Cardiac Electro-Mechanical Adaptations to 21-Day Head-Down Tilt Bed Rest and Gravitational Reinstatement

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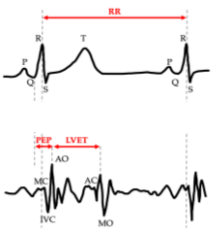
Microgravity exposure induces cardiovascular deconditioning with impaired adaptation upon return to normal gravity. Head-down tilt bed rest (HDT) is a ground-based model to investigate these effects. While electrical markers have been widely studied, less is known about cardiac mechanical changes during HDT and recovery. We therefore investigated heart rate (HR) and seismocardiographic (SCG) biomarkers during a 21-day HDT campaign conducted by the Italian Space Agency within the SCIENCE FOR BED-REST program.

Twenty healthy volunteers (11 men, 9 women) underwent 21 days of HDT. Continuous 24 h ECG (1024 Hz) and SCG (256 Hz) were recorded (Ecg-Move4, Movisens GmbH) at baseline (BDC), on HDT days 5 and 19, and on the first day after HDT (R+1). HR was derived from ECG beats detection. On SCG, an ECG-based template-matching approach identified fiducial points for isovolumetric contraction (IVC), aortic valve opening (AO) and closure (AC), and pre-ejection period (PEP), left ventricular ejection time (LVET), and IVC-AO systolic amplitude were derived. The effect of HDT was assessed (Friedman, $p<0.05$, Bonferroni-corrected post-hoc Wilcoxon signed-rank), and comparisons between genders (Mann-Whitney U, $p<0.05$).



Fiducial points on ECG and SCG.

Main alterations emerged at gravitational reinstatement. At R+1, daytime HR increased versus BDC by +31.9% in males and +22.3% in females; nighttime HR increased by +14.6% and +21.7%, respectively. Daytime LVET increased at R+1 by +14.1% in males and +13.3% in females. IVC-AO amplitude decreased during bed rest both during the day (males up to -16% and females -22.2% at BR19), and at night (up to -28% in males at BR19 and -39% in females at BR5), with an inverse trend observed at R+1 (up to +22% in males), except for the female group at night (-16%).

These findings suggest that the largest cardiac electromechanical adjustments occur during return to normal gravity.