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Accelerator-based neutron capture therapy: in-vitro efficacy evaluation and in-sample dosimetry using gold nanoparticles

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We provide in-vitro efficacy evaluation of an accelerator-based neutron source for BNCT, constructed at the Budker Institute of Nuclear Physics (BINP, Novosibirsk, Russian Federation) [1]. CHO-K1, V79, U251MG, and T98 cells were incubated with boric acid or BPA in different concentrations and irradiated with epithermal neutrons during 1-3 hours in the modified Snyder head phantom using 2.0 MeV proton energy and 1-3 mA proton current, which resulted in neutron fluence of up to 2.16×10^{12} cm^{-2}. Absorbed doses were calculated by the Monte Carlo method using PRIZMA code. T98 cells were additionally incubated in the medium with BPA and gold nanoparticles. After irradiation, based on the gold activation, which resulted in generation of radioactive ^{198}Au isotopes, in-sample dosimetry was done and provided data for boron-related dose evaluation. The cell survival data confirm the efficacy of the accelerator neutron source with the lithium target at BINP to produce a sufficient number of neutrons to initiate boron neutron capture reaction within and in proximity to the tumor cells. The provided epithermal neutron fluence still might be insufficient for clinical trials, and further improvement of the accelerator, including stabilization of an increased (up to 5 mA) proton current and development of a new lithium target and neutron beam shaping assembly is in progress. A new method of boron dose evaluation in BNCT using a boron compound containing an additional element, such as gold, can be effectively used for in-sample dosimetry and treatment efficacy estimation.

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References

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