Paper ID: 71988
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IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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CARDIOVASCULAR DECONDITIONING DURING THE ARTIFICIAL GRAVITY BED REST EUROPEAN SPACE AGENCY (AGBRESA) STUDY – INSIGHTS FROM 4D-FLOW CARDIAC MRI

Abstract

Long-duration spaceflights, and especially microgravity, lead to the deconditioning of many physiological systems, including the cardiovascular one. It has been suggested that exposure to artificial gravity (AG) might help maintaining cardiovascular integrity and health.

As part of the AGBRESA study, 24 subjects (16 males, 8 females) were investigated during 60-day strict -6 head-down-tilt bed rest (HDBR). Subjects were equally distributed into three groups. Two groups underwent daily continuous (30 minutes) or intermittent (6x5 minutes) AG through short-arm centrifugation with 1 g at the heart and 2 g at the feet, while the third group was a control group with no countermeasure. 4D-flow cardiac MRI was acquired in supine position before (-9 days), after (+4 days), and at several timepoints of the HDBR phase (5, 21, and 56 days). Post-hoc image analysis was performed with dedicated commercial software. The cardiovascular effects of HDBR and the assessment of the countermeasure efficacy were determined from flow and vascular parameters: heart rate, stroke volumes (SV), aortic pulse wave velocity (PWV), and wall shear stress (WSS). Results are presented as relative differences between day 56 of HDBR and baseline as median [quartiles].

No intergroup differences were found at any timepoint, so data from the three groups were pooled. Total, lower body, and upper body SV all decreased by the end of HDBR compared to baseline (-23% [-16%;-33%], -30% [-22%;-35%], and -20% [+11%;-30%], respectively). However, heart rate increased (+8% [+1%;+15%]), which helped ensuring a relatively constant blood supply to the upper body and, ultimately, to the brain. The aortic PWV also increased during HDBR compared to baseline (+7% [+0%;+10%]), while the mean aortic WSS decreased (-15% [-3%;-20%]).

The inefficacy of the chosen countermeasure agrees with findings from other teams involved in the same study. It supports the fact that the level and duration of AG chosen in the two countermeasure

groups were not sufficient to prevent cardiovascular deconditioning. The smaller decrease of SV in the upper vs. lower body is certainly a consequence of cerebral autoregulation mechanisms. Aortic WSS and PWV changes are subclinical and probably the sole consequence of hemodynamic – rather than structural – changes. In addition, most of the modifications tended to or returned to baseline 4 days after HDBR, thus indicating no permanent cardiovascular adaptations following 60 days of strict HDBR.