Carbon Nanotubes Target Tumors

January 8 2007

In the first experiment of its kind, investigators at the Center for Cancer Nanotechnology Excellence Focused on Therapy Response (CCNE-TR), based at Stanford University, have shown that single-walled carbon nanotubes (SWCNTs) wrapped in poly(ethylene glycol), or PEG, can successfully target tumors in living animals. The results of this work, which was conducted by Hongjie Dai, Ph.D., and colleagues, appear in the journal *Nature Nanotechnology*.

The CCNE-TR team began by coating commercially available SWCNTs with PEG, a biocompatible polymer used frequently in drug delivery applications to increase circulation lifetimes and water solubility. The investigators used PEG of two different lengths, producing coated SWCNTs of 1 nanometer in diameter/100 nanometers in length or 5 nanometers in diameter/300 nanometers in length.

The researchers then attached a tumor-targeting peptide known as cyclic-RGD to the end of the PEG chains. RGD, short for the arginine, glycine, and aspartic acid amino acids that make up this peptide, binds to the protein $æ_v ß_3$, which is found on the surface of certain types of malignant cells. Each nanotube contained multiple cyclic-RGD targeting molecules.

To track the nanotubes in living animals, the researchers also attached to the PEG chains multiple copies of a molecule, known as DOTA, that will bind to various metal ions. In this case, the investigators used the DOTA molecules to bind a radioactive isotope of copper, 64Cu, which can be imaged using positron emission tomography (PET). Stability assays showed all of these add-ons remained firmly attached to the

nanotubes even after heating them to 70°C for more than one week.

The investigators injected a solution of this nanotube into mice bearing tumors that express $æ_v ß_3$ on their surfaces and used PET to track the fate of the nanotubes over the next 24 hours. This experiment showed that 10 to 15 percent of the SWCNTs coated with the larger PEG molecules accumulated within tumors. Uptake was rapid, reaching a maximum within 6 hours after injection.

In contrast, only 3 to 4 percent of the nanotubes coated with the smaller PEG molecules accumulated in tumors. The investigators were able to confirm the presence of the targeted SWCNTs in tumors using Raman spectroscopy, which can detect the unique optical signals emitted by these nanotubes.

This work, which was funded by the National Cancer Institute's Alliance for Nanotechnology in Cancer, appears in a paper titled, "In vivo biodistribution and highly efficient tumour targeting of carbon nanotubes in mice." An abstract of this paper is available at the journal's website.

Source: National Cancer Institute