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MICROGRAVITY-INDUCED ALTERATIONS OF CARDIAC MECHANICAL ACTIVITY ASSESSED  
THROUGH THE ANALYSIS OF SEISMOCARDIOGRAPHIC SIGNAL MORPHOLOGY**Abstract**

Head-Down Tilt (HDT) bed rest induces alterations in cardiovascular activity, reproducing the effects of prolonged permanence in microgravity. When positioned in contact with the thorax, inertial sensors can measure the precordial vibrations generated by cardiac contraction. The resulting signal is known as seismocardiogram (SCG). This study evaluates cardiac activity during prolonged HDT by assessing alterations in the SCG signal morphology. Also, the effect of high-intensity physical exercise is evaluated. 23 healthy male volunteers were enrolled in a 60-day HDT bed rest: 12 were assigned to the physical exercise group (JUMP), and 11 to the control group (CTRL). Synchronous ECG and SCG acquisitions were performed before HDT (BDC), on the 5th (HDT5), 21st (HDT21) and 58th (HDT58) day of HDT, as well as one (R+1) and four (R+4) days following re-ambulation. The protocol included a supine controlled breathing session consisting of 10 repetitions of 4-second length breathing cycle, corresponding to a physiological breath duration. Single SCG beats were identified using the ECG signal as reference and used to compute an SCG-beat template, on which the points of isovolumetric contraction (IVC), aortic valve opening (AO) and closure (AC) were identified. Temporal (tIVC-AO, tIVC-AC) and amplitude (AMPAO-IVC, AMPAO/AMPAC) parameters were computed, as well as the IVC-AO slope. Two-factorial linear mixed models ( $p < 0.05$ ) statistical analysis was performed, including acquisition epoch and group as fixed factors. Post-hoc tests were implemented in case of significance. The temporal intervals tIVC-AO and tIVC-AC remained unvaried throughout the experiment in both CTRL and JUMP groups. Only at HDT21 a difference between the two groups was found in tIVC-AO (CTRL: 46[43;51] ms; JUMP: 25[23;45] ms). In CTRL, the AMPAO-IVC appeared affected by HDT (HDT5 versus BDC: -36.4[-56.0;-17.3]%; HDT58 versus BDC: -32.7[-46.9;-15.9]%), while it remained unchanged in the JUMP group. This caused the presence of group effect in the IVC-AO slope, significantly reduced in CTRL at HDT5 (-41.3[-46.6;-24.4]%) and HDT58 (-38.4[-58.7;-17.7]%) compared to BDC. Possible effects of cardiac deconditioning elicited by 60-day HDT bed rest were observable through the morphological analysis of the SCG signal, particularly in IVC-AO amplitude and slope. Their decrease observed in the CTRL group could be related to the larger reduction (-22%) in stroke volume measured by MRI in the same subjects,

compared to the JUMP group (-12%), confirming the effectiveness of the applied countermeasure on the cardiovascular system in counteracting HDT-induced deconditioning.