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

Space flight-induced muscle atrophy, particularly in the postural and locomotory muscles, may impact task performance during long-duration space missions and planetary exploration. High intensity free weight (FW) resistive exercise training has been shown to prevent atrophy when performed 3 times per week; however, its effectiveness is limited by equipment constraints on the International Space Station (ISS). The Advanced Resistive Exercise Device (ARED) has been developed to address these limitations by providing: i) fluid loaded cylinders to simulate the inertial loading of free weights (FW), ii) a variable loading mechanism, iii) the ability to allow subjects to perform a full range motion, and iv) an eccentric load to potentially increase muscle hypertrophy. The purpose of this study was to compare the effects of ARED and FW training on muscle mass of subject with parabolic aircraft maneuvers.

Introduction

• Muscle atrophy and reduced muscle strength have been observed following long-duration space flight (Falcoff, 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 crew mission performance and mission success during long duration missions and planetary exploration.
• The International Space Station (ISS) is a microgravity environment that affects muscle mass and muscle strength, but does not provide a training program to counteract these losses (Lee, 2000).
• The Advanced Resistive Exercise Device (ARED) has been developed to provide a training modality that provides the capability to perform resistive exercise at similar levels of intensity and resistance as on Earth. The ARED uses fluid-filled cylinders to provide an eccentric load and a variable resistance to simulate the inertial components of free weight exercise, and provides a full range of motion, simulating ground-based exercise.

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.

Materials and Methods

• Twenty-four healthy volunteers (14 men, 10 women) participated in the study. Subjects were randomly assigned to either the ARED or FW control group. The study protocol was reviewed and approved by the Institutional Review Board (IRB).
• Subjects performed squat, heel raise, and deadlift exercises 3 d·wk−1 for 16 weeks.
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• Quadriceps, hamstrings, and calf muscle strength (1RM) was measured before, after 8 weeks, and after 16 weeks of training to provide an evaluation of muscle strength change.
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• Images were analyzed using the GNU Image Manipulation Program (GIMP 2.6.6, www.gimp.org) to determine muscle atrophy.
• Subjects performed squat, heel raise, and deadlift exercises 3 d·wk−1 for 16 weeks.
• Some subjects during bed rest utilized loads as high as 254 kg during their exercise sessions (Falcoff, 2000; Trappe, 2009).
• The increase in V and Add shows a possible need to revisit either the primary exercises themselves (squat, heel raise, and deadlift) or the eccentric load (4±1%) applied.
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RESULTS

• 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 effect similar to FW and a full load capacity, ARED still provides a countermeasure to disuse-induced muscle atrophy.

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REFERENCES