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Magnetic nanoparticles and cancer treatment

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Key point

Nanotechnologies are widely spreading in medicine to cancer detection and therapy. Modern anticancer therapies are based on the targeted delivery of magnetic nanoparticles (MNPs) into the tumor cells, causing specific tumor destruction. One of the applications of MNPs is treatment of cancer by different ways such as loading drugs onto MNPs and directed them into the tumor tissue.

Introduction

Nowadays, nanotechnologies are widely spreading in medicine to cancer detection and therapy. Magnetic nanoparticles (MNPs) because of their unique physical properties and being excellent candidate for application at the cellular and molecular level of biological interactions are considered as the next generation of targeted drug delivery. The aim of this paper is to introduce of application of MNPs as targeted drug delivery into the tumors for purposes of cancer treatment.

Modern anticancer therapies are based on the targeted delivery of MNPs into the tumor cells, causing specific tumor destruction (1). In this regard, MNPs due to their biocompatibility, nontoxicity, ease of surface modification and magnetic properties is a good candidate and can be used in combination with chemo- or radiotherapy (2-4). MNPs are synthesized by several methods such as co-precipitation, thermal decomposition, sol-gel reaction, sonochemical method and polyol method (5,6).

They can be modified with biocompatible coatings as well as targeting and therapeutic molecules are used in medical imaging (2-7), drug delivery and hyperthermia (8). Magnetic hyperthermia, which is induced by nanoparticles (NPs) conjugated with targeting agents effect offers novel approaches to cancer treatment. Recently, aptamers are becoming an increasingly popular class of targeting agents, and are an interesting alternative to antibodies (1).

Application of MNPs

Before using MNPs in vivo, their general properties in terms of hydrodynamic size, shape should be considered. In this section these considerations will be discussed briefly. It has been observed that smaller sized, spherical NPs increase the nanoparticle concentration at the center of a blood vessel and thereby limiting interactions with endothelial cells and prolonging nanoparticle blood circulation time (8). Another factor that affects on bio-distribution is nanoparticle shape and related studies suggests that anisotropically shaped NPs can avoid bio-elimination better than spherical NPs (9).

The important issue in drug delivery is to direct MNPs to the desired tissue selectively, not non-specific binding to the normal tissues. NPs can be engineered so that bind to target tissue specifically by passive, active and magnetic targeting ways (7,8).

The surface of MNPs is coated with various materials in order to limiting agglomeration of iron oxide cores, better functionalization of them with drug molecules, targeting ligands (10).

Surface coating of MNPs can be accomplished through different materials such as organic materials like polyethylene glycol (PEG), dextran, chitosan, polyethyleneimine (PEI), liposomes and micelles, and inorganic materials like gold and silica (10-13).

MNPs can be used to treat tumors in three different ways. Specific molecules such as antibodies and aptamers can be conjugated to the MNPs to selectively bind to related receptors and inhibit tumor growth (4). Also, MNPs can be used for hyperthermia for tumor therapy. Another way is to loading drugs onto the MNPs for tumor therapy (8). In MNPs-based hyperthermia, MNPs are targeted to tumor tissue and then an external alternating magnetic field is applied that induces heat through Neel relaxation loss of the MNPs (1,8). This causes increasing of tumor tissue temperature above 43°C, which causes necrosis of cancer cells (1).

Overall, MNPs have been extensively used in biomedical applications. One of the applications of MNPs is treatment of cancer by different ways such as loading drugs onto MNPs and direct them into the tumor tissue. Another way is heating cancer tissue that MNPs accumulated in it using an external alternating magnetic field.

Authors' contribution

DSG and MK wrote the paper equally.

Conflicts of interest

The authors declared no competing interests.

Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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