
48th Meeting of the Particle Therapy Co-Operative Group

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Meeting Abstract

Heavy ions and X-rays in brain tumor treatment: acomparison of their biological effects on tissue slice cultures

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Text

Background: In this interdisciplinary project, the biological effects of heavy ions are compared to those of X-rays using tissue slice culture preparations from rodents and humans. Advantages of this biological model are the conservation of an organotypic environment and the independency from genetic immortalization strategies used to generate cell lines. Its open access allows easy treatment and observation via live-imaging microscopy.

Materials and methods: Rat brains and human brain tumor tissue are cut into 300 µm thick tissue slices. These slices are cultivated using a membrane-based culture system and kept in an incubator at 37°C until treatment. The slices are treated with X-rays at the radiation facility of the University Hospital in Frankfurt at doses of up to 40 Gy. The heavy ion irradiations were performed at the UNILAC facility at GSI with different ions of 11.4 A MeV and fluences ranging from 0.5–10 × 10⁶ particles/cm². Using 3D-confocal microscopy, cell-death and immune cell activation of the irradiated slices are analyzed. Planning of the irradiation experiments is done with simulation programs developed at GSI and FIAS.

Results: After receiving a single application of either X-rays or heavy ions, slices were kept in culture for up to 9d post irradiation. DNA damage was visualized using γH2AX-staining. Here, a dose-dependent increase and time-dependent decrease could clearly be observed for the X-ray irradiation. Slices irradiated with heavy ions showed less γH2AX-positive cells distributed evenly throughout the slice, even though particles were calculated to penetrate only 90–100 µm into the slice.

Conclusions: Single irradiations of brain tissue, even at high doses of 40 Gy, will result neither in tissue damage visible on a macroscopic level nor necrosis. This is in line with the view that the brain is highly radio-resistant. However, DNA damage can be detected very well in tissue slices using γH2AX-immuno staining. Thus, slice cultures are an excellent tool to study radiation-induced damage and repair mechanisms in living tissues.