Application of carbon nanohorn containing boron to BNCT

K. Nakai[1,2], K Endo[2], A. Zaboronok[2], E. Sato[2], F. Yoshida[2], T. Kurita[2], M. Yudasaka[3], S. Okazaki[3], Y. Iizumi[3], Y. Ishikawa[3], Y. Ikehara[3], S. Taskaev[4], D. Kasatov[4], A. Makarov[4], I. Schudlo[4], I. Sorokin[4], T. Sycheva[4], V. Kanygin[4], O. Volkova[5], L. Mechetina[5], A. Taranin[5], M. Koka[6], N. Yamada[6], A. Kitamura[6], T. Satoh[6], T.Yamamoto[2] and A. Matsumura[1]

[1]*Ibraki prefectural University of Health Sciences, Ibaraki japan,*
[2]*Department of Neurosurgery, Faculty of Medicine, University of Tsukuba, Tsukuba Japan*
[3]*National Institute of Advanced Industrial Science and Technology, Tsukuba Japan*
[4]*Budker Institute of Nuclear Physics, Novosibirsk, Russia*
[5]*Institute of Molecular and Cell Biology, Novosibirsk, Russia*
[6]*Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency Takasaki Japan*

email: knakai@neurosurg-tsukuba.com

Carbon nanohorn (CNH) is horn-shaped sheath aggregate of graphene sheets. CNH can be a candidate of drug delivering. We use CNH as a boron delivery system, Boron source was BNC_2 and these are encapsulated in the CNH. The surface of the CNH or Boron-capsulated-CNH were coated with polyethylene glycol with or without folic acid. (CNH, CNH-FA, BN-CNH, BN-CNH-FA)

To evaluate these four nanoparticles, because there was no neutron source for experiment in Japan in 2015, we use the accelerator based neutron source of Budker institute of Nuclear Physics (Novosibirsk, Russia). Due to export controls, all boron agents were made of natural isotopic composition.

V79 and U251 cell line were used. Cell medium were adjusted 40μg Boron-10/mL for boron BN-CNH, same concentration were used for CNH. After 24hrs exposure, cells were suspended and samples were irradiated neutron with tandem accelerator of Budker institute of Nuclear Physics. Because the thermal neutron dose was not equal to previous Japanese reactors, and the methods of calculations are also different, boric acid were used as a control. The colony forming assay were performed, survival rate was compared with controls.

Micro-PIXE/PIGE analysis was performed at Takasaki Ion Accelerators for Advanced Radiation Application (TIARA, Takasaki, Japan). The cellular samples with same condition that attached on thin polycarbonate membranes were freeze-dried. Elements (Potassium, Phosphate, Boron) distribution images were analyzed using MATLAB, and calculate intra cellular area boron concentration / extra cellular area boron concentration ratio.

Survival rate of 40μg Boron-10/mL of boric acid was 0.09 for U251 and 0.19 for V79. The survival rate of CNHs has showed no difference between controls. BN-CNH showed 0.23 for U251, 0.52 for V79, BN-CHN-FA showed 0.42 for U251 and 0.51 for V79.

Though these data were incomplete, but with U251 human glioma cell lines, the intra /extra B ratio reached about 2 with carbon nanotubes, and 1 with boric acid.

Though beam dose was not well established, boric acid would be useful for control. BN-CNH revealed neutron effect at least, further investigation will have needed.