Induction and Repair of HZE Induced Cytogenetic Damage

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Risk from prolonged manned space flight includes the radiation exposure from Galactic Cosmic rays containing high energy, heavy ions like ^{56}Fe. Studies were conducted at the Brookhaven National Laboratory by exposing Wistar rats to high mass and energy (HZE) particles using the Alternating Gradient Synchrotron (AGS). The animals were sacrificed, and the frequency of micronuclei induced in the respiratory tract cells was defined as a function of time after radiation in vivo. The biological effectiveness of ^{56}Fe ions (1000 GeV/AMU) relative to low-LET gamma rays and high-LET alpha particles for the induction of micronuclei was also determined. In animals sacrificed within one day of radiation exposure, the frequency of micronuclei in rat lung fibroblasts, epithelial cells and tracheal epithelial 1.2×10^{-3} and 1.1×10^{-3} micronuclei/binucleated cell/Gy, respectively. After 49 days or recovery or repair in vivo the frequency of micronuclei in the tracheal epithelium still showed a significant increase as a function of exposure but the slope was only 1/10 that observed when the animal were sacrificed on the day of exposure. For the deep lung fibroblasts and deep lung epithelial cells there was no dose related increase in the frequency of micronuclei. This suggested that there was in vivo loss or repair of the cells containing the radiation induced cytogenetic damage. It was determined in respiratory tract cells that the HZE exposure was between 0.9 and 3.3 times as effective in producing micronuclei as ^{60}Co. However, the HZE exposures were only 0.2 times as effective as radon in producing micronuclei in either deep lung or tracheal epithelial cells. Studies are being conducted to determine the fraction of the initial response that is induced by the primary particles and the fraction that induced by delta rays. These calculations suggest that much of the energy deposited by the primary HZE particles is “wasted” for the production of micronuclei relative to the energy deposited by radon or other ionizing radiation.

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