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HEART KINETIC WEARABLE MONITORING VS C-MRI: CARDIAC DECONDITIONING DURING THE 60-DAYS ESA-RSL HEAD-DOWN BED-REST STUDY.

Abstract

Aims. Long duration head-down (-6 degrees) bed-rest (HDBR) generates cardiac deconditioning that simulates some aspects of a long duration space flight. The effects of 60-days HDBR on the cardiac function were assessed by a non-invasive wearable heart kinetic (HK) cardiac monitoring method. The Heart-Kinetic technique is a major improvement of past Ballistocardiography (BCG) and Seismocardiography (SCG). Results are compared to phase-contrast (PC) MRI-derived stroke volume (SV). Our hypothesis was that cardiac deconditioning would result in lower stroke volume (SV) and lower kinetic energy of the heart used as a marker of cardiac contractility. Methods. 24 healthy male volunteers (mean age 286) were enrolled in the ESA-RSL-BR study. A controlled breathing (CB) protocol (7.5 breath per minute) was imposed while acquiring HK before (PRE) and after 58-days (HDT58) of BR, on the same day as the PC-MRI protocol. For the CB protocols, a miniature accelerometer was placed in the lumbar region of the subject to record the overall linear and angular accelerations in a 6-degrees of freedom (6-DOF). Seismocardiogram (SCG), ECG, ICG and nasal thermistor signals were recorded using Cardiovector, a portable digital system developed for the international space station. The calibrated 3-linear and 3-rotational components of acceleration were integrated, squared and combined together with the Newtonian equations of kinematics to provide total heart kinetic energy (HKtot), the sum of HKrot and HKlin. PC-MRI aortic images were acquired on a Siemens mMobigraph 3T and velocities integrated over the aortic lumen area to allow computation of SV. Results. After 58-days HDBR, compared to baseline values a significant ($p<.05$, paired t-test) decrease in SV (22%), was accompanied by a similar decrease in HKtot (27%) and HKrot (30%) but not in HKlin. Conclusions. This is the first study assessing HK as a marker of cardiac contractility together with PC-MRI during HDBR deconditioning. Total heart kinetic energy decrease was mostly due to a decrease in rotational twist of the heart and associated with a similar decrease in SV. As this could not be seen with the linear or uni-dimensional BCG, this suggests the great advantage of HK over past BCG for monitoring cardiac functional deconditioning. The Heart-Kinetics technology utilized in this study for simulated space research is being tested for clinical trials.