75 min, and in individual experiments – for 90 min.

LITERATURE CITED

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