Effect of 17 MeV and 22. 7MeV Protons on Mammalian Cells ◇

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Biological experiments with protons were performed at the vertical beamline of the tandem accelerator in Munich. The advantage of the vertical beam is that cells can be irradiated through the bottom of the petri dish in medium at 37^0 C and in a controlled atmosphere.

A chinese hamster cell-line, a glioblastoma cell-line and two primary skin fibroblasts were irradiated with protons of 17MeV and 25MeV. One primary skin fibroblast cell-line had a normal radiosensitivity while the other cell-line was found to be 1.7times more sensitive to X-rays. The sensitive cell-line was from a patient with a Nimegen breakage syndrom (NBS), a rare autosomal recessive disease with immunodeficiency, microcephaly, risks of malignancies at young age, chromosomal instability and hypersensitivity to ionising radiation. It is assumed that the deficiency of the NBS-protein (Nibrin) causes a DNA double-strand break-repair defect.

The colony-forming ability of the cells was measured by the cell-survival assay. The number of colonies formed was counted by an automatic colony analysing-machine from which besides the cell number, the volume of each colony may be obtained. The colony volume represents the number of cells in each colony and shows a radiation-induced decrease in the repopulation of the colony.

At both proton energies a slightly increased relative biological efficiency (RBE) was observed with an RBE of 1.03 at a linear energy transfer of 2.2 keV/m and an RBE of 1.13 at 3keV/m (chinese hamster cells). The colony volume of the proton-irradiated cells decreased slightly more in comparison to the volume of the X-ray irradiated cells (1.06 at 2.2 keV/m and 1.18 at 3 keV/m). The RBE was thus higher if the colony volume is taken as a measure of survival.

The RBE values found fit RBE values from the literature. However, if the colony volume and therefore the cell repopulation is considered, the results of the proton irradiation show that the repopulation of the cells is reduced and a higher RBE is found.

The glioblastoma cells (22.7MeV) showed just barely an increased RBE (1.02) while the skin fibroblasts (RBE 1.2) and especially the fibroblasts with NBS (RBE 1.6) had a higher RBE. These results indicate that different cells may exhibit different RBE values.

Future experiments will show whether repopulation will be reduced more efficiently in experiments with protons of lower energy. Experiments under anaerobic conditions are in progress.

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