MODULATION OF CARBOHYDRATE AND LIPID METABOLISM IN RATS DURING ADAPTATION TO HIGH ALTITUDE HYPOXIA

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In energy supplying of cells and whole organism under hypoxia, carbohydrates and lipids can serve as two main energy substrates. It is known that fat oxidation is more dependent on oxygen availability than the oxidation of carbohydrates. Because, it is logical to assume that carbohydrate metabolism is prevailed under high altitude hypoxia. However, the data in this behalf are contradictory. Recently we found hypoglycemic reaction in humans and in rats which staying in the middle mountain. Therefore, the aim of our investigation was to characterize hypoglycemia development, and modulation of carbohydrate and lipid metabolism during adaptation to moderate chronic hypoxia. Male Wistar rats acclimatized to high altitude hypoxia (2100 m) were exposed acute hypobaric hypoxia séance in barochamber (5600 m during 3 h). Sea level rats were investigated during 3 week adaptation to high altitude hypoxia (2100 m). Expression of insulin independent glucose transporter GLUT-1 and insulin dependent glucose transporter GLUT-4 mRNA in tissues was determined by real time PCR. Mitochondrial respiration in heart and liver was assessed by polarograph method (Chance) using different metabolic substrates. It was shown that in acclimatized rats, GLUT-1 mRNA expression was significantly increased in the heart, without changes in GLUT-4 expression. After acute hypoxia, hypoglycemia was intensified; mRNA expression of GLUT-1 was not changed in the lungs and hearts, whereas the expression of GLUT-4 was increased by 3-5 days. These data indicate the activation of insulin independent way of glucose metabolism in chronic hypoxia, and activation of insulin dependent way in acute hypoxia. In nonadapted rats, we found activation of carbohydrate metabolism at beginning of adaptation, and shift to lipid substrate cleavage in 2-3 week of adaptation. It may be due to hypoxic induction of target genes and remodeling of cardiorespiratory system, which only in this period get supply the necessary level of oxygen delivery. We propose that hypoglycemia may be a trigger starting metabolism rebuilding to lipid substance cleavage. Thus, adaptation to moderate high altitude hypoxia is accompanied with consequent intensification of lipid metabolism, and relative decrease in carbohydrate metabolism. Carbohydrate substrates as more mobile and easily accessible reserve provide energy spending of the body in the early period of adaptation, and utilization of lipid substrates and reinforcement of fat metabolism is necessary for long-term adaptation.