Paper ID: 72612
student

IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Interactive Presentations - IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (IP)

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BEING IN SPACE CAN INDUCE PHYSIOLOGICAL DE-CONDITIONING

Abstract

Since humanity first moved away from the Earth's gravitational pull with the dawn of the Space Age, it has been realized how the microgravity environment can have a negative influence on the musculoskeletal system, and a prolonged exposure to microgravity causes different damage to these components:

1. Muscles, especially those that counteract gravity, the so-called Anti-G muscles, can become very atrophic when exposed to microgravity, losing 15-20% of their mass. There is also a transition from slow twitch fibres(type I, used in standing) to fast twitch fibres(type II, used to push from one wall of the ISS to the other). Therefore, not only atrophy but also change in the type of muscle fibres occurs.
2. Bones can lose up to 2% a month, where as on Earth a postmenopausal woman could lose something around 1% a year. It is important to note that the lower limbs and the spine are most affected. Unlike muscle tissue which appears in time to be restored after returning to Earth's gravity, long-term studies have identified incomplete recovery of mineral density and bone structure, meaning that permanent bone damage remains a major concern.
3. The joints, in particular synovial joints, would seem to show deterioration of the cartilage and this in the medium to long term could cause astronauts to experience increasing pain and a loss of mobility, with a clinical picture that could evolve towards osteoarthritis. The data suggest that measures such as active exercise and pre-flight and post-flight physiotherapy, with the addition of mid-flight exercise (ARED, T2, CEVIS), are necessary to counteract long-term musculoskeletal problems.

Most of our data and knowledge comes from decades spent in LEO and from ground-based experiments. It follows that we must ask ourselves some interesting questions:

- About Gravity: What is the minimal amount of gravity required to maintain a healthy musculoskeletal system? Several experiments have been conducted with fractional gravity generated by centrifugal forces to counteract the effects of microgravity. The application of gravity, even partial (0.16 G), may be the best countermeasure to reduce the incidence of microgravity-induced pathologies.
- About Radiation: Does increased radiation exposure affect tissue healing? Earth's magnetic field is known to protect space vehicles in LEO, however on the lunar surface, the effects of radiation on biological systems could be significant, with a combined effect on muscles and cartilage.

If the goal is a Moon mission, further studies must be conducted on space stations in LEO, and especially beyond, if we are to have a better understanding of the effects on the musculoskeletal system.