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EFFECT OF MICROGRAVITY ON THE NUCLEUS

Abstract

The shape of the nucleus and its position is found to be altered in various pathological conditions, such as cancer, laminopathy and muscular dystrophy. Cells sense the external mechanical cues and these cues alter cytoskeletal forces, which in turn are sensed by the nucleus due to the mechanical coupling between the nucleus and the cytoskeleton. The shape of the cell and shape of the nucleus are closely related and any changes to the morphology of the cell results in changes in nuclear shape and gene expression. Interestingly, several cell types cultured in microgravity have altered morphology and their cytoskeleton is reorganized. To understand the effects of microgravity on nuclear morphology, we analyzed 3-dimensional parameters of the nuclei in human fibroblast cells cultured on International Space Station (ISS) for both 3 days and 14 days. The cells were in confluent status before being launched to ISS. Due to contact inhibition, more than 90% of the cells were in G1 phase. The confocal images acquired from the fixed samples were used to reconstruct the 3-D structures of the nucleus, which revealed neither the vertical height of the nucleus and nor the aspect ratio (length/width) changed significantly in cells exposed to microgravity for 3 days or for 14 days compared to the 1 g control cells. Fibroblasts cultured in simulated microgravity environment (SMG) for 20 hours and 48 hours showed a significant change in the x-y projection aspect ratio of the nuclei compared to the aspect ratio of the nuclei in 1 g control condition. Taking together the lack of changes in cell and nuclear morphology, and also in gene and miRNA expression levels in long duration ISS study; and the significant changes observed in short duration SMG studies it is possible that the exposure to microgravity for 3 days and 14 days is giving the cells enough time to adapt to the mechanical effects of microgravity in fibroblasts.