Effects of Bed Rest on Conduction Velocity of the Triceps Surae Stretch Reflex and Postural Control

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Despite rigorous exercise and nutritional management during space missions, astronauts returning from microgravity exhibit neuromuscular deficits and a significant loss in muscle mass in the postural muscles of the lower leg. Similar changes in the postural muscles occur in subjects participating in long-duration bed rest studies. These adaptive muscle changes manifest as a reduction in reflex conduction velocity during head-down bed rest. Because the stretch reflex encompasses both the peripheral (muscle spindle and nerve axon) and central (spinal synapse) components involved in adaptation to calf muscle unloading, it may be used to provide feedback on the general condition of neuromuscular function, and might be used to evaluate the effectiveness of countermeasures aimed at preserving muscle mass and function during periods of unloading. Stretch reflexes were measured on 18 control subjects who spent 60 to 90 days in continuous 6° head-down bed rest. Using a motorized system capable of rotating the foot around the ankle joint (dorsiflexion) through an angle of 10 degrees at a peak velocity of about 250 deg/sec, a stretch reflex was recorded from the subject's left triceps surae muscle group. Using surface electromyography, about 300 reflex responses were obtained and ensemble-averaged on 3 separate days before bed rest, 3 to 4 times in bed, and 3 times after bed rest. The averaged responses for each test day were examined for reflex latency and conduction velocity (CV) across gender. Computerized posturography was also conducted on these same subjects before and after bed rest as part of the standard measures. Peak-to-peak sway was measured during Sensory Organization Tests (SOTs) to evaluate changes in the ability to effectively use or suppress visual, vestibular, and proprioceptive information for postural control. Although no gender differences were found, a significant increase in reflex latency and a significant decrease in CV were observed during the bed rest period, with a return to baseline 3 to 5 days after bed rest, depending on the duration of bed rest. In addition, a relationship between CV and loss of muscle strength in the lower leg was observed post bed rest for most subjects. Immediately post-bed rest, most subjects showed decreased performance on SOTs, with the greater decrements on sway-referenced support and head movement conditions. Post-bed rest decrements were less than typically observed following spaceflight. Decrements in postural control and the stretch reflex can be primarily attributed to the unloading mechanisms this ground-based analog provides. The stretch reflex is a concise test measurement that can be obtained during the head-down phase of bed rest, as it does not interfere with the bed rest paradigm. This makes it an ideal tool that can detect, early on, whether a countermeasure is successful in preserving muscle function.