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HIGH-INTENSITY EXERCISE TO COUNTERACT CARDIOVASCULAR DECONDITIONING DURING SIMULATED WEIGHTLESSNESS

Abstract

Head down bed rest mimics changes in hemodynamics and autonomic cardiovascular control induced by long-term stay in zero-gravity. However, the time course and reciprocal interplay of these adaptations have not been fully elucidated and the effect of different exercise protocols must be further investigated. As part of the European Space Agency sponsored study “Reactive jumps in a Sledge jump system as countermeasure during Long-term bed rest”, we analyzed the effects of 60 days of 6 degrees head down tilt bed rest (HDT) with and without a short-duration, high-intensity training protocol on hemodynamics and cardiac autonomic modulation. A total of n=23 healthy, young, male participants were enrolled and randomly allocated to two different subgroups: training (TRAIN), n=12 and non-training (CTRL), n=11. During the 60-day of HDT, the TRAIN group underwent a resistance training protocol using reactive jumps (5-6 times per week), whereas the CTRL group did not perform any countermeasure. Cardiovascular data (by means of impedance cardiography and continuous finger cuff plethysmography) were collected on the 2nd (HDT2), 28th (HDT28) and 56th (HDT56) day of HDT. The same data were also collected 7 days before the start of HDT (BDC-7) and 10 days after the end of HDT (R+10) in both sitting and supine (0 degrees) positions. This approach allowed us to investigate (1) the isolated effects of long-term HDT by comparing all the supine positions (including BDC-7 and R+10 at 0 degrees), and (2) the reactivity of the autonomic response before and after long-term bed rest using a specific postural stimulus (i.e. supine vs sitting). Two-factorial mixed linear models were used to assess the time course of HDT and the effect of the countermeasure. Starting from HDT28, heart rate (HR) increased ($p<0.02$) and parasympathetic tone decreased in the CTRL group ($p<0.0001$). No significant changes were observed in the TRAIN group. Similar effects were found for the comparison of recovery data with respect to baseline in supine position: in the CTRL group, systolic blood pressure and total peripheral resistance were lower ($p<0.0001$, $p<0.05$ respectively), whereas HR of CTRL increased and significantly differed from HR of TRAIN ($p<0.05$). These data show that 60 days of HDT induces a cardiovascular and autonomic deconditioning that is not completely compensated after 10 days recovery. High-intensity, short-duration exercise training was effective in minimizing these impairments and should deserve consideration in further studies as a cardiovascular deconditioning countermeasure for spaceflight.