Monte Carlo based treatment planning methods for X-ray microbeam radiotherapy (MRT)

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Keywords: Monte Carlo, X-ray microbeam, radiotherapy treatment planning

High intensity X-rays from synchrotron sources can be used to deliver microbeams a few tens of microns wide. This high definition is achieved by using extremely short pulses that in effect freeze the movement of the patient in time. Microbeams have been shown to damage normal tissue far less than would occur if the dose were spread out, and some success has been achieved in treating the highly radioresistant glioma tumour in animal models. Microbeams are also highly penetrating due to the forward scattering of photons associated with Compton scattering, the prodominant interaction at typical energies of 150-250 keV. The dose due to scattering is diffuse and therefore does not achieve a microbeam effect but is highly conformal and may be able to be utilised in a fashion similar to intensity modulated radiotherapy (IMRT) even for relatively deep-seated tumours. Calculations of dose distributions for typical MRT configurations have been performed with the Monte Carlo code EGS5. The dose distributions can be visualised with a treatment planning system and though dose-volume histograms compared to conventional treatment approaches. Following practice used in the treatment planning in binary therapy, the dose distribution due to the microbeam portion of the beam can be overlaid with predicted biological enhancements in order to indicate the therapeutic advantage achieved over conventional approaches.