Muscle Volume Increases Following 16 Weeks of Resistive Exercise Training with the Advanced Resistive Exercise Device (ARED) and Free Weights

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Abstract

A Rear-induced muscle atrophy, particularly in the posterior and lower extremities, may impact task performance during long-duration space missions and planetary exploration. High-intensity free weight (FW) resistance training has been shown to prevent atrophy during long-duration space flights (Shackelford, 2004). However, FW training involves significant amounts of time, can be demanding, and can lead to increases in muscle mass. The Advanced Resistive Exercise Device (ARED) can be used to induce muscle exercise in a variety of configurations during International Space Station (ISS) missions. The purpose of this study was to compare the efficacy of ARED and FW training to induce muscle mass and strength increases in critical muscle groups in ambulatory subjects prior to deploying ARED on the ISS. METHODS: Twenty volunteers (14 men, 6 women) consented to participate in this study and were assigned to either a FW or ARED training group. The study protocol was reviewed and approved by the Johnson Space Center’s Committee for the Protection of Human Subjects. Subjects performed squat, heel raise, and deadlift exercises 3xwk-1 for 16 weeks using a periodized resistive exercise training program. Each group performed 3-4 sets maximum strength measurements (1RM) on both the ARED and FW. Training loads were prescribed from the 1RM acquired on the training specific hardware for each exercise before training and after 8 weeks of training. FW and ARED 1RM were measured pre-, mid-, and post-training for all three exercises. Magnetic Resonance Imaging (MRI) were acquired pre- and post-training. Data were analyzed using a training group x time repeated-measures ANOVA. RESULTS: Total body mass significantly increased in the VRF (±2.5%), HST (±1.9%), AD (±1.3%), DF (±1.9%), ELF (±1.7%), and TFL (±1.1%) after training. There were no between-group differences in muscle strength or volume. CONCLUSIONS: The increase in muscle volume and strength following ARED training is not different than FW training. With the training efforts similar to FW and 5-6 lb load capacity ARED truly will prevent muscle atrophy in microgravity.

Introduction

• Muscle atrophy and reduced muscle strength have been observed following long duration space flights (Laffoon, 2000; Trappe, 2009).
• Decreased muscle performance is considered a human health and performance risk by the Human Research Project at the Johnson Space Center, National Aeronautics and Space Administration (NASA). Decreased muscle function may impact core performance and mission success during long duration missions and planetary exploration.
• The in-flight Resistive Exercise Device (iRED) has been utilized since the first International Space Station (ISS) mission as a countermeasure for strength losses and muscle atrophy, but did not prove to be completely protective (Lee, 2004).
• ARED was deployed on ISS in Expedition 18, using 272 kg of resistance using 2 vacuum cylinders (constant load). 20 vehicles to simulate the inertial component of free weight (FW) exercise, and provides an eccentric load using a constant load.
• By providing the capability to perform resistive exercise at similar levels of intensity, with an acceptable load, we suspect that muscle and bone will be better preserved than previously observed (Lee, 2004; Trappe, 2009).
• The increase in the V and DF muscle groups indicates a possible need to revisit the primary exercises themselves (squat, deadlift, and possibly the kinematics or potentially add other exercises focusing on the other muscle groups).

Purpose

The purpose of this study was to compare the efficacy of ARED and FW training to induce hypertrophy in specific muscle groups in ambulatory subjects.

Acknowledgments

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Results

• Subject groups were not different in age (AGED: 36±7; FW: 32±4 years), height (AGED: 73±2; FW: 71±3 cm), or body mass (AGED: 79±14; FW: 78±11 kg).
• There were no between-group differences in strength gains in squat, bench press, or deadlift (Lee, 2008).
• Muscle volume increases significantly in the VST (ADD, LG, MG, and DP) but did not in RF and ALC after training. Also, there were no between-group differences (P>0.05).
• Muscle volume increases were greater in the VST and ADD than the RF and HST in the thigh (P<0.05). In the calf LG and MG muscle volume increases were greater than the ALC and DP (P<0.05).

Conclusions

• ARED training elicited increases in muscle volume and strength that were not different than those elicited by FW training.
• Some subjects during bed rest did not achieve load as high as 234 kg during their exercise training to prevent muscle atrophy and bone demineralization (Shackelford, 2004). By providing the capability to perform resistive exercise at similar levels of intensity, with an acceptable load, we suspect that muscle and bone will be better preserved than previously observed (Lee, 2004; Trappe, 2009).
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Overall Study Design

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References