Nanotechnology in medicine/Nanomedicine in oncology

Nanomedicine provides means that can be used both diagnostically and therapeutically. Nanosensors can be used as sensitive sensor, e.g. on biochips analyzing a whole range of analytes, including possible DNA or RNA sequence analyses. Nanoparticles can also be used as contrast agents in imaging methods to determine the extent of cancer. In therapy, nanoparticles are used as transport medium for the targeted application of substance that are toxic to tumor cells and also used as carriers of substances that increase the tumor´s sensitivity to other incentives, or they can increase this sensitivity themselves.

Nanotechnology in oncological diagnostics

The relationships between nanotechnology and molecular medicine are applied and used when detecting a tumor and determining its type, i.e. determination of typing and grading. In simpler terms, molecular medicine will supply the parameters that identify the tumor and the nanomedicine will supply the procedures that allow these parameters to be evaluated. Analyzing the datas is not easy, because of the large amount of data are obtained. Here, nanomedicine meets another relatively new and rapidly developing field, named bioinformatics. Nanochips are the mainly used nanotechnological application.

Determing the type of tumor alone is not enough in clinical practice, because for a complete diagnosis you also need to know the staging. Here, nanomedicine offers an expansion of the possibilities of imaging methods, mainly by constructing more perfect contrast agents for practically all diagnostic modalities. Contrast agents in connection with nanotechnologies can acquire new qualities that significantly improve diagnostic capabilities. One of these new qualities is the **multimodality of nanocontrast agents**. For example, a paramagnetic substance can be enclosed in one case as a magnetic resonance contrast agent and a fluorescent substance for easier intraoperative differentation of healthy and pathological tissue. Another advantageous quality oftenly used that nanoparticles can bring is the possibility of measuring the nanoparticle by a receptor, thanks to which the distribution of specific surface molecules can be monitored in the patient´s body. The main nanotechnological application are liposomes or fullerens.

Nanotechnology in oncology therapy

Nanomedicine offers procedures that enable the targeted transport of cytotoxic substances to the tumor with maximal sparing of the surrounding tissues. Liposomes are mainly used for transporting the drugs, which can transport lipophilic and hydrophilic substances of a relatively large volume. The disadvantage of liposomes is primarly the limited possibility of targeting. Targeting can be achieved much easier with, for example dendrimers, but the limiting factor here is only a small transport capacity.

At the same time, cytostatics aren´t the only toxic substances for the tumor. Concepts related to the radiotherapy or tumor sensitization to other external physical factors are also being developed.

An example of the use of nanoparticles in radiotherapy is increasing the effectiveness of neutron capture therapy. Boron isotope 10B is injected into a nanoparticle, e.g. a dendrimer, and afterward the tumor is infiltrated with such nanoparticles. When the target field is irradiated with neutrons, boron nuclei react with slow neutrons (thermal and near-thermal) to form an α particle and the isotope 7 Li. The newly created particles then destroy the tumor locally.

Another interesting application is the targeted hyperthermia used on a tumor by the action of an external magnetic field. A ferromagnetic substance is injected into the nanoparticle, then the tumor is infiltrated with such nanoparticles and after the exposure to a variable magnetic field, a significant heating and thermal destruction happens. Similarly, nanofoam can also be used, which is also interesting because its ferromagnetic properties disappear relatively quickly.

In the therapy of tumors located close to the surface of the body, the fact that the tissues have only a small absorbance for near infrared radiation can be used. Nanocases can be mae so that their absorbation maximum lies precisely in the near-infrared region. After saturating the tumor with these nanocapsules and after being irradiated with practically harmless near-infrared radioation, thermal destruction of the tumor occurs.

Links

Literature

- JAIN, Kewal K.. *The Handbook of Nanomedicine.* 1. edition. Humana Press, 2008. ISBN 9781603273183.

External links

- Robert A. Freitas Jr.: Nanomedicine (https://foresight.org/Nanomedicine/)
- Václav Gerla: Nanotechnologie v medicíně (semestrální práce FEL ČVUT) (http://nanomedicina.sweb.cz/)

Lecture presentation

- Carmel J. Caruana: Nanotechnologie v medicíně (http://www.med.muni.cz/biofyz/doc/lec-cs/NanotechnologieVMedicine-1h.ppt)
- J.Šrámek: Nanotechnologie v medicíně (2008/09) (http://www.med.muni.cz/~formol/doc/nano-prezentace.pdf)