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EFFECTIVENESS OF HIGH-INTENSITY JUMP TRAINING COUNTERMEASURE ON MITRAL AND AORTIC FLOW AFTER 58-DAYS HEAD-DOWN BED-REST ASSESSED BY PHASE-CONTRAST MRI

Abstract

Aims. Prolonged immobilization generates cardiac deconditioning, a risk factor for cardiovascular disease: efficient countermeasures (CM) are needed to prevent it. Our aim was to assess the effectiveness of high-intensity jump training CM on aortic and mitral flow by Phase-Contrast (PC) MRI during long-term head-down (-6 degrees) bed-rest (BR).

Methods. 23 male participants (29+\-6 years, 181+\-6 cm, 77+\-7 kg) were enrolled at :envihab (Koln, DLR, Germany) as part of the European Space Agency BR studies. Participants were randomly allocated to the jump training group (JUMP, n = 12) or the control group (CTRL, n = 11). A typical training session consisted of 4x10 countermovement jumps and 2x10 hops in a sledge jump system, with 5-6 sessions per week. PC-MRI images (3T Biograph mMR, Siemens) with interleaved three-directional velocity encoding (VENC: x and y: 80 cm/s; z: 150 cm/s) were obtained (spatial resolution 1.4 x 1.4 mm2) at the level of the aortic root, and of the mitral plane, before (PRE), after 58-days (HDT58), and on the fifth day after BR conclusion (R+4). The resulting planar magnitude data and three-directional velocity images were semi-automatically analysed to compute the following parameters: cardiac output (CO), stroke volume (SV), flow rate (Qpeak), systolic duration and heart beat duration (RR), rapid filling (Efilling) and inflow rate (Epeak). Results. In CTRL, compared to PRE, after 58-days BR a significant ($p<.05$, paired t-test) RR (14%) and systolic (10%) shortening, with a decrease in CO (8%), SV (22%), Qpeak (12%), Efilling (26%), Epeak (26%) were observed. In CM, only RR was shortened (8%), together with a decrease in SV (12%), Qpeak (7.5%), Efilling (11%), Epeak (15%). Interestingly, at R+4, compared to PRE, RR decreased by 10% in both groups, and Epeak increased by 18% in CTRL and by 15% in CM. All other parameters returned to baseline level, except for CO (+19%) and SV (+8%) in CM group only. Conclusions. In this first study addressing aortic and mitral flow using PC-MRI during BR experiments, cardiac deconditioning resulted in reduction of aortic outflow and mitral inflow. The

applied CM appeared effective in partially reverse this phenomenon, as visible by the reduced changes in the computed parameters at HDT58, and by an increase in CO and SV at R+4. This information could be useful to better understand physiologic changes in patients undergoing long periods of immobilization, as well as to apply the studied countermeasure during space flight to reduce cardiac deconditioning.