Radiosensitivity of Duck Embryo Brains to Arrays of Parallel Synchrotron-Generated X-Ray Microbeams and to Broad X-Ray Beams

Microbeam Radiation Therapy (MRT) uses arrays of parallel, synchrotron-generated x-ray microplanar beam slices (microbeams), each typically 30 μm wide, centimeters long, spaced ~100 μm on center, with a 50-70 keV half-power energy. Two effects were observed. First, there is sparing of normal tissues at doses that exceed by many folds the broad beams' tissue-necrosis thresholds. It is assumed that lethally injured endothelial cells lying in the direct paths of microbeams are replaced by endothelial cells that survive between microbeams. Second, single-fraction unidirectional MRT of 9LGS rat brain tumor eliminates the tumor or slows its growth. We used duck embryos to study microbeams' radiotoxicity on growing and developing CNS tissues. Duck eggs were irradiated with single-fraction unidirectional microbeams and broad beams 3-4 days before hatching (i.e., incubation days 24-25). With the eggs upright, x-ray fluorescence radiography was used to position the head, and irradiation over 10 mm x 11-mm envelope was administered; angle of the embryo's head to the beam was unknown. Microbeam-irradiated embryos given 78, 156 and 312 Gy in-slice entrance doses and 100-μm beam spacing hatched and developed normally to 8 months at almost the same success rate to that of unirradiated ducks. Broad-beam-irradiated embryos given 45 Gy had a median lifespan of 32 days, while those given 15 and 30 Gy developed close to normal. Research supported by the Children's Brain Tumor Foundation and the U.S. Department of Energy.