Optimizing X-ray source for glioma radiotherapy with gold nano-particles

Alexander Zaboronok[1], Hideo Tsurushima[1], Tetsuya Yamamoto[1, 2], Tomonori Isobe,[2] Kenta Takada,[2] Akira Matsumura[1]

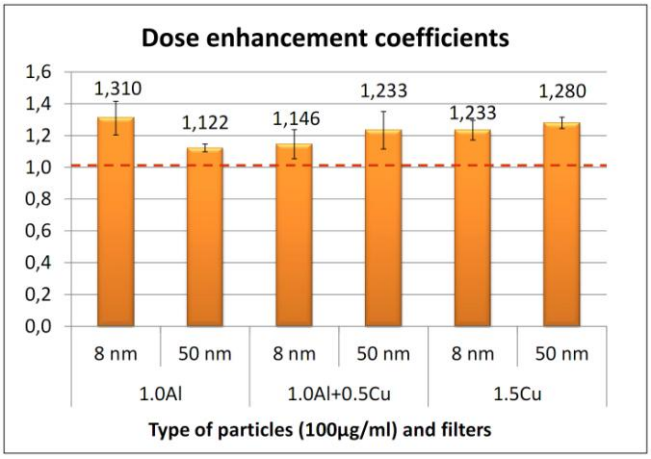
1 Department of Neurosurgery, University of Tsukuba、2 Proton Medical Research Center, Tsukuba University Hospital

Malignant gliomas, accounting for about 50% of all tumors of the central nervous system, are characterized by fast invasive growth and radioresistance. Specific radiosensitizers may solve the problem of radioresistance and prolong life of patients. Gold, as a high-Z element (Z=79), can be used as a radiosensitizer to enhance the effect of X-rays in the form of nano-particles.

In a number of publications little attention was paid to the description of optimal treatment conditions, such as proper X-ray filtration in compliance with the size of gold nano-particles (GNPs). Theoretically, the effect of radiotherapy enhancement with GNPs is determined by Auger electrons and additional photons emitted by gold atoms being irradiated with X-rays. The emitted electrons and photons interact with water molecules producing free radicals, which break the DNAs of tumor cells.

In our study we evaluated the additional effect of GNPs by determining the amount of additional free radicals formed in buffer water solution (PBS) after irradiation with X-rays using different filters. The spectra of the biological irradiator Hitachi MBR-1520R (150kV, 20mA), used in our experiments, were calculated by *SpekCalc* software, based on Poludniowski method.

We used non-fluorescent agent Dihydrorhodamine-123 (DHR-123), which is transformed by free radicals into fluorescent Rhodamie-123. 8 and 50 nm GNPs were diluted in PBS to the concentration of 100 μg/ml, and then irradiated with X-rays using 1.0mm Al, 1.0mm Al+0.5mm Cu or 1.5mm Cu filters. The effect of GNPs combined with proper filtration was later evaluated by colony forming assay with human U251 malignant glioma cell line.



Our study have shown that the increase in free radicals of about 30% is observed using 1.0mm Al filter (mostly soft X-rays) with smaller 8 nm GNPs and 1.5mm Cu filter (shift to harder X-rays) with bigger 50nm gold nano-particles. U251 cells survival in colony forming assay confirmed the results of the additional free radicals evaluation.