Custom Nanoparticle Regresses Tumors When Exposed to Light

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A unique nanoparticle to deliver a localized cancer treatment inhibits tumor growth in mice, according to a team of Penn State researchers.

The nanoparticles, developed by Daniel Hayes, associate professor of biomedical engineering, have a specific chemistry that allows a microRNA (miRNA) to attach to it. A miRNA is a molecule that when paired to a messenger RNA (mRNA) prevents it from operating. In this case, it prohibits the mRNA in a cancer cell from creating proteins, which are essential for that cancer cell to survive.

In their study, the researchers delivered nanoparticles to the cancer cells of mice through an IV. Once the nanoparticles built up in the cancerous area, they used a specific wavelength of light to separate the miRNA from the nanoparticles. The miRNA then pairs with a mRNA in the cancer cell, causing the mRNA to stop making proteins. Eventually, the cancer cell dies.

Their paper appeared on June 22 in the journal Biomaterials.

“This delivery method gives you temporal and spatial specificity,” said Adam Glick, professor of molecular toxicology and carcinogenesis. “Instead of having systemic delivery of a miRNA and the associated side effects, you are able to deliver the miRNA to a specific area of tissue at a specific time by exposing it to light.”

Hayes said having temporal and spatial specificity is important when dealing with cancer treatments.

“miRNA can have vastly different effects in different types of tissue which can lead to unwanted side effects and toxicity,” Hayes said. “Delivering and activating miRNA only at the site of the tumor reduces these side effects and can increase the overall effectiveness of the treatment.”

Using this method, Yiming Liu, a biomedical engineering graduate student in the Hayes Laboratory, was able to show that skin tumors in about 20 mice that were given the miRNA coupled nanoparticle and exposed to light completely regressed within 24 to 48 hours and did not regrow.

Additionally, the specific miRNA that Hayes and Glick are using may be more effective in killing cancer cells than other similar methods.

“What is different about this as a therapeutic is that the miRNA that we are using can regulate a broad set of genes and is particularly powerful to treat a heterogenous disease such as cancer,” said Liu.

This could mean that the overall effectiveness of killing a cancer cell is higher because the treatment is attacking multiple points in that cell. It may also lead to a decrease of a cancer cell’s ability to become resistant to the treatment because the miRNA is able to pair with different mRNAs in the cancer cell, diversifying the ways in which it can stop the cell from producing proteins.

The types of cancer that might be responsive to this type of treatment include cancers in the oral cavity, the gastrointestinal system or the skin — anywhere that could be exposed to light via a fiber optic cable.

“We would like to develop this further for internal tumors that are more significant in terms of mortality, such as esophageal cancer,” Glick said.

Read the original article on Pennsylvania State University (Penn State).