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Human Physiology in Space (2)

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MAIN RESULTS OF SPACE EXPERIMENT "CARDIOVECTOR" AND ITS FURTHER DEVELOPMENT

Abstract

Background: The idea to record ballistocardiogram in space flight conditions belongs to V.V. Parin, an outstanding Soviet physiologist and founder of space cardiology (1967). The first record was received in December of 1977 aboard vehicle Salyut-7. Since 2014 the space experiment Cardiovector combines heart rate variability (HRV), seismo-, impedance cardiography, and 3D-ballistocardiography in one device to test the possibilities and limits of wearable devices for crew cardiovascular health monitoring. Material: Eleven cosmonauts have been studied during six-months missions and one cosmonaut during a year-long ISS mission. The sessions were scheduled every month during the mission and conducted twice prior to launch and twice post landing. Measurements are performed under resting conditions and during standardized breathing maneuvers. Results: 1) Classification based on HRV parameters showed in most cases only a moderate shift from a normal regulatory type before flight to a prenosological state with large inter individual differences. 2) Stroke volume estimated by transthoracic impedance cardiography remained stable during space flight and was comparable with preflight supine values. 3) Cardiac mechanical force measured by 3D-BCG is profoundly increased in space compared to preflight measurements. However, kinetic energy was lower if calculated from 3D linear BCG data. 4) Respiratory variations of the BCG during fixed breathing were reduced or even reversed during space flight. These results indicate increased thoracic blood volume and possible changes in ventricular interaction during breathing in weightlessness. Conclusion: Our results demonstrate that wearable devices combining classical noninvasive techniques can be used to screen for individual changes in cardiovascular control and function. These findings encourage the use in terrestrial medicine for home monitoring or screening. Measurements of central blood pressure and aortic pulse wave velocity (Mobil-O-Graph device) will complement future experiments. Two six-component BCG sensors will be used to estimate the displacement of the center of mass of the whole body and to verify our findings regarding the changes of ballistic forces and kinetic energy including rotational components. Pre- and postflight cardiac MRI will be used to verify structural and functional changes of the heart.