RESULTS: SQ, HR, and DL 1RM increased in both FW (SQ: 49±6%, HR: 12±2%, DL: 23±4%) and ARED exercises 3 d·wk⁻¹ for 16 wks. SQ, HR, and DL muscle strength (1RM) was measured before, after 8 wks, and subjects were assigned to either the ARED (8 males, 3 females) or FW (6 males, 3 females) group and muscle groups in ambulatory subjects prior to deploying ARED on the ISS. METHODS: Twenty untrained resistent exercise training has been shown to prevent atrophy during bed rest, a space flight analog. NASA cross-sectional images (8 mm slices with a 2 mm gap) were analyzed and summed. Anatomical references (V), hamstring group (H), hip adductor group (ADD), medial gastrocnemius (MG), lateral gastrocnemius (LG), and deep posterior muscles (including tibia) were measured using MRI pre- and post-training. Consensus muscle volume images were obtained using a 1.5 T whole-body MRI scanner (Magnetom Vision, Siemens Medical Systems, Erlangen, Germany). Two independent blinded raters measured muscle area. Percent change (%) was normalized to baseline measurements as the change in muscle volume from the start to the end of the experiment. The anterior compartment was divided into the vasti group (V), rectus femoris (RF), adductor group (ADD), and the DP (green). The image above is the CSA of a calf. The four muscle groups are the ALC (blue), the LG (yellow), the MG (purple), and the DP (green).

Acknowledgments

• 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.

• 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.

• 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.

Thigh Muscle Volume

Change in the Rectus Femoris Muscle Volume

Pretest               Posttest

FW                      ARED

Percent Change (%)

10  20  30  40  50

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 H (yellow), and the Add (green). The image above is the CSA of a calf. The four muscle groups are the ALC (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 squat, heel raise, and deadlift exercises 3 d·wk⁻¹ for 16 weeks using a periodized resistive exercise training program.
• Each group performed 8-10 sessions maximum strength measurements (1RM) on both the ARED and FW. Training loads were prescribed from the load on the training-specific hardeware for each exercise before training and after 8 weeks of training.
• FW & ARED 1RM were measured pre- and post-training for all three exercises.
• Magnetic Resonance Imaging (MRI) was acquired pre- and post-training.
• 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). Taking a post hoc test was used to determine pair-wise differences when a significant F score was found.

MRI Methods

• MRI was used during the training protocol to determine muscle volume changes following training. MRI was performed with a 1.5 T whole-body MRI scanner (Magnetom Vision, Siemens Medical Systems, Erlangen, Germany). MRI was acquired pre- and post-training.
• The anterior compartment was divided into the vasti group (V), rectus femoris (RF), adductor group (ADD), and the DP (green). The image above is the CSA of a calf. The four muscle groups are the ALC (blue), the LG (yellow), the MG (purple), and the DP (green).

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 utilized loads as high as 254 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 acceptable loading, we expect that muscle and bone will be better protected than previously observed (Lee, 2004; Tropp, 2009). The increases in the V, A, LF, MG, and MG of the vastus medialis group indicates a possible need to revisit either the primary exercises themselves (squat, heel raise, and deadlift) and the kinetics or potentially add other exercises focusing on the other muscle groups.