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THE USE OF BALLISTOCARDIOGRAPHY IN RUSSIAN SPACE FLIGHTS – HISTORY AND PROSPECTS

Abstract

History. The first ballistocardiogramm (BCG) in space has been registered by the crew-commander Juri Romanenko on December 26, 1977 during the first expedition on orbital station Salute-6. Further BCG experiments were carried out from 1980 to 1984 on orbital stations Salute-6 and Salute-7. BCG during the initial phase of weightlessness (1981, joint Soviet-Romanian mission) and the first triaxial-BCG in space (1984, joint Soviet-Indian mission) were recorded. A renewal of BCG experiments took place onboard the orbital station Mir. The 3D-BCG experiment Vector has been carried out during the 3-rd expedition on orbital station Mir. This was the first experiment aiming to estimate the changes of spatial distribution of cardiac forces in three dimensions during long term weightlessness. The results of this experiment have never been published in English. In a next step, the experiments Sleep and Night used contactless BCG recorded with an accelerometric gauge connected to the sleeping bag starting with the Russian-Austrian research mission the early nineties. Experiments onboard the ISS. The transfer of the collected experience during the MIR - era to the new International Space Station (ISS) was one of the major aims of the Russian life science program. Hence, accelerometric gauges were implemented into the concept of cardiovascular Russian flight experiments from the very beginning. A seismosensor, an accelerometer detecting the displacement of the chest wall with each heart beat at the apex of the heart, was included in the experiments Sonocard and Pneumocard. Sonocard has the aim to use the seismocardiogram for heart rate variability, respiratory, and movement analysis during sleep. Pneumocard is carried out in cooperation with German experts since March 2007. The new flight-experiment Cardiovector a continuation of Pneumocard will start in 2013-2014. BCG with 6 degrees of freedom (3 linear axes and 3 axes of rotation) will be recorded in addition to the electrocardiogram, impedance cardiogram, seismocardiogram and respiration. This approach will allow the use of new data processing and data analysis techniques to measure cardiac forces and to model the translation of cardiac forces into acceleration and displacement vectors of the human body. Conclusion. Based on the experiences of BCG in weightlessness new sensor technologies as well as data processing approaches may allow a deeper insight into individual cardiovascular adaptation to weightlessness, improve crew health monitoring and may also provide the possibility to translate the results from space research into terrestrial applications.