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Biology in Space (8)

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GROWING BLOOD VESSELS IN SPACE: THE SPHEROIDS PROJECT

Abstract

Purpose: Humans returning from space have shown muscle-skeletal and cardiovascular problems accredited to injury of the endothelium. The SPHEROIDS project investigates the effects of microgravity on endothelial cell function, with respect to blood vessel formation, cell proliferation, and apoptosis. Results could help in the development of potential countermeasures to prevent cardiovascular deconditioning in astronauts and improve knowledge of endothelial function on Earth. We hope to understand three-dimensional (3D) growth and to improve the *in vitro* engineering of biocompatible vessels which could be used in surgery. **Methodology:** We used adherent human endothelial cells from blood vessels in an automatic flight hardware, specially designed to culture cells in space. A 14-day experiment onboard the International Space Station examined effects of real microgravity on formation of 3D cell structures. Cells were cultured inside the hardware in absence and presence of the vascular endothelial growth factor (VEGF), which had shown to have a cell-protective effect on endothelial cells in simulated microgravity. The fixed cells were investigated by immunohistochemistry and the cell supernatants were examined by Multianalyte Profiling technology. Previously to the spaceflight experiment, the hardware materials had been intensely tested to biocompatibility, experimental setup, science validation, and sequence tests. **Results:** The flight hardware enabled growth of endothelial cells as tube-like structures, similar to previous results observed when we put endothelial cells in simulated microgravity on Earth generated by a Random Positioning Machine (RPM). We detected 3D cell aggregates after the retrieval of the fixed samples from the flight hardware, which assembled after the launch of the experiment until

their fixation approximately 5 and 12 days later. We investigated these aggregates for morphological changes (fibronectin, 3D spheroid formation). The results from space samples, like an altered secretion of several growth factors, cytokines and extracellular matrix components were comparable to data observed with the RPM. **Conclusion:** Normally endothelial cells grow as single layers on the bottom surface of cell-culture flasks. In simulated microgravity we noticed the endothelial cells formed three-dimensional, tube-like cell aggregates that resemble a small, rudimentary blood vessel. The SPHEROIDS project now has shown that similar processes occur in space.