Functionalized magnetic nanoparticles of iron oxides for biomedical applications

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Nanoparticles of iron oxides have been extensively studied in the last decade due to their unique magnetic, electric and optical properties. Mainly two of iron oxide polymorphs, maghemite (γ-Fe_2O_3) and magnetite (Fe_3O_4), with the desirable superparamagnetic behaviour connected with large surface area, non-toxicity and suitable surface biocompatible functionalization, are nowadays widely used in many biomedical applications such as MRI (Magnetic Resonance Imaging), drug delivery, hyperthermia or cell labelling. In biotechnologies, strong magnetic properties of magnetic nanoparticles play a key role for immobilization, separation and purification of various biosubstances such as enzymes, proteins, antibodies and nucleotides by using an external magnetic field[1].

Here we describe the synthesis of new MRI negative per-oral contrast agent consisting of superparamagnetic maghemite nanoparticles prepared from iron(II) acetate homogenously adsorbed on the surface of bentonite sheets (smectite mineral). Such prepared nontoxic biocompatible nanocomposite showing a high effective negative contrast was clinically tested on patients with various small bowel diseases. From the statistic analyses the results of the clinical tests demonstrate a desirable applicability and high diagnostic value in imaging the abdomen mainly in MRCP (Magnetic Resonance Cholangiopancreaticography). Nowadays MREg (Magnetic Resonance Enterography) investigations of patients with inflammatory bowel diseases are being evaluated. It seems it should be a promising tool especially for investigation of coeliac disease, where mesenterial edema, mural edema in jejunal loops and extraluminal free fluid are visible[2].

The second example of applicability of magnetic iron oxides nanoparticles shows the labeling of cells, which are used in cell therapy. For advanced cell-based therapy it is necessary to monitor the spatio-temporal distribution of transplanted cells *in-vivo*. Labeling the cells with superparamagnetic nanoparticles as MRI contrast agents appears to be a promising tool for the cell monitoring[3]. In our work the efficacy of labeling of mesenchymal stem cells with magnetic nanoparticles differing in size, surface shell and charge is studied (in-vitro viability tests and characterization by microscope techniques). At the same time contrast effect of magnetically labeled cells is measured by MRI phantom experiments. The results will be used to monitor stem cells in-vivo for patients after myocardial infarction or to follow-up the stem cells therapy for patients with diabetic diseases (such as diabetic foot).

References

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Figures

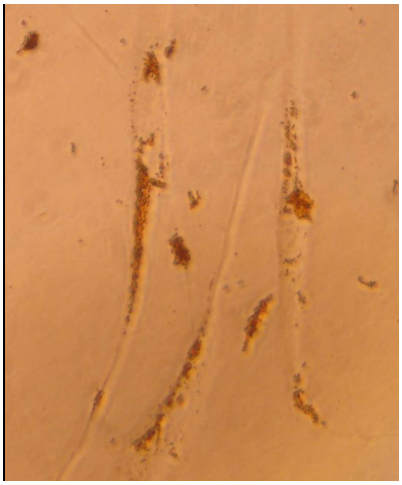

Image of mesenchymal stem cells after incubation of magnetic nanoparticles, Notice: nanoparticles incorporated into the cells did not affect cellular proliferation and viability.