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ESTIMATION OF SOME ADVANTAGES OF GADOLINIUM IN NCT

Neutron Capture Therapy (NCT) is a radiotherapeutic technique still in experimental phase, that exploits the high thermal-neutron cross section of gadolinium isotopes and the
ability to selectively accumulate in tumor cells such isotopes chemically bound to suitable tumor-seeking compound [1]. 157Gd (σth = 255000 b) has been considered too, owing to the Auger-electron-induced DNA damages. In the reaction of 157Gd with thermal neutrons, prompt gamma rays of various energies are emitted. The disadvantage of GdNCT over BNCT is just the long-range gammas emitted by 157Gd reactions that deliver dose also far from the reaction position, with damage to healthy tissue. In this work, Monte Carlo (MC) calculations concerning radiation transport and gamma dose distribution in a cubic water phantom with 14 cm side were carried out. MCNPX has been used to run simulations about neutron fluence and gamma dose in various configurations. Calculations were performed 157Gd. Considering that suggested concentrations in tumor tissue are 100 ppm for 157Gd and that the conventional carrier selectivity is around 3.5, for calculations suitable concentrations of the two isotopes in the water phantom were taken. The following simulations were performed: (i) water phantom (in order to evaluate fluence and gamma dose coming from epithermal neutron thermalization in water, as reference data); (ii) water phantom containing 28.6 ppm of 157Gd; (iv) water phantom containing 14.3 ppm of 157Gd. Results show that 28.6 ppm of 157Gd reduce significantly the thermal neutron fluence and increase substantially the gamma dose. The simulation with 157Gd (in the halved amounts) shows lower reduction of thermal neutron fluence and lower gamma dose; moreover, it highlights a more advantageous condition because it joins an acceptable gamma dose in healthy tissue to the ability to perform Gadolinium imaging. No drastic changes have been found by introducing volumes with limited extension containing 100 ppm of 157Gd .
The problem of the high absorbed dose in healthy tissue could be overcome by using,
a Gd pharmaceutical with very high tumor-to-tissue uptake ratio. For additional investigation of above mentioned effects we developed and carried out experimental study with use of Magnelec, a paramagnetic contrast agent for magnetic resonance imaging. For this study we developed new model for analysis in vitro, using survival slices of glial tumours of human brain [2]. Preliminary results revealed that despite of low flux density at absorbed doses 5,10-20 Gy about 10-20% of tumor cells died 24 hours after irradiation. Dosimetry calculations are complex owing to the multiplicity of secondary radiation emitted during Gd reactions:electrons and photons with many possible energies and then many different ranges in tissue [3].

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