Detection of DNA damage by space radiation in human fibroblast cells flown on the International Space Station

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Although charged particles in space have been detected with radiation detectors on board spacecraft since the early discovery of the Van Allen Belt, reports on effects of direct exposure to space radiation in biological systems have been limited. Measurement of biological effects of space radiation has been difficult due to the low dose and low dose rate nature of the radiation environment, and the difficulty in separating the radiation effects from microgravity and other space environmental factors. In astronauts, only a small number of changes, such as increased chromosome aberrations in lymphocytes and early onset of cataracts, attributed primarily to the exposure to space radiation. In a recent experiment, human fibroblast cells were flown on the International Space Station (ISS). Cells fixed on Days 3 and 14 after reaching orbit were analyzed for phosphorylation of a histone protein H2AX by immunofluorescent staining of cells, which is a widely used marker for DNA double strand breaks. The 3-dimensional γ-H2AX foci were captured with a laser confocal microscope. Quantitative analysis revealed a small fraction of foci that were larger and displayed a track pattern in the flight samples in comparison to the ground control. Human fibroblast cells were also exposed to low dose rate γ rays, as well as to protons and Fe ions. Comparison of the pattern and distribution of the foci after γ ray and charged particle exposure to our flight results confirmed that the foci found in the flown cells were indeed induced by space radiation.