Magnetic smart nanosystems for the treatment of osteoarthritis

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With the development of technology and fundamental research, it is becoming possible to create nanoscale devices for applications in biomedical engineering, pharmacology, regenerative medicine and related fields of science. In this work, monodisperse magnetite (Fe_3O_4) nanoparticles were prepared by various synthesis methods, including chemical coprecipitation and laser ablation using femtosecond laser. The technology of magnetically guided targeted delivery of functionalized magnetic nanoparticles (MNPs) is investigated and will be used in the comprehensive treatment of osteoarthritis (OA) of large joints by targeting damaged tissues and immune cells. The results of the study of structural, physicochemical and magnetic properties of nanoparticles obtained by a complex of physical methods allow us to give the most complete description of the synthesized nano-objects. Special attention is paid to the interaction of magnetic nanoparticles with biological objects, including joint fluids and cells, under the action of an external magnetic field.

Osteoarthritis is the most common form of degenerative joint disease and one of the most chronic musculoskeletal diseases affecting 240 million people across the world [1]. Nanotechnology platforms may be combined with cell, gene, and biological therapies for the development of a new generation of future OA therapeutics. The prevailing age is 40-60 years. Magnetic nanoparticles and other nanotechnology-based drug and gene delivery systems may be used for targeting molecular pathways and pathogenic mechanisms involved in OA development. Magnetic fields could regulate the biological behaviors of cells, such as the morphology, proliferation and differentiation, which may be relate to magnetomechanical interactions and radical pair effects when magnetic fields interactions with the cells [2].

A high-frequency AMF would activate the magnetocaloric effect of the magnetic NPs, which would release heat and lead to the death of surrounding cells. Despite that, if the thermal dose is properly controlled, the magnetocaloric effect can be used to give promotion to the dissociation of thermo-responsive materials. Pulsed magnetotherapy is the therapeutic use of low frequency magnetic field pulses 0.125 – 1000 imp/s, magnetic induction not more than 100 mT. The high efficiency of this method is due to the threshold sensitivity of the body 0.1 Tesla. Unlike intra-articular magnet that needs to be removed after translation, the external magnetic force system with less invasiveness is easy to handle and could be completed under arthroscopy. The current research on the dynamic process of immunosuppressive nanomaterials in vivo and their interaction with immune cells are not precise and elaborate enough, and the safety still demands to be further tested.

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