

EFFECT OF EXERCISE AND ACCELERATION TRAINING ON RESTING AND ORTHOSTASIS INDUCED CHANGES IN HEMATOLOGICAL VARIABLES

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INTRODUCTION

Losses of aerobic power and orthostatic tolerance are significant effects of manned spaceflight that can negatively impact crew health and safety. Daily acceleration and aerobic training may ameliorate these effects. The purpose of this investigation was to determine the influence of passive intermittent +Gz acceleration (PAS) training, constant +Gz acceleration + interval exercise (CAE) training, and intermittent +Gz acceleration + interval exercise (IAE) training on the orthostatic, plasma volume, and vasoactive hormone responses to 70° head-up tilt. It was hypothesized that all three acceleration-training protocols would improve orthostatic tolerance and the addition of aerobic conditioning would not alter this effect. This improved orthostasis would result in a smaller decrease in plasma volume (PV) and a greater increase in plasma renin activity (PRA) and smaller increases in plasma vasopressin (PVP) and norepinephrine (NEPI) in response to tilt testing.

CURRENT STATUS OF RESEARCH

Methods

Three subjects underwent PAS training on the Ames Research Center human powered centrifuge (HPC) for 30 min [warm-up, 24 min of 2 min acceleration intervals (+1.0 Gz to 50% $G_{z_{max}}$, +2.4 ± 0.1 Gz), and cool-down] 5d/wk for 3 wk. The other 3 underwent constant +Gz acceleration (CAE, 50% of HPC maximal acceleration, +2.3 ± 0.2 Gz) while performing supine interval training on a cycle ergometer [warm-up (40% peak oxygen uptake ($\dot{V}O_{2peak}$)), 24 min of 2 min intervals (40% - 90% $\dot{V}O_{2peak}$), cool-down] 5d/wk for 3 wk. A crossover design was used with 3 wk of ambulatory deconditioning between protocols. A third group of 6 men then underwent IAE training consisting of linked intermittent +Gz acceleration and cycle ergometry [warm-up (40% peak acceleration tolerance (+Gz_{peak})), 24 min of 2 min intervals (40% - 90% +Gz_{peak}), cool-down] 5d/wk for 3 wk. Before and after each training protocol, peak (_{peak}) $\dot{V}O_2$, workload (WL), and heart rate (HR) were determined supine. Resting (_r) HR and blood pressures (SBP, DBP, and MAP) after 40 min of supine rest and orthostatic responses to 70° head-up tilt (_t), to presyncope or 60 min were measured pre- and post-training (data reported for last 2 min of tilt). Maximal human powered +Gz acceleration tolerance was determined using the HPC.

Results

Both the CAE (1766 ± 88 to 1967 ± 49 kpm) and IAE (1750 ± 43 to 2017 ± 48 kpm) protocols improved work capacity ($p \leq 0.05$). PAS training increased HR_r (63 ± 4 to 71 ± 5 bpm) and HR_t,

(71 ± 8 to 89 ± 7 bpm) while CAE and IAE had no effect on HR, but IAE eliminated the tilt induced decrease in MAP (30.7 ± 14.0 vs. -8.9 ± 4.8 %). PAS (3424 ± 185 to 3461 ± 97 mL) and IAE (3592 ± 125 to 3787 ± 120) increased resting PV, while CAE (3616 ± 215 to 3533 ± 130 mL) decreased it. None of the protocols appears to have impacted the endocrine response to 70°-head-up tilt.

Conclusion

PAS and IAE training are more similar than either is to CAE training. Intermittent acceleration appears to have a greater training effect than constant load acceleration.

FUTURE PLANS

This study assessed the training response in ambulatory subjects. The next step is to determine if acceleration training is an effective countermeasure for bed rest-induced orthostatic intolerance.

INDEX TERMS

Acceleration, Human Powered Centrifuge, Orthostasis, Hemodynamics, Endocrine

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