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Medical Care for Humans in Space (3)

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3D PRINTED BIOMIMETIC SCAFFOLDS FOR BONE-CELLS MICROGRAVITY RESPONSE

Abstract

The aim of this paper is to present innovative 3D printed biomimetic platforms to resemble the bone trabecular structure in order to suggest ad-hoc regenerative strategies to address microgravity conditions, assessed so far by a very limited number of investigations. In this study, 3D printed polymeric scaffolds are designed to mimic physiological and pathological bone microarchitectures, thanks to a patented algorithm, and fabricated by means of fused deposition modeling (FDM) which allows to reproduce the developed models in a fast, reproducible and cost-effective manner, processing biocompatible and approved polymers. To evaluate the biological response, the tissue engineered constructs (scaffolds + osteoblastic model cells) were cultured in simulated microgravity conditions by means of a rotary cell culture system (RCCS). Primary results showed how cell adhesion and viability are affected by scaffold morphology, mainly in suspended culture conditions highlighting the importance of the biomimetic approach. Bone mass loss is a consequence elicited by microgravity exposure (about 1.5%/month) and a critical issue to be addressed. Effective countermeasures are still to come since skeletal unloading, and the subsequent demineralization, enhances calcium excretion, its balance decreases to about 250 mg/day during flight and leads to an altered bone homeostasis with an increased fracture risk, related to a premature osteoporotic phenotype expression. An experimental strategy to elucidate the results collected so far and provide innovative models for space research, is highly recommended if referred to the planned long-distance space missions, due to gravity variability and the adverse biological outcome. Bone-like instructive scaffolds capable of limiting cell dysfunctions and supporting the assessment of physio-pathological conditions can pave the way to novel protocols for treating microgravity-related issues, highlighting cellular mechanisms, refine existing therapeutic protocols and developing new countermeasures. The potential of space research, aimed to deeply assess the affections induced by the environment and ensure crew health, can also benefit ground applications as it has been reported that the exposure to microgravity may lead bone marrow stromal cells to preferentially differentiate into adipogenic instead of osteogenic lineage cells which is comparable to the aging mechanism. In this regard, tailored experimental protocols, closely resembling

the physio-pathological conditions and carried out in microgravity conditions, represent an accelerated model to study bone-related diseases on Earth.