HUMAN MODELING AND EXPERIMENTATION UNDER ARTIFICIAL GRAVITY USING THE MIT COMPACT RADIUS CENTRIFUGE

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Artificial gravity is introduced as a comprehensive countermeasure that is capable of challenging all the physiological system at the same time, therefore maintaining overall health during extended weightlessness. The use of a small radius centrifuge is an affordable approach to generate artificial gravity in space or on the surface of another planet. Ground studies have shown that intermittent artificial gravity combined with ergometer exercise is effective in preventing cardiovascular and musculoskeletal deconditioning. However, these studies have been done in very different conditions, and confounding factors between the studies (including centrifuge configuration, exposure time, gravity level, gravity gradient, and use/intensity of exercise) make it very difficult to draw clear conclusions about the parameters needed to maintain physiological conditioning in space.

The first objective of our current AG research effort is to analyze the effects of different artificial gravity levels and ergometer exercise workload on musculoskeletal and cardiovascular functions, as well as motion sickness and comfort. Human experiments will be conducted using a new configuration of the MIT Compact Radius Centrifuge (CRC). The centrifuge has been constrained to a radius of 1.4 meters, the upper radial limit for a centrifuge to fit within an ISS module without extensive structural alterations. In addition, a cycle ergometer was added for exercise during centrifugation, as well as mechanical and physiological sensors. Furthermore, the subject has been positioned sidewise to eliminate knee lateral deflection due to Coriolis forces while cycling. A pilot run has been already conducted, validating the side-spinning the centrifuge combined with exercise.

The second objective is to gain a better understanding of the effects of the gravity gradient on the cardiovascular system. The gravity gradient generated when using a short radius centrifuge has not been investigated in detail. Previous research on cardiovascular effects under artificial gravity using short radius centrifuges has been limited to studies under one particular gravity gradient. A computational model of the cardiovascular system that captures cardiovascular regulation in a high gravity gradient environment will be developed and validated with experimental measurements using the MIT CRC.

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