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FUNCTIONAL TASK TEST: 2) SPACEFLIGHT-INDUCED CARDIOVASCULAR CHANGES AND RECOVERY DURING NASA'S FUNCTIONAL TASK TEST

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INTRODUCTION

The overall objective of the functional task test (FTT) is to correlate spaceflight-induced physiological adaptations with changes in performance of high priority exploration mission-critical tasks. This presentation will focus on the recovery from fall/stand test (RFST), which measures the cardiovascular response to the transition from the prone posture (simulated fall) to standing in normal gravity, as well as heart rate (HR) during 11 functional tasks. As such, this test describes some aspects of spaceflight-induced cardiovascular deconditioning and the course of recovery in Space Shuttle and International Space Station (ISS) astronauts. The sensorimotor and neuromuscular components of the FTT are described in two separate abstracts: Functional Task Test 1 and 3.

METHODS

Shuttle astronauts (n=7, mission duration: 10–15 d) participated in the FTT before launch (PRE), on landing day (R+0), and 1 (R+1), 6 (R+6), and 30 (R+30) days after landing. ISS astronauts (n=4, mission duration: 160–165 d) participated pre-flight and on R+1, R+6, and R+30. The RFST consisted of 2 min of prone rest followed by 3 min of quiet standing during which HR (Holter monitor) and continuous blood pressure (BP; Portapres) were measured. Autonomic activity was approximated during the RFST by systolic BP low frequency power (SBP LF; an index of sympathetic activity), R–R interval high frequency power (RR HF; an index of parasympathetic activity), and R–R interval LF to HF ratio (RR LF/HF; an index of sympathovagal balance). Statistical analyses of Shuttle data were performed with 2-factor repeated-measures ANOVA. The mean HR, RR LF/HF, RR HF, and SBP LF were log-transformed to convert these data to a normal distribution for statistical analysis. Results were considered statistically significant when $p < 0.05$. Low subject number of ISS astronauts to date precluded statistical analyses of these data. Data are reported as mean ± SE.

RESULTS

Shuttle Missions. During the RFST, HR was higher on R+0 and R+1 than PRE during the prone rest (62 ± 3, 75 ± 4, 71 ± 3) and standing (74 ± 4, 96 ± 7, 89 ± 5). Standing HR still was higher than PRE on R+6 (90 ± 5), but prone HR only tended to be higher (69 ± 2). Both standing and prone HR were not different than PRE on R+30. RR HF was lower than PRE during prone rest on R+0 (973 ± 344 vs. 143 ± 52) and during standing on R+0, R+1, and R+6 (114 ± 52, 12 ±4, 15 ± 5, 22 ± 6). RR LF/HF was elevated on R+0 (day effect), but was not different on R+1, R+6, or R+30. BP and SBP LF were not affected by spaceflight during the RFST. HR was higher on R+0 than PRE during all 11 tasks analyzed. HR was elevated for 7 of the 11 tasks on R+1 and 6 of the 11 tasks on R+6. At R+30, HR during functional tasks was not different than PRE.

ISS Missions. Preliminary analyses of ISS data seem to show similar changes in HR and autonomic activity to that of Shuttle data. During the RFST, HR, RR LF/HF, and SBP LF appear to be elevated, while RR HF appears to be lower on R+1 during prone rest and standing. Furthermore, HR on R+1 appears to be elevated during all 11 functional tasks. By R+30, HR and autonomic activity during RFST and HR during the functional tasks seem to have recovered to PRE values.

CONCLUSION

Despite large differences in mission duration, exposure to weightlessness appears to result in similar changes in the cardiovascular responses to quiet standing and in the performance of mission-critical tasks. During RFST, in both groups of astronauts, HR and sympathovagal balance are elevated and parasympathetic activity is decreased. Similarly, HR is elevated during other functional tests. Additional data collected from future ISS astronauts will allow us to confirm this relationship and more completely describe the course of recovery from spaceflight. This will provide essential information to crew performance and recovery upon arrival at Mars after long-duration spaceflight.