IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medical Care for Humans in Space (3)

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FAR INFRARED (FIR) RAY-EMITTING GARMENTS TO MITIGATE MUSCLE LOSS ONBOARD THE INTERNATIONAL SPACE STATION (ISS)

Abstract

Muscle atrophy and loss of muscle strength have become a huge concern during spaceflight. Studies have shown that astronauts are losing around 20 percent of their muscle mass on spaceflights lasting five to 11 days. In this paper, the objective is to test the efficacy of garments radiating far infrared rays (FIR) in improving muscle strength and preventing muscle atrophy in long-duration spaceflight. Far Infrared rays is a nonionizing radiation emitted when a molecule de-excites from a higher vibrational or rotational quantum level, which is physically expressed as heat. Far-infrared is a region in the infrared spectrum of electromagnetic radiation from 3 to 100 m, which penetrates up to 1.5 inches (almost 4 cm) beneath the skin and reaches the muscles. Particularly, in the range of 8–14 mm, FIR is proven to have many biological effects. The emitted heat and radiation from FIR garments influence cell membrane potentials and mitochondrial metabolism and can increase blood circulation, tissue regeneration, induce upregulation of calcium-dependent nitric oxide (NO), and calmodulin in different cell lines, having positive effects on antioxidative, anti-inflammatory, and analgesic activities.

The aim of this study is to investigate the effects of wearing skin-fit (non-compressive) garments covering both the lower and upper body for 90-120 min-session, on the indirect markers of spaceflight-induced muscle atrophy for 30 days during the unloading state onboard the ISS. Markers of muscle damage (Creatine kinase (CK), lactate dehydrogenase, myoglobin, troponin, aspartate aminotransferase (AA), and carbonic anhydrase (CAIII) will be obtained from serum and urine analysis. Pain intensity will be measured using the visual analogue scale (V) before and after the intervention.

Desired launch date is be summer 2023. Our hypothesis is that using non-invasive FIR-emitting clothes decreases the indirect markers of muscle atrophy. Exposure to far infrared radiation leads to an intracellular increase in reactive oxygen species (ROS) and a subsequent rise in nitric oxide (NO) synthesis and calcium intracellular levels (Ca2+). Eventually, this decreases oxidative stress, induces vasodilation and stimulates growth factor production and extracellular matrix deposition leading to tissue repair.