Biocompatible quantum dot images tumors in live animals

January 20 2012

Quantum dots, small semiconductor nanoparticles that fluoresce brightly with sharply defined colors, have tremendous promise as biomedical imaging agents except for one problem—most are made from potentially hazardous materials such as cadmium and selenium. Now, however, a collaborative effort between researchers at Stanford University and Xiamen University in China has produced a stable, biocompatible quantum dot that appears to have the desired set of properties needed for biomedical imaging.

The team led by Zhen Cheng of Xiamen University and Sanjiv Gambhir of Stanford University School of Medicine reported its work in the journal *Nano Letters*. Dr. Gambhir is the co-principal investigator of the Stanford University Center for Cancer Nanotechnology Excellence and Translation.

To solve the biocompatibility problem, the investigators searched for semiconducting materials that had the desired optical properties of fluorescing in the near-infrared region of the spectrum and yet were not potentially toxic. They settled on a combination of indium phosphide and zinc sulfide and created a nanoparticle with an indium phosphide core and a zinc sulfide shell. The resulting quantum dots fluoresced brightly at 710 nanometers, a wavelength of light that passes through biological tissues and can be seen from within the body. To improve the pharmacological properties of the quantum dots—their ability to travel unimpeded through the blood stream, penetrate tissues, and reach biological targets—the researchers coated the nanoparticles with a

biocompatible polymer known as a dendrimer. This coating also served as a convenient attachment point for a three amino acid peptide arginine-glycine-aspartic acid, known as RGD, that targets many types of tumors.

Tests with cancer cells and tumor-bearing animals demonstrated that these nanoprobes clearly imaged tumors known to bind to RGD. Because of their small size, the quantum dots accumulated in tumors via the leaky blood vessels that surround tumors. Biodistribution tests showed that approximately 60 percent of an injected dose of the new quantum dots was cleared from the body within a day, and that 100 percent clearance was achieved within one week. Equally important, animals dosed with this new type of nanoparticle experienced no apparent ill effects.

This work, which is detailed in a paper titled, "A novel clinically translatable fluorescent nanoparticle for targeted molecular imaging of tumors in living subjects," was supported in part by the NCI Alliance for Nanotechnology in Cancer, 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.

Provided by National Cancer Institute