USE OF NANOTECHNOLOGIES AT THE CREATION OF MODERN DRUGS IN ONCOLOGY

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Despite the fact that the field of nanomedicine is still in its infancy, it has already been established that the creation of nanodrugs that will be delivered directly to the target organ with the blood flow is promising. This formulation of the question is the most relevant in the field of oncology, since until today the leading place in the treatment of cancer patients is occupied by drug therapy. At the same time, numerous clinical observations show that the prescription of chemotherapy drugs is associated with a number of significant problems. First of all, this is the high toxicity of antitumor drugs to organs and tissues not affected by the tumor.

When designing drug delivery systems, special attention should be paid to issues related to the choice of nanomaterials.

Magnetic nanoparticles are a promising object for possible applications in medicine. Magnetic nanoparticles are known to be used in medicine for magnetic separation techniques as contrast agents in magnetic resonance imaging, for local hyperthermia, or as magnetically oriented carriers for delivery of a multi-drug system. For use in biological organisms, these particles must be biocompatible. It turned out that starch-coated magnetic iron oxide nanoparticles were well tolerated.

Magnetite particles exhibit superparamagnetic properties and can be attracted by an external magnetic field. In addition, nanosized particles must be small enough to prevent occlusion of the vascular system, especially capillaries. The required particle size is likely to be less than 5 µm. On the other hand, magnetic nanoparticles should not be too small to be attracted by an external magnetic field gradient.

For local chemotherapy of cancer, the possibility of using iron oxide nanoparticles coated with starch, dispersed in deionized water by intra-arterial application in the tumor artery and delivered to the target area by applying an external magnetic field of 1.7 T was investigated. The magnetic particles were coupled to the chemotherapeutic agent mitoxantrone and held after being delivered to the tumor site with a strong external magnetic field gradient (magnetic drug targeting). It has been shown that the applied dose of the drug can be reduced to 20% of the usual systemic dose. Tumor remission was achieved without any of the negative side effects that often occur after regular cancer chemotherapy. These results point to the great advantage of this magnetically targeted drug delivery system due to the reduced amount of this chemotherapeutic agent protecting healthy tissue.

The successful use of drugs by magnetic targeting is associated with the need for prompt (in a short period of time) determination of the amount of the drug in vivo by determining the concentration of magnetic nanocarriers of the drug. Magnetic resonance imaging (MRI) can serve as such a method.

Magnetic nanoparticles change the electromagnetic excitation spectra of organic molecules in the human body. Registration of these spectra using MRI provides information about the distribution of particles in space and, consequently, the concentration of drugs associated with them.

External control of nanocomposites with a drug substance can be carried out with a constant, variable, pulsed and combined magnetic field, which provides not only targeted drug delivery, but also its prolonged action with gradual release from the tumor.

The results of the analysis aimed to study the effect of a constant magnetic field and ultrasound showed that it is possible not only to ensure the directed movement of the nanocomposite, but also to determine the concentration of magnetite nanoparticles in the target area by the magnitude of the induction voltage caused by oscillations of nanoparticles in a constant magnetic field and by the ultrasound intensity. The experiment was carried out using magnetite nanoparticles, the concentration of which was not more than 0.15% in a colloidal medium with blood viscosity. It turned out that the concentration of magnetic nanocarriers was proportional to the magnitude of the induction voltage caused by oscillations of nanoparticles in a constant magnetic field and velocity of the nanoparticles was proportional to the magnitude of the constant magnetic field.

In contrast to the MRI method, in this method using the action of ultrasound on magnetic particles moved by a constant magnetic field, the magnitude of the constant magnetic field is significantly lower than in the MRI method (three or more T), which makes this method safer for the body. Note that 1.7 T is sufficient for drug delivery by a magnetic field, which is almost two times less than the field in magnetic resonance imaging.