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SKELETAL MUSCLE PLASTICITY: IMPLICATIONS FOR MISSION PERSONNEL & ASTRONAUT CAREERS

Abstract

As research continues to examine the deleterious impact of long-duration spaceflight on human muscle physiology, there remain gaps in our knowledge; especially in examining how muscle's ability to recover or rehabilitate from weightlessness may modify the consequences of future missions. The purpose of this study was to analyze the effects of volitional resistance exercise training on muscle mass and anabolism during recovery following a bout of unloading, as well as explore any potential role exercise may have on a subsequent period of weightlessness. To model microgravity, recovery, and exercise training, male Sprague-Dawley (6 mo) rats were randomly assigned to the following groups: 28d hindlimb unloading (1HU), 28d HU followed by a 56d recovery period of normal cage ambulation at 1g (1HU+REC), 2 cycles of 28d HU with a 56d recovery period between unloading (2HU), 2HU followed by an additional 56d recovery at 1g (2HU+REC), or an age- and housing-matched control group (CON). In addition, following the initial 28d HU period, two groups of animals supplemented their 1g recovery period with an 8wk (3 sessions/wk) moderate-intensity, moderate-volume voluntary resistance exercise program (1HU+REC+EX), in which the animals were trained to perform a controlled squat-like motion with full extension of the lower limb while applying resistance up to 65% above bodyweight, and one group performed a second unloading (2HU+EX). At the conclusion of the experimental period, soleus (SOL) and gastrocnemius (GAST) muscles were carefully excised, weighed, and assessed for protein anabolism via cumulative (24hr) muscle protein synthesis rates. Key results, achieving significance established at p<¡0.05 are as follows: absolute muscle mass for SOL and GAST were similarly reduced with each unloading bout and was not rescued with moderate exercise (1HU=2HU=2HU+EX), and while SOL did not recover to control values during 1HU+REC, mass of both muscles were restored by the end of the second recovery period (2HU+REC=CON). Rates of protein synthesis were depressed during 1HU, but not different from control animals during 2HU. Exercise did not increase absolute mass or acute rates of synthesis during recovery, but masses were elevated relatively when accounting for body weight fluctuations. These findings indicate that given adequate recovery, any reductions in muscle mass and anabolic capability during an initial exposure to microgravity can be fully restored to preflight values, and provide evidence that a principal long-duration mission may actually improve muscle's responses to future missions, conclusions of possible interest to career astronauts and agencies selecting mission crews.