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Human Physiology in Space (2)

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RESPIRATORY VARIATION OF THE BALLISTOCARDIOGRAM (BCG) IS REVERSED IN SPACE - RESULTS OF THE EXPERIMENT "CARDIOVECTOR"

Abstract

Background: In the fifties of the last century ballistocardiographer used respiratory variations as a diagnostic marker. During fixed breathing the inspiratory to expiratory ratio ranges around 1.3. An increase has been described with ageing, in patients with angina pectoris and following sympathectomy. Water immersion and abdominal binders decrease the ratio. The amount of pulmonary blood, intrathoracic pressure, venous return, and respiratory sinus arrhythmia are factors influencing the right- and left ventricular interaction which is at least in part responsible for respiratory BCG variations. We used BCG respiratory variations during space flight to assess cardiovascular adaptation. Material and Methods: 11 cosmonauts were studied on 6-month missions and one cosmonaut in the year-long mission twice before flight, monthly in flight and twice after landing. ECG, respiration, impedance cardiogram, seismocardiogram and BCG were recorded during 5 minutes of normal breathing followed by 3 min fixed respiration at 12 breaths/min, 3 min fixed respiration at 6 breaths/min. The BCG-sensor was placed on the back of the cosmonaut between scapulae. Maximal changes of the amplitude of the BCG were analysed during each breathing cycle and averaged. Results: The inspiratory to expiratory ratio of BCG amplitudes was in the range of about 1.3 before and after flight. In microgravity the ratio was profoundly decreased or even reversed in all cosmonauts during spontaneous and fixed breathing. No significant changes were detected during the different phases of space flight. The BCG changes were correlated with the changes in thoracic impedance and stroke volume. Conclusion: The decreased I/E ratio in space may reflect the blood redistribution to the upper body and a larger pulmonary blood pool. BCG of the whole body recorded at the cosmonauts back as well as transthoracic impedance cardiography have poor spatial resolution. Nevertheless, we speculate that changes in ventricular interaction may contribute to the results. Combination of several methods like ECG, BCG, ICG and SCG using wearable devices with new sensor technology and new methods of signal analysis is promising for ISS crew health monitoring as well as for screening of patients on earth.