Paper ID: 53884
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

Author: Mr. Jeremy Rabineau
Université Libre de Bruxelles, Belgium

Mr. Amin Hossein
Université Libre de Bruxelles, Belgium
Ms. Federica Landreani
Politecnico di Milano, Italy
Ms. Roberta Egoriti
Politecnico di Milano, Italy
Prof.Dr. Enrico Gianluca Caiani
Politecnico di Milano, Italy
Prof. Jens Tank
DLR (German Aerospace Center), Germany
Prof. Philippe van de Borne
Université Libre de Bruxelles, Belgium
Dr. Pierre-François Migeotte
Université Libre de Bruxelles, Belgium

CARDIOVASCULAR DECONDITIONING DURING TWO MONTHS OF BED REST: COMPARISON OF WEARABLE MONITORING BASED ON BALLISTO- AND SEISMO-CARDIOGRAPHY WITH MRI

Abstract

Introduction & Aim:

Long duration head-down (-6^o) bed-rest (HDBR) induces cardiovascular changes that simulate some aspects of space flights. The effects of a 60-day HDBR on the cardiovascular system were assessed with Cardiovector, a non-invasive wearable system combining multi-dimensional (6D) ballistocardiography (BCG) and seismocardiography (SCG), measuring cardiac induced vibrations on the surface of the skin. Cardiac MRI protocols were conducted in parallel, with the hypothesis that the expected decrease in stroke volume (SV) and left ventricle (LV) mass would correspond to a decrease in the BCG and SCG metrics. In addition, efficiency of the ESA-RSL JUMP countermeasure was evaluated.

Methods:

23 healthy males were enrolled in the study and randomly assigned to either a training group, performing regular sessions of physical exercise (JUMP), or to a control group (CTRL). A controlled breathing protocol (4, 6, 8, 10 seconds cycles) was imposed while recording 6D BCG (in the lumbar region) and dorsoventral SCG (at the apex) in parallel to ECG and plethysmography. Ensemble average was computed for all channels and respiratory protocols. The integral of the linear and rotational kinetic energies transferred to the BCG sensor by cardiac activity provided KE_{Lin} and KE_{Rot} metrics, respectively. In addition, LV mass and SV were measured with cardiac MRI. Linear mixed-effects models analysis was performed on the 8 s breathing protocols with baseline (-4 days), end (58 days) and recovery $+4$ days

$(R+4)$, subject and group as independent variables.

Results:

After 58 days of HDBR, significant changes ($p < 0.05$) are seen in CTRL for SV (-22%), LV mass (-9%), BCG KE_{Lin} (-37%), and BCG KE_{Rot} (-26%). Changes in the JUMP group are less important and significant only for SV (-12%), BCG KE_{Lin} ($+14\%$), and BCG KE_{Rot} (-23%). At $R+4$, the different metrics tend to go back to baseline in both groups, while LV mass (-7%) and BCG KE_{Lin} (-24%) in CTRL remained significantly lower.

Conclusions:

This is the first study assessing the efficiency of multidimensional BCG as a marker of altered cardiovascular inotropic state together with cardiac MRI during a 60 days HDBR campaign. Consequences of cardiovascular deconditioning were observed with all these techniques, with enough sensitivity to differentiate the control and training groups. This study can be used as a validation of the ISS Cardiovector protocol and opens the path for such non-invasive wearable systems to be used for the follow-up of cardiovascular condition in planetary exploration.