Nanoparticle-based thermal treatment cures intestinal cancer in mice

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A group of scientists from NUST MISIS has presented the test results of an innovative oncotherapy technology based on hyperthermia—heating nanoparticles that have been introduced into a tumour to kill it. A drug based on cobalt ferrite nanoparticles cured 100% of the mice with

intestinal cancer from the experimental group. Project results have been published in the *Nanomedicine: Nanotechnology, Biology, and Medicine* international scientific journal.

Magnetic hyperthermia is a new and developing method of treating cancer, in which intense heating can cause cellular protein denaturation, which quickly destroys tumor cells. However, to protect healthy tissues, the method involves the selective introduction of an agent with magnetic properties into the tumor. Via these properties, it provides localized and controlled heating in the presence of an electromagnetic field. The agent, composed of metal oxide nanoparticles, contacts the tumor cells and heats up under the influence of a kilohertz variable electromagnetic field, destroying them.

However, the technology has not yet been systematized. Scientists are looking for materials, and most importantly, temperature conditions that are the most effective for this procedure. Material scientists and biochemists at the NUST MISIS Biomedical Nanomaterials Laboratory have reported promising in vitro and in vivo studies that have shown that for successful antitumor therapy, it is necessary to select the temperature regimen specifically for each type of cancer.

In particular, the group achieved the complete elimination of malignant neoplasms in 100% of mice with colon cancer after heating the tumor at a temperature in the range 41-43 °C. The scientists used cobalt ferrite nanoparticles, which have high magnetic properties, meaning that they can heat cells and tissues in a wide temperature range in response to the influence of the electromagnetic field. In addition, they are extremely stable under physiological conditions, have no toxic effect on cells and tissues of the body, and they can also be easily and inexpensively obtained.

"We have been observing the groups of animals with two different tumor

models—patients with mildly aggressive colon cancer CT26 and aggressive metastatic breast cancer 4T1. Both groups received an injection of a suspension of cobalt ferrite nanoparticles into the tumor and further therapy with magnetic hyperthermia at three different temperature conditions," says Anastasia Garanina, an engineer at the Biomedical Nanomaterials Laboratory at NUST MISIS.

The scientists conducted a comparative analysis of the effects of different temperatures on two models of malignant tumors—non-aggressive and actively metastatic—and have found that colon cancer cells are more sensitive to hyperthermia and die even when heated in the range 41-43 ° C.

"Breast cancer, according to a series of experiments, turned out to be more resistant to heat, and its cells died only with high-temperature hyperthermia greater than 47 °C, " Garanina adds. In the groups of animals that were treated at temperatures of 46-48 °C and 58-60 °C, the survival rate was 25-40%. However, the researchers discovered that magnetic hyperthermia therapy leads to a reduction in the incidence of metastases in the animal's body compared to surgical removal of the tumor.

Currently, the team continues laboratory research to optimize the work of nano preparation as part of preclinical studies.

More information: Anastasiia S. Garanina et al. Temperature-controlled magnetic nanoparticles hyperthermia inhibits primary tumor growth and metastases dissemination, *Nanomedicine: Nanotechnology, Biology and Medicine* (2020). DOI: 10.1016/j.nano.2020.102171

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