IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Human Physiology in Space (2)

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SURVEY ON STUDIES INVESTIGATING THE EFFECT OF SIMULATED MICROGRAVITY ON THE MUSCULOSKELETAL SYSTEM

Abstract

Purpose: Astronaut training for space missions is expensive and elaborative, astronauts need extensive preparation for the circumstances they are exposed to in space. One aspect is microgravity, which can be simulated with parabolic flights or in underwater training scenarios. Both methods are expensive and need special facilities and a lot of personnel. We strive to optimize and intensify this training by simulating microgravity for the upper limbs of the human by means of an active exoskeleton. In the first step to achieve this goal we performed a literature analysis to evaluate relevant research and parameters to assess the feasibility and innovation of the proposed approach.

Methodology: To evaluate the need and potential success of such a training scenario we performed intensive literature research analyzing what kind of comparable experiments have already been done on parabolic flight campaigns. To this end, we analyzed previous European parabolic flight campaigns to see if there had already been similar investigations. We searched for experiments containing the keywords EMG, EEG and exoskeleton. Additionally, we expanded our search to PubMed and added the keyword parabolic flight to find studies which were not conducted in Europe. We focused on studies published in the last two decades.

Results: In previous experiments, the influence of microgravity on EMG and EEG signals was investigated. Most of them only compared the effects of microgravity with Earth gravity. There are studies with simulated microgravity using an end-effector based robotic support system. The results showed strong differences of EMG activity under real microgravity compared to simulated microgravity. What is missing is the comparison between the effects of real microgravity and simulated microgravity based on multi-contact full-arm approach by means of an actuated exoskeleton on the human body. Our approach is comparable, but due to the multiple contact points we assume that the arm weight is better compensated and therefore improved results can be achieved. Such a study would answer the question: Is it possible to achieve the same effects on the human body with an exoskeleton simulating microgravity as under real microgravity?

Conclusions: Exoskeletons that simulate microgravity have high potential to optimize astronaut training in the future. Literature research supports the novelty of our idea and the relevance for evaluating the possibility to simulate microgravity with such an approach. The planned studies could provide an answer to the question of whether exoskeleton-based microgravity simulation can approximate real microgravity.