Trackable and Guided ‘Nanomissiles’ Deliver Cancer-fighting Drug Straight to the Tumor

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Researchers from Skoltech and their colleagues from Hadassah Medical Center have developed hybrid nanostructured particles that can be magnetically guided to the tumor, tracked by their fluorescence and pushed to release the drug on demand by ultrasound. This technology can help make cancer chemotherapy more targeted. The paper was published in the journal Colloids and Surfaces B: Biointerfaces.

Current treatments for cancer include chemotherapy, immunotherapy, radiation, and surgery, but these are often not selective enough to target just the tumor and not the healthy tissues around it. They are also highly toxic for the whole organism, which makes therapy hard to tolerate for the patient. One solution to these problems is so-called focal therapy, and specifically delivering drugs to the tumor in nanoparticles, for which several biocompatible materials have been explored. That technology can also be used for diagnostic purposes, augmenting medical imaging.

The Skoltech team, led by Professor Dmitry Gorin from the Center for Photonics and Quantum Materials and Professor Timofei Zatsepin from the Center for Life Sciences, developed multifunctional nanostructured particles containing magnetic nanoparticles, fluorescent Cy5 or Cy7 dyes, and the drug doxorubicin. MRI imaging was performed by Dr. Kirill Petrov from the Hadassah Medical Center. Dynamic light scattering, fluorescent tomography, and histology studies were performed using the equipment of the Bioimaging and Spectroscopy Core Facility of the Skolkovo Institute of Science and Technology.

These tiny capsules can be magnetically guided to the specific sites of the tumor, provide good contrast in high-resolution MRI, optoacoustic, and fluorescent imaging, and can be triggered to release the drug with ultrasound. Multicomponent capsules allow multifuctionality of the capsules: multimodality for imaging (fluorescent, optoacoustic, MRI), remote release (focused ultrasound), and navigation (magnetic field gradient).

“Drug delivery carriers were prepared by combination of two methods. The first one was suggested by the co-authors of this article earlier and is called freezing induced method (FIL). This method has been successfully applied for loading of vaterite submicron particles by inorganic nanoparticles, proteins, low molecular drugs etc. The vaterite particles served as templates for drug delivery carriers and were removed after formation of a polymeric shell. Second method is layer by layer assembly that has been used for polymer biodegradable shell formation,” Gorin explains.

The team used in vitro experiments and in vivo animal studies to show that the method is functional: they were able to show increased targeted delivery of doxorubicin in the liver after ultrasound-mediated release.

“This technology should pass preclinical studies using animal models to evaluate therapeutic efficiency and safety of such drug delivery system. It will be the next step of our research,” Zatsepin notes.

Read the original article on Skolkovo Institute of Science and Technology (Skoltech).