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PERIPHERAL COOLING AS A COUNTERMEASURE TO ORTHOSTATIC STRESS DURING PARABOLIC FLIGHT – THE COOLFLY EXPERIMENT

Abstract

Objective: Cardiovascular stability is vital for human spaceflight success. Dynamic acceleration profiles cause peripheral blood pooling, leading to cardiovascular instability and sudden drops in blood pressure. This study investigates the effectiveness of peripheral cooling as a countermeasure to changes in g-force during parabolic flight. We hypothesize that peripheral cooling will reduce peripheral blood pooling, ultimately leading increased cardiovascular stability.

Methods: Six healthy participants, including three men and three women, took part in the 39th DLR parabolic flight campaign. During the experiment, a peripheral skin cooling system was applied to the legs, thighs, and waist of one participant during the first 15 parabolas of the flight, while another participant wore the cooling system for the subsequent 15 parabolas. Each participant acted as their own control in a cross-over design. To examine the effects of cooling on the cardiovascular system and peripheral venous pooling, we employed continuous non-invasive techniques to monitor blood pressure, pulse wave velocity, and peripheral perfusion using laser doppler and near-infrared spectroscopy. Near-infrared spectroscopy and laser doppler were attached to the legs, while pulse wave analysis and pulse transit time were recorded on the subjects' arm. Additionally, we evaluated the body composition status of the participants using bioelectrical impedance analysis before and after the flight.

Results: Our findings demonstrate the favourable impact of peripheral cooling on overall perfusion stability and blood pressure under hyper-gravity conditions. The most pronounced cardiovascular effects were observed during the transition phases into hyper-gravity, which resulted in considerable reductions in blood pressure, peripheral, and microvascular perfusion, along with a prolongation of both peripheral and central pulse wave velocity. However, the application of the peripheral cooling system successfully mitigated these effects by reducing the amplitude of change between micro/normo- and hyper-gravity and elevating baseline perfusion and blood pressure levels.

Conclusion: In summary, this study demonstrated the feasibility and potential benefits of the peripheral cooling system as a countermeasure for use in parabolic flight. This system holds promise for improving cardiovascular stability and could be valuable for astronauts, military pilots, and patients after prolonged bedrest, as it does not rely on pharmacological interventions, thereby carrying a lower risk of side effects or harmful application. To further strengthen the rigor of our results, two more parabolic flight campaigns involving 12 additional subjects are planned. These future studies will help us to gain a more comprehensive understanding of the effectiveness and safety of this countermeasure system.