boron compounds

Elemental Boron Nanoparticles obtained by the method of pulsed laser ablation in liquids as sensitizers of BNCT

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The great issue of boron neutron capture therapy (BNCT) is related to the lack of effective and safe boron delivery systems. An ideal boron containing compound should provide selective uptake of ^{10}B by tumor tissues at concentration 20 μg of ^{10}B per 1 g of tumor tissue or more, high boron concentration ratios between tumor: normal tissue and tumor: blood, the retention of ^{10}B in the tumor for several hours, and rapid clearance from organs and blood [1]. High expectations are now related to the employment of nanotechnology approaches [2]. We have investigated several types of elemental boron nanoparticles fabricated using the methods of pulsed laser ablation in liquids. Amorphous BNPs of 10-30 nm size were synthesized by the ablation of a pure boron micropowder by nanosecond laser radiation, followed by the laser fragmentation of the formed solution [3]. For the formation of partially crystalline BNPs with a mean size of 50 nm, a technique of ultrashort femtosecond laser ablation from a bulk boron target was used [4]. Both BNPs were coated with polyethylene glycol to improve their biocompatibility and colloidal stability. The BNPs did not show any cytotoxicity effects in ^{10}B concentrations necessary for successful BNCT. The U87 and SW-620 cells were previously incubated with BNPs and then were irradiated at the accelerator-based neutron source VITA with a thermal neutrons for 30 min. Colony forming capacity of cells from BNCT groups dropped down significantly, whereas the effect of irradiation by neutron beam without boron was negligible. In vivo biodistribution studies of boron after intratumoral administration of BNPs in SCID mice with heterotopic U87 xenograft recorded excellent retention of boron in tumor.

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References:

1. R.F. Barth *et al*. Boron neutron capture therapy of cancer: where do we stand now? Cancer Commun (Lond) 44(8) (2024) 889-892.