AbstractID: 13208 Title: Monte Carlo Simulation of Dose Enhancement in Tumors Using Gold Nanoparticles

Purpose:
In the radiation oncology setting, high atomic number (Z) nanoparticles may provide a local dose enhancement in tumors when combined with low energy x-rays. At energies near the K-shell edges of these materials, the mass energy absorption coefficient (μ_{en}/ρ) may be significantly higher than that of tissue. For materials such as gold, the K-shell edge falls in the lower energy spectrum of a conventional CT scanner. Irradiating nanoparticles inside tumor with a CT scanner may provide a high dose to the tumor while sparing healthy surrounding tissue. As a first step, a simulation of gold nanoparticles in a phantom can quantify the magnitude of this effect.

Methods:
Monte Carlo simulations were performed for different concentrations of gold using the program MCNPX. Simulations were performed using a cylindrical phantom with a tumor having various concentrations of gold nanoparticles. Four concentrations of nanoparticles were used: no gold, 1mg/g, 5mg/g, 10mg/g. The source of radiation was modeled using the spectrum of a 140kVP CT scanner. Each scenario was run using 10^9particles.

Results:
For all cases, the total energy deposited in the target was determined. These calculations indicate that using nanoparticles provides a sizeable increase in the energy deposited inside the target. For 1mg/g, 5mg/g, and 10mg/g nanoparticle concentration the increases were 1.13, 1.78, and 2.58 times relative to no gold.

Conclusions:
Monte Carlo simulations of a phantom with different concentrations of gold nanoparticles irradiated by an x-ray source reveal a dose enhancement relative to no nanoparticle presence. Dose enhancements of over 2.5 times for nanoparticle concentrations of up to 10mg/g indicate that localizing nanoparticles in tumor may be effective at providing an improved therapeutic ratio. The results of this simulation can be used to guide measurements for confirmation of this effect.

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