Introduction

• Muscle atrophy and reduced muscle strength have been observed following long-duration space flight (Calloway, 2000; Trappe, 2009).
• Decreased muscle performance is considered a human health and performance risk during long-duration space flight (LeBlanc, 2000; Trappe, 2009).
• Resistance exercise training has been shown to prevent atrophy during bed rest, a space flight analog. NASA performance during long-duration space missions and planetary exploration. High intensity free weight (FW) exercises provide an eccentric load on the muscle and provide an effective countermeasure to disuse-induced bone loss. J Appl Physiol, 97: 119-129, 2004.

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.

Abstract

Space flight-induced muscle atrophy, particularly in the posterior and hamstring muscles, may impact task performance during long-duration space missions and planetary exploration. High intensity free weight (FW) exercises have been shown to prevent muscle atrophy during bed rest, a space flight analog. NASA has developed the Advanced Resistive Exercise Device (ARED) to simulate the characteristics of FW exercises during space flight. The overall purpose of this study was to compare muscle strength and hypertrophy in the thigh and calf following 16 weeks of ARED and FW training in untrained men.

Thigh Muscle Volume

CONCLUSIONS: The increase in muscle volume and strength following ARED training is not different than FW training. With the training effects similar to FW and the added safety, ARED likely will protect against muscle atrophy in microgravity.

Calf Muscle Volume

MRI Methods

• MRI of the thigh and calf was acquired pre-, mid-, and post-training using a 1.5 T GE Signa HDx MR scanner.

Results

• Subject groups were not different in age (ARED: 36 ± 7; FW: 32 ± 4 yrs), height (ARED: 176 ± 10; FW: 171 ± 7 cm), and body mass (ARED: 79 ± 14; FW: 75 ± 11 kg).

• There were no between-group differences in muscle strength (1RM) for all three muscle groups. ARED & FW 1RM were measured pre-, mid-, and post-training for all three muscle groups.

• CS = (# of pixels)

Figure Legend

The image at left is the CSA of a thigh. The four muscle groups in this image are the RF (red), the V (blue), the ALC (green), and the DP (purple). The image above is the CSA of a calf. The four muscle groups are the ALG (blue), the LG (yellow), the MG (purple), and the DP (green).

• A main effect of time (p < 0.05)
• There were no differences between the training groups in any of the muscle groups.

Overall Study Design

• 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 isometric heel raises, and dual-fatigue exercises 3 x wk−1 for 16 weeks using a protocol-specific resistive exercise training program.

• Each group performed 3-segment maximum strength measurements (1RM) on both the ARED and FW. Training loads were prescribed from the HSM on the training specific handbooks for each exercise before training and after 8 weeks of training. FW & ARED 1RM were measured pre-, mid-, and post-training for all three muscle groups.

• Data were analyzed using a training group x time repeated-measures ANOVA (p<0.05) and a muscle group x time ANOVA (p<0.05). Pair-wise comparisons were used to determine pair-wise differences when a significant F score was found.

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The protocol of the study was reviewed and approved by the University of Houston Institutional Review Board for Human Subjects.

References


