IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Life and Microgravity Sciences on board ISS and beyond (Part II) (7)

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THE EFFECTS OF LONG-TERM VIBRATION ON HUMAN CHONDROCYTES.

Abstract

Background/Aims: In the articular cartilage, chondrocytes are the major cells distributed in the dense extracellular matrix which provides resistance against mechanical forces and friction for the joints. They exhibit a well-differentiated phenotype with unique physiological functions of the load-bearing cartilage tissue. A long-term stay in space can lead to bone loss and cartilage breakdown. Due to the poor regenerative capacity of cartilage tissue, this degradation may disturb the flight crews' mobility and may negatively influence mission activities. While microgravity certainly is a factor for these processes, other factors such as cosmic radiation and vibration might be important in the cartilage degeneration. Whole-body vibrations at different frequencies showed varied effects on cartilage *in vivo* (10-20 Hz were beneficial, 30-40 Hz were detrimental), and little is known about the direct impact of vibration on chondrocytes *in vitro*. After a two-hour exposure to vibration in vitro human chondrocytes exhibit an altered gene expression of inflammation markers. However, little is known about the impact of long-term vibration on chondrocytes.

Methods: Human cartilage cells were exposed for 24 h (VIB) to a specialised vibration device (Vi-

braplex), repeatedly simulating the vibration profile which occurs during parabolic flights and compared to static control conditions (CON). Afterwards, phase-contrast microscopy, rhodamine phalloidin staining, microarray analysis, quantitative real-time PCR (qPCR) and western blot analysis were performed to examine effects on cell viability and shape as well as protein and gene expression.

Results: Morphological investigations revealed no changes between CON and VIB chondrocytes. F-Actin staining showed no alterations of the cytoskeleton in VIB compared with CON cells. DAPI and TUNEL staining did not identify apoptotic cells. ICAM-1 was elevated and vimentin, beta-tubulin and osteopontin proteins were significantly reduced in VIB compared to CON cells. PCR of cytoskeletal genes, *ITGB1*, *SOX3*, *SOX5*, *SOX9* did not reveal differential regulations. Microarray analysis detected 13 differentially expressed genes, mostly indicating unspecific stimulations. Pathway analyses demonstrated interactions of PSMD4 and CNOT7 with ICAM.

Conclusion: Long-term vibration did not damage human chondrocytes *in vitro*. The reduction of osteopontin protein and the down-regulation of *PSMD4* and *TBX15* gene expression suggest that in-vitro long-term vibration might even positively influence cultured chondrocytes.