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Three days bed rest appreciably impairs whole-body glucose disposal (which is fully restored by exercise), but is not further accentuated after 56 days bed rest

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INTRODUCTION:
Immobilisation reduces insulin-mediated whole body and muscle glucose disposal (GD) (1). However, the rate and magnitude of change in GD and substrate oxidation (SO) during bed rest (BR) is unresolved, particularly during chronic BR. Furthermore, failure to control for dietary energy intake has resulted in a lack of clarity regarding whether end-point measurements are attributable to BR per se and/or overfeeding. We therefore determined whole-body GD and SO during acute and chronic BR whilst maintaining energy balance, and also the impact of prescribed exercise on restoration of GD and SO following acute BR.
METHODS:
Healthy males (n=10, 24±1.25yrs, body mass index (BMI) 22.7±0.60) underwent 3 days of -6o head down tilt (HDT) BR, followed by 3 days of unilateral leg exercise (5x30 one-legged maximal isokinetic knee-extensions, 90 degrees per second). A second cohort of BMI matched healthy males (n=20, 34±1.8 yrs, BMI 23.8±0.41) underwent 56 days of -6o HDT BR. An isoenergetic diet was calculated (2) and maintained throughout both studies (30% fat, 15% protein, 55% carbohydrate). A 3 hr hyperinsulinaemic euglycaemic clamp (60 mU/kg lean mass/min) was performed on day -4 (pre BR in both studies), after 3 days BR (acute BR) and 3 days unilateral leg exercise, and after 56 days BR (chronic BR). Indirect calorimetry was performed before and during the final 30 min of each clamp to calculate whole-body SO. A two-way repeated measures ANOVA was performed to detect differences in means on endpoints. A statistical level of $p < 0.05$ was accepted. All data are expressed as mean ± SEM.
RESULTS:
Acute BR resulted in a 30% reduction in insulin-mediated GD (normalised to DXA determined lean body mass) from pre BR (11.0 ± 0.75 vs 7.8 ± 0.55 umol/kg/min respectively, $p<0.001$), which was fully restored by 3 days on non BR and unilateral leg exercise (11.7 ± 0.86 umol/kg/min). The rate of insulin-stimulated carbohydrate oxidation was unchanged from pre BR following acute BR (3.69 ± 0.39 vs 4.34 ± 0.22 mg/kg/min, respectively). Compared to pre BR, chronic BR produced a 22% reduction in GD (10.2 ± 0.42 vs 7.9 ± 0.28 umol/kg/min respectively, $p<0.05$) and a 19% decline in the rate of carbohydrate oxidation (3.34 ± 0.18 vs 2.72 ± 0.13 mg/kg/min respectively, $p <0.05$). The rate of fat oxidation under insulin clamp conditions was reduced by both acute and chronic BR, however the magnitude of suppression was less in chronic BR such that fat oxidation was greater Post BR compared to Pre BR (0.85 ± 0.06 vs 0.60 ± 0.07 mg/kg/min, respectively, $p<0.05$).
CONCLUSION:
Impairment of whole-body insulin-mediated GD is significant after 3 days of BR, which was fully restored by 3 days non BR and unilateral leg exercise. Surprisingly, the magnitude of this decline in GD during acute BR is not further accentuated after 56 days BR. However, whole-body SO does differ between acute and chronic BR demonstrating dissociation of the regulation of GD from fuel oxidation from the acute to chronic BR state.

Topic: Health and Fitness

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