

Musculoskeletal system and microgravity

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Editorial

An italian roadmap to the study of the musculoskeletal system in microgravity

Appropriate loading conditions are required to maintain the normal structure and function of the musculoskeletal system. This is clearly illustrated by the dramatic effects of unloading due to prolonged bed rest or space flight, that causes loss of muscle mass, strength and endurance, as well as bone loss and risk of bone fractures. Similar changes are found, though in a longer time scale, in individuals affected by chronic diseases and also during normal aging, thus represent a major medical and social problem. The striking effects of even short space flights in young healthy individuals provide a unique model to explore the effect of unloading per se, without the additional factors that complicate the interpretation of chronic diseases and conditions. Thus a better understanding of the pathogenesis of muscle atrophy and osteoporosis induced by microgravity may help in finding therapeutic targets to cure the effect of inactivity and prevent muscle atrophy and bone loss in human subjects affected by chronic diseases especially in the aging population.

In 2006 the Italian Space Agency (Agenzia Spaziale Italiana, ASI) launched a research program on Osteoporosis and Muscle Atrophy (OSMA) to promote research activities aimed at understanding the causes of microgravity-induced bone and muscle pathology and devising countermeasures to prevent them. A specific objective of these studies is to couple the study of microgravity in space and on ground models to the potential application of this knowledge for the prevention of the deleterious effects of inactivity in human chronic diseases.

This special issue of Basic and Applied Myology contains a selection of articles reflecting representative areas of OSMA research activities. These include the first results of space flight experiments with the FOTON-M3 Italian Mission (LIFE, September 2007), in which muscle fibers from adult mouse muscles and osteoclast cultures were maintained for several days in a microgravity environment. The upper limbs play a major role in posture and locomotion for the subjects living in the space station, and an OSMA group, as reported here, has implemented and validated on ground a facility built by the Kayser Italia, to be installed on board the International Space Station (ISS), for measuring muscle mass and force of proximal upper limb in microgravity. Two articles focus on the first European automated rodent spaceflight payload, the Mouse Drawer System (MDS) built by Alenia Space Italia, and report i) biocompatibility tests and ii) analyses of skeletal muscle changes in mice housed in MDS for several weeks. These studies show that the new payload meets NIH guidelines for various parameters, from temperature and humidity to food and water access and waste management, and is thus ready to take off in the upcoming MDS space mission. Bed rest is a well established on ground model of microgravity in humans and OSMA has organized two bed rest campaigns in Valdotra (Slovenia) in 2007 and 2008: several non invasive and invasive studies were performed in these campaigns, including analyses of energy/protein intake and muscle protein profile, which are reported in two articles of this issue. The hindlimb unloading model is an appropriate ground model of microgravity in mice, as reported in another article comparing the effect of unloading in young and adult mice. Finally, two articles discuss bone remodeling results from the antagonistic activity of osteoclasts and osteoblasts, which is altered in microgravity and leads to progressive bone loss.

It is clear from this brief survey that italian science is competitive at the highest levels in the area of muscle and bone biology and physiopathology, and that the support of ASI has promoted fruitful interactions between different research centers and, most importantly, between basic science and industry, an essential condition for the progress in space research.

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