Using radio waves to bake tumors

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(Phys.org) -- Nanothermal therapy - the use of nanoparticles to cook a tumor to death - is one of the many promising uses of nanotechnology to both improve the effectiveness of cancer therapy and reduce its side effects. Now, a team of investigators from the Texas Center for Cancer Nanomedicine has shown that liver cancer cells will take up targeted gold nanoparticles, absorb radio waves, and generate heat that damages the cells. In addition, the researchers have discovered how to increase the thermal toxicity of these nanoparticles.

This research was led by Steven A. Curley, of the University of Texas M.D. Anderson Cancer Center, and Lon Wilson, of Rice University. The investigators published their results in the journal Nanomedicine.

Biocompatible gold nanoparticles are ideal vehicles for delivering heat to tumors because they are non-toxic, stable, and can be coated with a variety of molecules to target them to tumors. Unlike conventional anticancer agents, gold nanoparticles are harmless unless first activated by an energy source, such as a near-infrared light delivered by a laser. In fact, laser-activated gold nanoparticles are being tested in human clinical trials for the treatment of head and neck cancer. Radio waves, however, have a potential advantage over laser energy because radio waves do not interact with biological tissues and thus can penetrate more deeply within the body than can laser light.

One of the major obstacles to using radiofrequency-activated gold nanoparticles to treat cancer is their tendency to clump together, which reduces their ability to absorb energy and convert it to heat. In the current study, the Texas researchers aimed to develop a precise understanding of why clumping occurs and develop the means to keep it from happening. Their experiments showed that the low pH within endosomes - the tiny vesicles that bring antibody-targeted nanoparticles into cells - is the primary cause of aggregation.

In an attempt to neutralize the acidic pH within endosomes, the investigators treated the cells with one of two different drugs - concanamycin A, an antibiotic not designed for use in humans, and chloroquine, an approved antimalarial agent - that are known to prevent endosome acidification. When the treated cells were exposed to antibody-targeted gold nanoparticles and then radiofrequency activation, heat-triggered cell death increased markedly compared to that seen with cells that were not pre-treated with the acid blockers, by preserving the protein coating on the gold nanoparticle surface. Based on these results, the investigators are now developing antibody-targeted nanoparticles with coatings that will prevent aggregation in the acidic environment of the endosome.

This work, which is detailed in a paper titled, "Stability of antibody-conjugated gold nanoparticles in the endo-lysosomal nanoenvironment: Implications for non-invasive radiofrequency-based cancer therapy," was supported in part by the NCI's Physical Sciences-Oncology Center program, a comprehensive initiative designed to accelerate the application of nanotechnology to the prevention, diagnosis, and treatment of cancer. An abstract of this paper is available at the journal's website.

More information: View abstract here.

Provided by National Cancer Institute

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