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HYPERGRAVITY INDUCES CHANGES OF ERYTHROCYTE MEMBRANE AND ANTIOXIDANT POTENTIAL OF MICE HOUSED IN THE MDS FACILITY

Abstract

To sustain safe human space exploration, it is important to understand how the different effectors, including gravitational forces, influence organisms. Altered levels of gravity affect the physiological function of multiple tissues, cells, and organs in living organisms. Many adverse conditions present in Space, such as hypoxia, hypothermia, and microgravity, cause integrated alterations in the lipid membrane composition, inducing greater sensitivity to oxidative stress. Indeed, previous studies, suggested that microgravity modifies the permeability of the plasma membrane and cellular metabolism in erythrocyte, modifying cholesterol and phospholipid levels. In addition, hypergravity also affects the physiological functions of tissues and organs; furthermore, the evaluation of the effects of the hypergravity is a fundamental step towards complete knowledge of the physiological response to altered gravity. Aim of this study was to investigate in vivo the effects of hypergravity on lipid phenotype and metabolism in mice erythrocytes. Animals were housed in the Italian Space Agency's Mice Drawer System (MDS), a facility designed to house rodents on the ISS and adapted by Thales Alenia Space to the Large Diameter Centrifuge (LDC-ESA), to expose mice to a 3xg environment. Vivarium animals and MDS-like cage animals were compared as controls. After 30 days of experiment a tissue sharing protocol allowed us to purified and analyzed the red blood cells.. The membrane lipid phenotype was assessed by gas-chromatography and liquid-chromatography. To analyze the impact on oxidative homeostasis, the hemolyzed fractions were used to test antioxidant enzyme activities. Our results show that the exposure of mice to an altered gravity induced a modification in the fatty acid composition of 3xg mice compared to control mice, indicating a direct effect of the increased level of gravity. The cholesterol content in membranes was significantly

increased. To evaluate the effect of hyper-gravity conditions on the animal's inflammatory and metabolic processes, the ratio between inflammatory eicosanoids and anti-inflammatory eicosanoid precursors was calculated, and a slight reduction was observed. These findings could be due to a process of metabolic compensation during long-term exposure that leads to a resolution of inflammation. To evaluate the impact of fatty acid composition on the potential level of oxidative stress, we calculated the peroxidability index (PI), that was significantly increased under 3xg conditions. The antioxidant activity indicate that GSH peroxidase was significantly increased in 3xg mice compared to control mice. This study demonstrates that hypergravity induces changes in both lipid composition and antioxidant system of erythrocytes.