EFFECT OF HYPOTHERMIA AND SPONTANEOUS REHEATING ON CONTENT OF SOME CARBOHYDRATE-PHOSPHORUS METABOLITES IN THE SUSLIK BRAIN AT DIFFERENT AGES

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The glucose and lactic acid concentrations in the suslik brain decrease with age. In animals aged 1 month the concentration of high-energy phosphates is higher than in animals with vision and sexually mature susliks. Hypothermia abolishes age differences in the level of high-energy phosphates in the brain.

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The object of this investigation was to study the dynamics of some carbohydrate-phosphorus brain metabolites during postnatal development under normal conditions, and during hypothermia and spontaneous reheating. A study of brain metabolism during hypothermia in ontogenesis, i.e., during the appearance and development of body temperature regulation, may help to elucidate the mechanism of action of hypothermia.

EXPERIMENTAL METHOD

Experiments were carried out on little susliks (Citellus pygmaeus Pallas) of three ages: 1) animals just capable of vision, 2) aged 1 month, 3) adult sexually mature animals. The susliks were cooled to a rectal temperature of 10°. The cooling was carried out either by placing the susliks in a refrigerator at —10° (groups 1 and 2) or by means of cold blankets in which water circulated at a temperature of 4° (group 3). Spontaneous reheating of the animals took place at room temperature. When the required state of the animals was achieved,they were quickly decapitated, the head frozen in liquid nitrogen, and the brain extracted and ground into powder during continuous cooling with liquid nitrogen. In a parallel series, control normothermic animals of the same age were decapitated. Proteins were precipitated with 5 % TCA. Glucose in the protein-free filtrate thus obtained was determined by the Hagedorn—Jensen method, inorganic phosphorus by the Fiske—Subbarow colorimetric method, creatine phosphate by Alekseeva's method, the total ATP + ADP after hydrolysis for 10 min from mercury residues in 1N acid solution, and lactic acid by the Barker—Summerson method.

EXPERIMENTAL RESULTS

The experimental results are given in Table 1. The concentrations of glucose and inorganic phosphorus in the suslik brain decrease with age ($P < 0.05$). The level of creatine phosphate, ATB + ADP, and lactic acid is highest in animals aged one month. This agrees with published data (obtained in rats and rabbits) showing a sharp increase in respiration [1, 2, 3] and in the activity of some oxidative enzymes [1] by this time, and an increase in the intensity of anaerobic glycolysis [6] and esterification of inorganic phosphorus, as a result of which the total concentration of high-energy phosphates and the intensity of their metabolism increased [4, 5].

In hypothermia the ATP + ADP concentration in the brain of susliks just acquiring vision and of adult animals was increased by 160 and 45.2 % respectively, and the concentration of creatine phosphate by 109.7 % (in the adults: $P < 0.05$). The slight increase in the glucose concentration in the brain of the month old animals (by 11.1 %) and adults (by 20.4 %) was evidently due to a decreased intensity of glycolysis, as indicated by a decrease in the lactic acid level.

During spontaneous reheating the concentration of high-energy phosphates in the brain of the adult animals fell by comparison with that in the animals during hypothermia, and settled at about the control level.

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TABLE 1. Concentration (in mg %) of Inorganic Phosphorus, Creatine Phosphate, ATP + ADP, Glucose, and Lactic Acid in Brain of Susliks of Different Ages under Normal Conditions, during Hypothermia (10 %) and during Recovery from It (M ± t; from 8 to 10 animals)

Age and state of animals	Inorganic phosphorus	Creatine phosphate	ATP+ADP	Glucose	Lactic acid
Just acquiring vision:					
control	46,6±3,1	15,2±1,5	9,5±0,5	134,3±6,1	
hypothermia	10,7±0,8	15,2±0,6	24,7±1,5	106,3±3,5	
Month old:					
control	33,2±1,0	22,9±1,3	24,6±1,3	114,4±5,3	52,7±1,3
hypothermia	27,3±1,5	16,0±0,9	25,2±1,5	127,1±5,5	22,1±1,1
reheating	20,5±1,0	17,8±0,8	29,9±1,4	176,9±10,1	17,3±1,3
Adult:					
control	15,3±1,3	6,2±0,9	15,9±0,8	95,6±3.8	32,8±1,1
hypothermia	13,0±0,9	13,0±0,9	23,1±1,0	115,1±2,7	20,3±1,3
reheating	22,9±1,0	10,0±0,9	12,6±0,7	116,4±4,5	28,9±1,9

The decrease in concentration of labile phosphates in the brain of the adult animals was accompanied by an increase in the concentration of inorganic phosphorus by 76.1 % compared with hypothermia. The glucose concentration in the brain was considerably higher in the month old susliks (by 39.2 %), and this was accompanied by a further decrease in the lactic acid concentration (by 21.7 %).

The absolute values and dynamics of carbohydrate-phosphorus metabolites in the brain determined in month old and adult susliks during hypothermia and reheating did not coincide. This presumably indicates that the carbohydrate-phosphorus metabolism of month old susliks has not completely attained the adult level.

It is interesting to note that in hypothermia the concentration of creatine phosphate and ATP + ADP in the suslik brain at different ages is established at about the same level, whereas in the control animals the concentrations of these compounds varied very considerable.

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