Microgravity Exposure Alters Sympathetic Modulation of Ventricular Repolarization Quantified from the ECG via Periodic Repolarization Dynamics

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Background: Prolonged microgravity exposure produces cardiovascular alterations, including orthostatic intolerance due to dysregulation of autonomic modulation of the cardiovascular system. Recent studies suggest that sympathetic modulation can be assessed non-invasively by measuring the index of Periodic Repolarization Dynamics (PRD), an ECG index quantifying the low-frequency components of the beat-to-beat angular changes in ventricular repolarization. The aim of this study is to quantify changes in PRD to assess the effects of simulated microgravity in the sympathetic control of cardiac electrical activity.

Materials and Methods: 22 male volunteers were enrolled in a long-term (60 days) head-down bed-rest (HDBR) study to emulate microgravity effects. The group was randomly distributed into a control subgroup (CTRL) and a counter-measure subgroup (JUMP), who exercised on a sledge jump system. 12-lead ECG signals recorded both at baseline and during a tilt test before (PRE) and after (POST) the bed-rest period were analyzed. These were delineated using a wavelet-based automatic system combined with post-processing rules. PRD was computed from the series of angular variations between consecutive T-waves by applying a spectral analysis.

Results: A very notable increase was found in the baseline PRD values measured at POST-HDBR with respect to PRE-HDBR: 2.41[3.77] deg2 vs 1.99 [2.02] deg2 (median[IQR]) for the CRTL subgroup and 2.83[2.63] deg2 vs 1.93 [1.16] deg2 for the JUMP subgroup. When PRD was evaluated at the end of tilt phase, a statistically significant increase was found in POST-HDBR with respect to PRE-HDBR (3.90[3.11] deg2 vs 1.80[2.57] deg2) for the CRTL subgroup, but this was not observed for the JUMP subgroup (1.91[1.85] deg2 vs 2.24[4.00] deg2).

Conclusions: Simulated microgravity has an effect on ventricular sympathetic modulation that is measurable by PRD. Significantly increased PRD values are found after 60-day exposure to simulated microgravity. A jump-based countermeasure is only partially effective in counteracting such an effect.