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DECREASED INOTROPIC STATE OF THE HEART AFTER ONE-MONTH EXPOSURE TO MICROGRAVITY ASSESSED BY CARDIOVECTOR-1

Abstract

Aim — Cardiovascular deconditioning is known to occur on astronauts exposed to microgravity, however with non-negligible inter-subject variability. The aim of this analysis is to evaluate changes in the inotropic state of the heart that occur during missions on the ISS, by measuring the vibrations on the surface of the body resulting from cardiac activity.

Methods — Data was recorded using CARDIOVECTOR-1 on 4 male cosmonauts, asked to perform a controlled breathing with 5 seconds cycles. In particular, 1-axis dorsoventral Seismocardiography (SCG, accelerations recorded on the sternum) and 6 degrees of freedom Ballistocardiography (BCG, 3-axis accelerations and 3-axis rotations, recorded between scapulae) were performed. In addition, ECG and plethysmograph were also acquired from CARDIOVECTOR-1. Thanks to the latters, SCG and BCG records were split in each of their related heart beats and associated to a respiration phase. Then ensemble average was performed on the different channels for all the beats of a same respiratory phase. Finally, the resulting signals were analyzed to compute kinetic energy and power transferred to the body by the cardiac contraction in the systolic phase.

Results — The measurements on Earth and in space are not directly comparable, as the position of the subject greatly influences the value of the computed parameters. Therefore, an analysis of the evolution of these parameters between the first and second month in microgravity was done. In particular,

we observed a decrease in the amplitude of the power peak transferred to the body during the systolic phase, for all the respiration phases and all the channels: ventro-dorsal SCG ($-44 \pm 27\%$), linear BCG ($-46 \pm 21\%$), and rotational BCG ($-16 \pm 12\%$), while RR interval was not significantly affected ($+4 \pm 2\%$).

Conclusions — Consequences of cardiovascular changes after one month in microgravity are observed on both SCG and BCG, with high inter-subject variability. However the intra-subject evolution of the parameters indicates the possibility to easily assess consequences of a cardiovascular condition evolution and ultimately efficiency of countermeasures. This experiment will be followed by CARDIOVECTOR-3, using 6 degrees of freedom records for SCG and BCG at the center of mass. With such a device, it will be easier to decouple the effects of heart contractions and blood flow in the arterial tree in the recorded parameters, and thus to better correlate the computed parameters to the standard ones (*e.g.* stroke volume and left ventricular ejection time).