10-11-2017

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Biomedical Engineering Society (BMES) Annual Meeting
October 11-14, 2017
Phoenix, AZ

Characterizing the Effects of Radiation on Muscle Cells

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Introduction: As longer space missions become more desirable to public and private institutions, the physiological impact on astronauts must be considered. One of the primary concerns for those spending time in low gravity and high radiation environments is muscle atrophy. A major cause of muscular atrophy is oxidative stress which is amplified by increased levels of ionizing radiation during spaceflight. Additionally, high levels of radiation can damage DNA, increasing the risk of cancer. Utah State University's Space Environment Test Facility was used to irradiate C2C12 myoblasts and human vascular endothelial cells with a dosage mimicking that on the International Space Station and a 3-year deep space mission. Cell changes due to increased levels of radiation were characterized with fluorescent imaging for H2AX, a marker of double stranded DNA damage, and Trypan blue viability staining.

Materials and Methods: Skeletal and cardiac cells were cultured in standard tissue culture flasks and well plates. Cells were maintained using high glucose DMEM nutrient medium with 10% FBS for four days then high glucose DMEM with 2% FBS to differentiate the cells. Undifferentiated cells were placed in USU's Space Environment Test Facility and exposed to radiation levels between 2 Gy and 50 Gy to model the radiation dosage seen on a deep space mission. Immediately after exposure, cells were analyzed for viability and morphology damage.
Another set of cells was cultured concurrently for seven days following radiation exposure prior to viability testing.

Results and Discussion: Cell viability decreased substantially with increased accumulated radiation dose. Following a seven-day recovery period, irradiated cell viability increased (Table 1). The cell morphology of irradiated cell samples was different from the control sample in that they did not differentiate within the recovery period or after 20 days of culture. Relatively high viability for high dose radiation treatment is likely due to the undifferentiated state of the cells within the test chamber.

Table 1. Viability results for C2C12 myoblast cells exposed to Strontium 90 beta-radiation.

	2 Gy	*10 Gy*	*20 Gy*	*50 Gy*
Immediate Testing Viability	97.1 ± 1.3	92.3 ± 1.4	74.7 ± 0.9	63.4 ± 1.7
Control Viability	98.3 ± 0.9	98.8 ± 0.5	97.8 ± 1.4	97.9 ± 0.6
Recovery Period Viability	92.1 ± 1.3	94.1 ± 1.6	82.8 ± 1.2	76.2 ± 1.8
Control Viability	95.6 ± 1.3	98.1 ± 0.9	98.4 ± 0.9	94.8 ± 1.3

Conclusions: Cells exposed to high dosage radiation have decreased viability immediately following and after a seven-day recovery period. Future studies include irradiation of differentiated cardiac and skeletal muscle cells in modified well plates and attached to micro carrier beads in a rotary cell culture system to simulate microgravity effects.

Acknowledgements: This research was funded in part by the Utah NASA Space Grant Consortium and the US Nuclear Regulatory Commission.