Mining Tiny Diamonds for Drug Delivery

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Northwestern University researchers have shown that nanodiamonds are effective at delivering chemotherapy drugs to cells without the negative effects associated with current drug delivery agents. Their study, published in the journal *Nano Letters*, is the first to demonstrate the use of nanodiamonds, a new class of nanomaterials, in biomedicine. In addition to delivering cancer drugs, the model could be used for other applications, such as fighting tuberculosis or viral infections, say the researchers.

Nanodiamonds promise to play a significant role in improving cancer treatment by limiting uncontrolled exposure of toxic drugs to the body. The research team, headed by Dean Ho, Ph.D., reports that aggregated clusters of nanodiamonds were shown to be ideal for carrying a chemotherapy drug and shielding it from normal cells so as not to kill them, releasing the drug slowly only after it reached its cellular target.

Another advantage of the material, confirmed by a series of genetic studies also reported in the paper, is that nanodiamonds do not cause cell inflammation once the drug has been released, and only bare diamonds are left. “There are a lot of materials that can deliver drugs well, but we need to look at what happens after drug delivery,” said Ho. “How do cells react to an artificial material left in the body? Nanodiamonds are highly ordered structures, which cells like. If they didn’t, cells would become inflamed. From a patient’s perspective, this is very important.”

To make the material effective, Ho and his colleagues manipulated single nanodiamonds, each only 2 nanometers in diameter, to form

aggregated clusters of nanodiamonds, ranging from 50 to 100 nanometers in diameter. The drug, loaded onto the surface of the individual diamonds, is not active when the nanodiamonds are aggregated; it only becomes active when the cluster reaches its target, breaks apart, and slowly releases the drug.

Because of the large amount of available surface area, the clusters can carry a large amount of drug, nearly five times the amount of drug carried by conventional materials. Nanodiamonds are also soluble in water, an important property for any potential drug delivery vehicle.

For their study, Ho and his team used living murine macrophage cells, human colorectal carcinoma cells, and doxorubicin hydrochloride, a widely used chemotherapy drug. The drug was successfully loaded onto the nanodiamond clusters, which efficiently ferried the drug inside the cells. Once inside, the clusters broke up and slowly released the drug.

In the genetic studies, the researchers exposed cells to the bare nanodiamonds (no drug was present) and analyzed three genes associated with inflammation and one gene for apoptosis (cell death) to see how the cells reacted to the foreign material. Looking into the circuitry of the cell, they found no long-term toxicity or inflammation and no cell death. In fact, the cells grew well in the presence of the nanodiamond material.

This work is detailed in the paper “Active nanodiamond hydrogels for chemotherapeutic delivery.” An investigator from NanoCarbon Research Institute, Ltd., also participated in this study. This paper was published online in advance of print publication. An abstract of this paper is available through PubMed.

Source: National Cancer Institute