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Meeting abstract

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Adhesion molecule expression and cell cycle control in cells of the immune system are sensitive to altered gravity

O Ullrich*[1], C Thiel[2], K Paulsen[1], K Huber[1], R Hemmersbach[3], M von der Wiesche[3], H Kroll[4], F Zipp[5] and F Engelmann[6]

Address: [1]University of Zurich, Institute of Anatomy, Zurich, Switzerland, [2]Max-Planck-Institute for Biophysical Chemistry, Goettingen, Germany, [3]Institute of Aerospace Medicine, German Aerospace Center DLR, Cologne, Germany, [4]German Red Cross, Dessau, Germany, [5]Cecilie-Vogt-Clinic for Neurology, Charité University Medicine Berlin, Germany and [6]University of Applied Sciences, Jena, Germany

* Corresponding author

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Introduction

Life on Earth developed in the presence and under the constant influence of gravity. Thus, it is a fundamental biological question, whether gravity is required for cellular functions at the molecular level in mammalian cells. Their special sensitivity to altered gravity renders cells of the immune system an ideal model system to understand if and how gravity on Earth is required for normal mammalian cell function and signal transduction.

Methods

Experiments have been performed using ground-based facilities such as fast-rotating 2D clinostat and hyper-g-centrifuges, and real microgravity provided by parabolic flights. For parabolic flight experiments on board the Airbus A300 ZERO-G, we developed RP (rapid prototyping)-based experimental equipment, which allows cell culture experiments with living mammalian cells in microgravity. We investigated the influence of altered gravity on T lymphocytes and on monocytic cells.

Results

In experiments with a fast rotating 2D clinostat, we detected strong and rapid initial changes of human T lymphocyte signal transduction within minutes of simulated weightlessness. However, most of the initial alterations returned to "normal" levels after 15 min-simulated weightlessness. Only the expression of p21 protein remained constantly elevated, compared to normogravity controls. In simulated weightlessness, human monocytic cells responded with tyrosine-phosphorylation of several proteins, whereas in PMA-stimulated monocytic cells, tyrosine-phosphorylation was nearly abrogated. Hypergravity of 1.8 g had no effects of the signal pathways investigated. In parabolic flight experiments, we found that 20 s microgravity resulted in distinct changes of expression of cell-cycle regulatory genes such as p21 and p27 on the transcriptional level in primary human T lymphocytes. In human monocytic cells, we detected a distinct downregulation of ICAM-1 (CD54) in non-stimulated and in PMA-stimulated cells.

Conclusion

Thus we conclude that dysregulation of immune function in microgravity might be a consequence of 1) sustained induction of p21 as a cell cycle arrest signal in T lymphocytes and 2) Downregulation of ICAM-1 in monocytes/macrophages, which are then no longer capable of interacting with T lymphocytes in the appropriate way. Since immune cells can respond and adapt to altered environmental conditions very effectively, it is indispendable to investigate whether the observed effects are still active after long-term exposure to altered gravity in the situation of adaptation and steady state. Thus, we are now the phase of preparation of two Space Experiments investigating the function of cells of the innate immunity, one scheduled for autumn 2009 on board of the International Space Station and one as a common Sino-German space life science

mission scheduled for January 2010 on board of Shenzhou-8 Spacecraft.