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Author: Dr. Mark Rosenberg
Medical University of South Carolina, United States

Dr. William Hoffman
Columbia University, United States
Dr. Luke Brane
University of Pittsburgh, United States

LEVERAGING AMPUTEE BODY PLANS FOR SPACEFLIGHT

Abstract

Long-duration spaceflight presents significant challenges to different aspects of human physiology, from the involvement of the cardiovascular system, vestibular system, and central nervous system. In particular, caudal fluid shifting is a widely studied and well-understood phenomenon of fluid redistribution following the loss of gravitational forces on the fluid column of the body. Acutely, in microgravity, the human body undergoes substantial fluid relocation in a caudal direction, resulting in facial swelling, lower limb volume reductions, third-spacing, and increased diuresis. Chronic cardiac remodeling and autonomic deconditioning also occur, with the strongly hypothesized spaceflight-associated neuro-ocular syndrome also associated with caudal fluid shifting.

However, all studies that have been performed on fluid shifts, or the human body in spaceflight, have occurred on individuals with the standard body plan of two arms and two legs. Arms and legs carry approximately four and seven gallons of fluid, respectively- and theoretically, a large amount of this fluid shifts during spaceflight. A group of individuals that likely do not exhibit such a wide variety of fluid shifting exists- amputees. Amputees, or individuals who have lost one or more limbs, may exhibit a unique adaptation in fluid regulation that could confer some degree of advantage in the microgravity environment. By leveraging their altered fluid dynamics and the adaptability afforded by prosthetic technologies, amputee astronauts may experience fewer physiological disturbances and enhanced operational performance during space missions. In this abstract, we lay the conceptual groundwork of a large, underutilized demographic that may be better suited for space travel due to diminished fluid-shifting capabilities. We will also discuss amputees' demographics, their respective fluid dynamics, current prosthetics technologies, and their applications in spaceflight. As humanity stretches into the cosmos, all individuals, including those who were previously prevented from spaceflight, must have the opportunity to participate. Further research and collaboration between space agencies and medical communities are warranted to fully explore the potential benefits of utilizing amputee individuals in future space endeavors.