High intensity exercise countermeasures do not prevent orthostatic intolerance following prolonged bed rest

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INTRODUCTION

Approximately 20% of Space Shuttle astronauts became presyncopal during operational stand and 80° head-up tilt tests, and the prevalence of orthostatic intolerance increases after longer missions. Greater than 60% of the US astronauts participating in Mir and early International Space Station missions experienced presyncope during post-flight tilt tests, perhaps related to limitations of the exercise hardware that prevented high intensity exercise training until later ISS missions. The objective of this study was to determine whether an intense resistive and aerobic exercise countermeasure program designed to prevent cardiovascular and musculoskeletal deconditioning during 70 d of bed rest (BR), a space flight analog, would protect against post-BR orthostatic intolerance.

METHODS

Twenty-six subjects were randomly assigned to one of three groups: non-exercise controls (n=11) or one of two exercise groups (ExA, n=8; ExB, n=7). Both ExA and ExB groups performed the same resistive and aerobic exercise countermeasures during BR, but one exercise group received testosterone supplementation while the other received a placebo during BR in a double-blinded fashion. On 3 d/wk, subjects performed lower body resistive exercise and 30 min of continuous aerobic exercise (≥75% max heart rate). On the other 3 d/wk, subjects performed only high-intensity, interval-style aerobic exercise. Orthostatic intolerance was assessed using a 15-min 80° head-up tilt test performed 2 d (BR-2) before and on the last day of BR (BR70). Plasma volume was measured using carbon monoxide rebreathing on BR-3 and before rising on the first recovery day (BR+0). The code for the exercise groups has not been broken, and results are reported here without group identification.

RESULTS

Only one subject became presyncopal during tilt testing on BR-2, but 7 of 11 (63%) controls, 3 of 8 (38%) ExA, and 4 of 7 (57%) ExB subjects were presyncopal on BR70. Survival analysis of post-BR tilt tests revealed no differences ($p=0.77$) between groups. Plasma volume (absolute or relative to body mass index) decreased ($p<0.001$) from pre to post-BR, with no differences between groups.

CONCLUSIONS

These preliminary results corroborate previous reports that the performance of a vigorous exercise countermeasure protocol during BR, even with testosterone supplementation, does not protect against orthostatic intolerance or plasma volume loss. Preventing post-BR orthostatic intolerance may require additional countermeasures, such as orthostatic stress during BR or end-of-BR fluid infusion.