Dosimetry for synchrotron stereotactic radiotherapy: Monte Carlo simulations and radiosensitive gels

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High grade gliomas are aggressive tumours for which current treatments are palliative. New therapeutic modalities have been proposed that combine the injection of high atomic number elements and an irradiation with low energy x-rays (below 100 keV) from a synchrotron source. Such techniques are denominated synchrotron stereotactic radiotherapy. In the framework of foreseen clinical trials, a treatment planning system should be available as well as procedures for the verification of dose delivery. Aims of this study were (1) the implementation of a dose calculation tool based on a Monte Carlo code and patient-specific geometry, and (2) three-dimensional dose measurements during a SSR irradiation. The developed dosimetric tool is based on the general purposed code MCNPX and performs the conversion of tomographic data into voxelized geometry. Calculations reveal that clinically acceptable isodoses (for a simple irradiation scheme) are only obtained when a significant amount of high atomic number element is added, thus increasing the interaction cross section of target tissues. Moreover, dose distributions were measured through magnetic resonance imaging of a radiosensitive polymer gel. Measured and calculated doses agree well in high dose gradient regions (5% in dose and a spatial criterion of 2.1 mm).

Keywords
Monte Carlo calculation, x-rays, dosimetry, radiosensitive polymer gel, synchrotron radiation, nuclear magnetic resonance, tomodensitometry