using a novel procedure to include the Tumor, the Insertion zone and the surrounding Precancerous tissue in a single section (TIP section), to study boron microdistribution using the neutron autoradiography technique.

Results: We observed a statistically significant increase ($p < 0.0001$) in boron uptake in tumors corresponding to the protocol BA + Early EP (47+/-10 ppm) versus control BA without EP (36+/-7 ppm), whereas for the BA + Late EP protocol boron tumor uptake (35+/-9 ppm) was similar to the control BA without EP (36+/-7 ppm). Both EP protocols, Early and Late, caused a statistically significant increase ($p < 0.0001$) in blood boron concentration compared to the control BA without EP, from 15+/-2 ppm (control) to 52+/-14 ppm (BA + Early EP) and 31+/-5 ppm (BA + Late EP). No changes in the boron concentration values were observed in precancerous tissue and normal pouch tissue in Early and Late EP vs BA only protocols. Measured values were within the range of 30-40 ppm and 28-38 ppm for precancerous and normal tissue, respectively. The boron concentration ratios Tumor/Precancerous tissue and Tumor/Normal tissue of the EP protocols were similar to the control without EP, in the range of 1.1 to 1.3. Conversely, the Tumor/Blood boron concentration ratio showed a decrease in tumor selectivity for both the EP protocols versus control without EP.

Conclusion: Biodistribution studies showed that Early EP induced an increase in mean gross boron concentration in tumor and would contribute to BA-BNCT-induced tumor response. Ongoing neutron autoradiography studies seek to determine if potential enhanced therapeutic efficacy would be partially due to EP induced changes in 10B microdistribution. Radiobiological studies in experimental oral cancer are necessary to assess the potential therapeutic efficacy and radiotoxicity of BA+EP/BNCT and the role of high boron concentration values in blood.
MA Garabalino and N Olaiz contributed equally

Keyword: Biodistribution, Boric Acid, Electroporation, oral cancer model, BNCT

Pa R1 04

Radiobiological in vitro and in vivo investigations on accelerator neutron source in Budker Institute of Nuclear Physics

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Introduction:
The studies were carried out using an accelerator-based epithermal neutron source constructed at the Budker Institute of Nuclear Physics in Novosibirsk Science City (Russia). The safety of neutron beam was evaluated. Neutron irradiation of U87 (glioblastoma) and FetMSC (human embryonic bone marrow) cell line was carried out. In the in vivo experiments we studied the radiobiological effects of neutron irradiation with BSH injection at a dose of 200 mg/kg intraperitoneally in immunodeficient SCID mice.

Materials and Methods:
In in vitro experiments the samples were located in a plexiglass phantom under the lithium target of the accelerator-based neutron source. The irradiation lasted 2 hours and 2 minutes with proton energy of 2.0 MeV and current integral of 2.69 mA*h. The maximum absorbed dose was 12 Gy-Eqs. The dose range was 0–12 Gy-Eqs. After irradiation, 104 cells per well were plated 96 well plates for MTT test 48 and 96 hours after irradiation. In in vivo experiments, after boron compound injection mice were irradiated with epithermal neutrons with proton energy of 2.0 MeV, and the current integral of 1.56 - 4.48 mA*h. The irradiation doses received by mice were 0-20 Gy-Eqs. Animals irradiated without boron and/or without irradiation were used as controls. We morphologically evaluated changes in the proliferative pool of the bone marrow, in the small intestine, kidneys, liver, brain, heart, and spleen.

Results:
According to the concept of tolerance of normal tissues, FetMSC, a line derived from normal embryo tissue, was more tolerant to epithermal neutron irradiation, while the response of the tumor U87 line was more prominent. Irradiation dose of 12 Gy-Eqs reduced survival fraction of U87 cells by 27% and FetMSC cells by 7%. All laboratory animals were alive 1 month after the irradiation. External pathological signs were found in mice that received doses of 16 Gy-Eqs to 20 Gy-Eqs in the form of trophic skin disorders and weight loss. The experiment shows that therapeutic dose received by mice healthy tissues during irradiation was well tolerated, and pathological structural changes in the studied tissues that have been exposed to radiation were not detected. However, at high doses of radiation, reversible changes in tissues, mostly in the small intestine and bone marrow, were revealed.

Conclusion:
Our experiments with normal or tumor cell lines irradiated with different doses suggest that effect of only neutron irradiation without boron-10 is insignificant for normal cells. Experimental data on animals show that doses up to 4 - 6 Gy-Eqs were optimal for carrying out BNCT in vivo experiments. Acknowledgments This work was funded by the Russian Science Foundation under project no. 14-32-00006 and was supported by the Budker Institute of Nuclear Physics and Novosibirsk State University.
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Keyword: bnct, radiobiological studies, accelerator

Pa B2 01

Development of a prompt gamma ray imaging detector using LaBr3(Ce) scintillator and arrayed MPPC for Boron Neutron Capture Therapy

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Introduction
In order to improve the quality of treatment of boron neutron capture therapy (BNCT), it is necessary to perform the detection of boron concentration during BNCT irradiation. In general, boron concentration has been evaluated by prompt gamma ray analysis with a high purity germanium detector and the induced coupled plasma methods. However, these procedures cannot obtain the information of the boron concentration during irradiation. The determination of boron concentration in real-time can be achieved by measuring the prompt gamma rays emitted from the reaction between boron-10 and thermal neutron. However, there are 511 keV annihilation gamma rays in BNCT irradiation fields; as a result, it is required to discriminate between prompt gamma rays of 478 keV and annihilation gamma rays. A detector system with an energy resolution below 6.5 % is required to discriminate the two gamma rays. A prompt gamma-ray imaging detector system was developed. It consists of a LaBr3(Ce) slab scintillator, 8 × 8 array Multi Pixel Photon Counter (MPPC), 64 channel amplifier, a shaper and ADCs. This paper reports the concept of this system and the results of characteristics of this system.