Golden Nanotubes Detect Tumor Cells, Map Sentinel Lymph Nodes

September 24 2009

(PhysOrg.com) -- Biomedical researchers at the University of Arkansas in Fayetteville and the University of Arkansas for Medical Sciences (UAMS) in Little Rock have developed a special contrast-imaging agent made of gold-coated carbon nanotubes that is capable of molecular mapping of lymphatic endothelial cells and detecting cancer metastasis in sentinel lymph nodes. The findings from this study, which was led by Jin-Woo Kim, Ph.D., M.S., University of Arkansas, and Vladimir P. Zharov, Ph.D., D.Sc., M.S., UAMS, were published in the journal *Nature Nanotechnology*.

Photoacoustic and photothermal methods developed by Dr. Zharov deliver energy, via laser pulses, into biological tissue through interaction of the laser light with carbon nanotubes. When some of the energy is absorbed by the carbon nanotubes and converted into heat, the nanotubes expand and emit sound waves. However, carbon nanotubes have not been previously developed as an imaging agent because of concerns about toxicity.

Dr. Kim's research team addressed the toxicity problem by depositing a thin layer of gold around the carbon nanotubes, enhancing absorption of laser radiation and reducing toxicity. In vitro tests showed only minimal toxicity associated with the gold nanotubes. Compared with existing nanoparticles, the gold nanotubes also exhibited high laser absorption at a miniscule diameter. The gold nanotubes required extremely low laser energy levels for detection, and low concentrations were required for effective diagnostic and therapeutic applications.

In the current study, the investigators coupled their gold nanotubes with an antibody specific to a critical lymphatic-endothelial receptor. This enabled the researchers to map the endothelial cells that line the internal surface of lymphatic vessels. This is important because lymphatic endothelial cells come into direct contact with other cells, such as immune-related cells, tumor cells, and bacteria entering the lymphatic system. The specific receptor, known as LYVE-1, is one of the most widely used markers of lymphatic endothelium.

In one set of experiments, the research team successfully demonstrated the unique ability of the gold nanotubes for integrated diagnosis and therapy at the single-cell level. First, they used photoacoustic spectroscopy to detect gold nanotubes that were binding to tumor cells within sentinel lymph nodes, the first lymph node or group of nodes reached by metastasizing cancer cells from a primary tumor, in mice bearing human tumors. They then switched to photothermal mode, which involved boosting the laser intensity by approximately sixfold, and demonstrated that they were able to destroy those very tumor cells.

This work, which is detailed in the paper “Golden carbon nanotubes as multimodal photoacoustic and photothermal high-contrast molecular agents,” was supported by the National Cancer Institute. An abstract is available at the journal’s Web site.

Provided by National Cancer Institute (news : web)

Citation: Golden Nanotubes Detect Tumor Cells, Map Sentinel Lymph Nodes (2009, September 24) retrieved 19 April 2024 from https://phys.org/news/2009-09-golden-nanotubes-tumor-cells-sentinel.html

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