SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

Author: Dr. Prashant Parmar
St. Joseph's / National Jewish Hospital, United States, pparmar.2017@gmail.com

MUSCULOSKELETAL OUTCOMES FROM CHRONIC HIGH-SPEED HIGH-IMPACT RESISTANCE EXERCISE

Abstract

Purpose: Preventing excessive bone resorption on long term microgravity missions is crucial to astronaut health. Osteocytes within the bone can sense strain and adapt to microfractures and stress by promoting bone formation. Current and proposed microgravity workouts do not involve repeated high-speed, high-impact countermeasures. We propose the use of a gravity-independent, high-speed, high-impact resistive device to induce bone formation and inhibit bone resorption.

Methodology: We hypothesize a chronic training program on the Inertial Exercise Trainer (IET) will yield significant changes to dependent variables related to musculoskeletal physiology and performance. 13 healthy subjects performed 30 sessions of resistive exercise on the IET with their left leg, with the right legs as untreated matched controls. Measurements taken before and after treatment include lower body DEXA scans, alkaline phosphatase, c-terminal telopeptides of type-I collagen, and isokinetic strength. Food logs measured kilocalorie, protein and calcium intakes.

Results: One-way ANOVAs showed non-significant changes in dietary kilocalorie, protein Ca+2 intakes. 2 (leg) x 2 (time) ANOVAs, w/ repeated measures on both IV, showed Inertial Exercise Training led to significant left knee ankle gains in peak torque. 2 x 2 ANCOVAs, w/ repeated measures on both IV scan area as a covariate, showed calcaneal BMD BMC significantly increased from Inertial Exercise Training. T-tests revealed Inertial Exercise Training led to a significant decline in type-I collagen C-terminal telopeptides, a marker of bone resorption.

Conclusion: Bone density and calcification significantly increased from IET use, bone resorption markers in the blood were significantly decreased, and there were significant gains in peak torque in treated knee and ankle versus control. The IET imparted high-speed, high-resistive force to the treatment legs, which then showed bone changes independent of diet.

Discussion: The IET is able to impart gravity-independent resistance to users in a manner differing from traditional musculoskeletal workouts in space. This form of exercise is invaluable in stimulating bone formation and inhibiting bone resorption, which is one goal of the NASA HRP roadmap. Thus, this exercise device and principle has promise as an in-flight countermeasure to ameliorate losses incurred by chronic unloading of the lower body in space and the over-stimulation of bone resorption.