‘COOLFLY’ – Countermeasure against cardiovascular instability in changing g-forces

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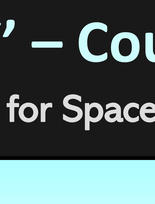
Introduction

Astronauts and military pilots are exposed to highly dynamic acceleration profiles which leads to peripheral blood pooling, resulting in cardiovascular instability.

We hypothesized that peripheral cooling would minimize peripheral blood pooling during hyper-gravity.

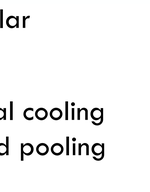
Results of this study will aid in the development of new countermeasure systems for human spaceflight.

Materials and methods



6 subjects participated in a parabolic flight campaign. Every subject was monitored during 15 parabolas with peripheral cooling, and during another 15 parabolas <u>without</u> peripheral cooling.

Each subject served as their own control in a cross-over design.



Peripheral skin cooling was achieved with “carbon cool” garment and topical application of menthol gel.

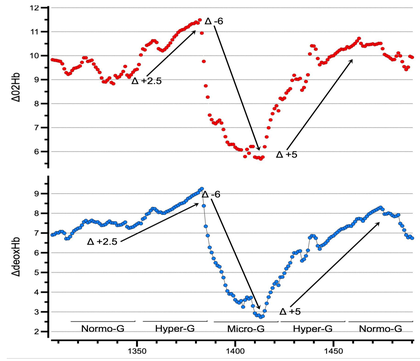


Continuous non-invasive blood pressure, pulse wave velocity and peripheral perfusion (near infra-red spectroscopy and laser doppler) were monitored.

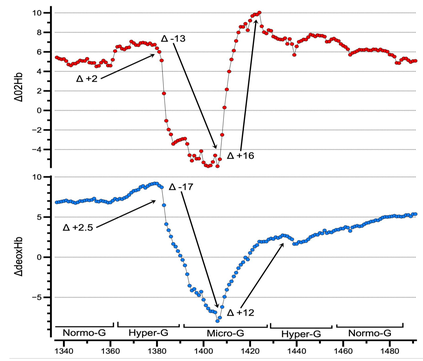
Results — Flight with peripheral cooling vs. control flight without peripheral cooling

<u>Vasoconstriction – Difference in Peripheral Tissue Oxygenation, Near Infrared Spectroscopy</u>:

Flight with peripheral cooling



Control flight <u>without</u> peripheral cooling



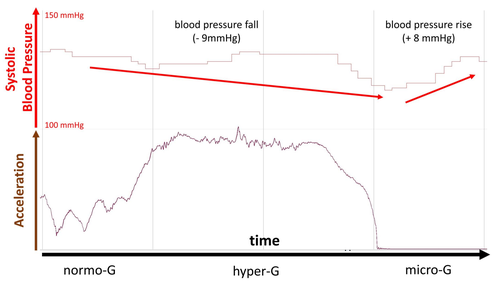
ΔO2Hb – oxygenated haemoglobin

ΔdeoxHb – deoxygenated haemoglobin

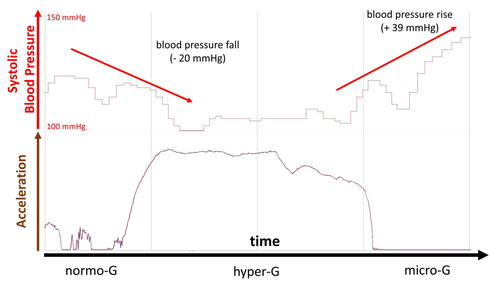
Peripheral cooling visibly limits the variability of both the oxygenated and deoxygenated hemoglobin during changes in gravitational force, indicating a reduced change in perfusion during orthostatic challenge.

<u>Continuous Blood Pressure Measurement</u>:

Flight with peripheral cooling



Control flight <u>without</u> peripheral cooling



The baseline systolic pressure was increased during the flight under peripheral cooling. Further, the blood pressure variability was visibly reduced during the peripheral cooling flight, indicating a marked reduction in reaction to orthostatic challenge in the cooled condition.

Conclusions



Peripheral vasoconstriction is significantly enhanced under cooled conditions.

Cooling effectively stabilizes cardiovascular function, particularly by maintaining blood pressure.

Peripheral cooling appears to be a safe and promising method for enhancing cardiocirculatory performance during acute gravitational changes.

The integration of blood pressure-sensitive cooling devices during landing and post-flight phases may represent a future strategy for preventing orthostatic intolerance.

Acknowledgments

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noveSpace

DLR Deutsches Zentrum für Luft- und Raumfahrt

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