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RAPID FLUID SHIFTS INDUCED BY PARABOLIC FLIGHTS ALTER THE THERMAL BALANCE IN HUMANS

Abstract

Background: While being exposed to microgravity astronauts complain about thermal discomforts: they report about cold acres and overheated heads. Also, it is well known that astronauts develop puffy faces and bird legs. Studies undertaken during short-term and long-term microgravity evidenced that this clinical appearance is due to fluid shifts into cranial direction following the absence of the hydrostatic pressure gradient along the body axis. So far, no study evaluated the time course of fluid shifts and changes in core temperature at different sites of the body. Furthermore, there has been no quantitative analysis of body core temperature changes in humans while in microgravity. This study aimed to show the narrow time frame within fluid shifts and temperature changes happen.

Methods: We studied 12 healthy subjects during a series of parabolic flights. They completed a protocol of up to 15 parabolas of changing gravity in upright position (1G, 1.8G, 0G). We assessed heart rate (HR), core temperature at the head and sternum, microcirculation (relative hemoglobin concentration - RAH) at the lower leg and the head. A infra-red camera captured thermographic images of the face and neck in order to evaluate fast changes in skin temperature.

Results: Analysis of the microcirculatory data revealed an increase in RAH from 59+/-4 to 68+/-5 (+15%) at the head during 0G compared to 1G. The lower leg showed a decrease in RAH from 82+/-4 to 72+/-4 (- 12%, $p<0.05$). The core temperature at the head increased during 0G compared to 1G. This finding is supported by an increase in skin temperature at distinct areas of the face (peri-oral, temporal, perio-cular) as revealed by the thermo-grafic images. Changes in microcirculation occurred before the core temperature in the head rose. The average time delay between these two findings was < 5 sec.

Discussion: The results suggest that rapid fluid shifts change the microcirculation of the skin. Since the relative fraction of hemoglobin in the blood is constant, the increase in RAH has to be due to an increased perfusion of the skin at the head. Vice versa, we can reason that the decrease in RAH at the lower leg is caused by an attenuated perfusion. Increased skin temperatures, which were rising immediately after the perfusion of the skin went up at the head, revealed the elevated heat emission induced by rapid fluid shifts to cranial direction and the close timely connection of these two physiological processes.