Polymer-stabilized elemental boron nanoparticles for BNCT: cell irradiation experiments.

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The boron compounds currently used in clinical and preclinical BNCT experiments, BSH and BPA, do not meet all the desired criteria for ideal treatment. Their imperfections motivate scientists to search for new solutions that better meet the requirements, one of which is the delivery of sufficient amounts of boron to tumor cells to reach a ^{10}B concentration of ≥ 20-30 µg/g in tumor tissue. Without addressing tumor-targeting issues, loading tumor tissue with a sufficient amount of boron can be solved using nanoparticles that contain large numbers of boron atoms per particle, compared to 1 or 12 boron atoms per molecule of BPA or BSH, respectively. Thus, a 3 nm nanoparticle contains ~ 120 thousand ^{10}B atoms and a 50 nm nanoparticle can deliver about 2 million ^{10}B atoms.

Here. we report on irradiation experiments using elemental boron nanoparticles (eBNPs) synthesized by a new method of cascade ultrasonic dispersion/destruction of elemental boron micron particles (10-20 microns) in an aqueous medium and stabilized with hydroxyethyl cellulose. BPA was used as a control. Transmission electron microscopy was used for particle visualization. Cytotoxicity analysis by MTS assay showed no obvious toxicity up to high nanoparticle concentrations in T98 human glioma cells. For irradiation experiments, the cells were incubated with nanoparticles or BPA in different concentrations for 24 hours, washed with PBS, trypsinized, centrifuged, collected, and then placed in 1ml plastic vials in the medium they were incubated with to avoid BPA leakage from the cells. The plastic vials with cells were placed in a plexiglass phantom to imitate the human head and provide the maximum thermal neutron fluence at the level of the vials. Neutron irradiation was performed at an accelerator-based neutron source with a subsequent colony-forming assay to evaluate cell survival. Cell-survival curves were fit to the linear-quadratic (LQ) model and radiobiological parameters were calculated.