Monte-Carlo dosimetry for Stereotactic Synchrotron Radiation Therapy (SSRT) of brain tumors

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High-grade glioma are still of poor prognostic value. Radiotherapy of such tumors requires high doses, whereas the tolerance of healthy brain tissues limits the maximum allowable dose. A radiation dose enhancement can be obtained in brain tumors after infusion of an iodinated contrast agent and irradiation with kilovoltage X-rays.

Preclinical trials using iodinated contrast agents have shown a significant extension of the life span in treated tumors bearing animals (1).

The aim of this study is to assess the dosimetric properties of the Stereotactic Synchrotron Radiotherapy (SSRT) applied to humans, when the irradiation is done from several entrance angles. SSRT with a continuos arch has already been studied (2).

Monte-Carlo is considered the state-of the art method in radiation physics calculations. The PENELOPE code has been used to determine the dose distributions in a head phantom (3) to assess the dose received by the tumor and the healthy tissues.

Nine beams irradiating the head from different entrance angles have been simulated. A theoretical cylindrical tumor of different sizes, loaded with different iodine concentrations was included in the calculations. Several simulations considering different positions of the tumor inside the brain were performed.

The presence of iodine in the tumor increases the deposited dose in the tumor by a factor depending on the iodine concentration, which increases the therapeutic effect. The enhancement factors for different iodine concentrations will be presented. The simulations show, as well, that the doses in the skull remain within tolerance whereas the dose received by the brain is significantly lower in average than in conventional radiotherapy. The dose distributions for the different positions, sizes of the tumor as well as for several iodine concentrations will be presented. The average doses received by the organs at risk will be showed.

This study demonstrates that SSRT with several entrance angles of human tissues is feasible. An enhancement factor of the dose delivered to the tumor is obtained while the dose in the healthy tissues remain within tolerances, with a greater sparing of the brain than in conventional radiotherapy.

References

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