ABSORBED DOSE OPTIMIZATION IN THE MICROPLANAR BEAM RADIOTHERAPY

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Abstract

Recent advances in synchrotron generated X-ray beams with high fluence rate, small divergence and sharply defined microbeam margins permit investigation of the application of an array of closely spaced, parallel or converging microbeams for radiotherapy.

The proposed technique takes advantage of the repair mechanism hypothesis of capillary endothelial cells between alternate microbeam zones, which regenerates the lethally irradiated capillaries. Unlike a pencil beam, more accurate dose calculation, beam width and spacing are essential to minimise radiation damage to normal tissue cells outside the target. The absorbed dose between microbeam zones should be kept below the threshold for irreversible radiation damage. Thus the peak-to-valley ratio for the dose distribution should be optimized.

The absorbed dose profile depends on the energy of the incident beam and the composition and density of the medium. Using Monte Carlo computations, the radial absorbed dose of single 24 x 24 μm^2 cross-section X-ray beams of different energies in a tissue/lung/tissue phantom was investigated. The results indicated that at 100 keV, closely spaced square cross-sectional microbeams can be applied to the lung. A bundle of parallel 24 µm-wide planar microbeams spaced at 200 µm intervals provides much more irradiation coverage of tissue than is provided by a bundle of parallel, square cross-sectional microbeam, although the former is associated with much smaller Peak (maximum absorbed dose on the beam axis) -to-Valley (minimum interbeam absorbed dose) ratios than the latter. In this study the lateral and depth dose of single and multiple microplanar beams with beam dimensions of width 24 µm and 48 µm and height 2-20 cm with energy of 100 kev in a tissue/lung/tissue phantom are investigated. The EGS4 Monte Carlo code is used to calculate dose profiles at different depths and bundles of beams (2 x 2 cm^2 to 20 x 20 cm^2 square cross section) with a 150 µm, 200 µm and 300 µm beam spacing. The peak-to-valley ratios are compared at different depths, bundles, heights, widths and beam spacing to determine the optimum parameters for irradiation.