Nanoparticles for Theragnostic Applications
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Introduction
Iron oxide nanoparticles (SPION) are promising candidates for various biomedical applications. Ranging from 7 to 20 nm in size, unique magnetic properties appear, such as superparamagnetism. Special inorganic or organic coatings and biological functionalization make these nanoparticles biocompatible, so they are of great interest for many categories of applications comprising separation, diagnosis and therapy.

Separation:
Cell and DNA separation is well established to be done by SPION beads of several hundred nanometers. However, in the fields of system biology, drug identification etc. it is of great interest to target and separate specific organelles and proteins from the cells and their compartments and depict intracellular interaction within the living systems. To achieve magnetic separation of proteins and organelles from a cell, the appropriate choice of coating materials and subsequent coupling to a biological compound is needed. Functionalized SPIONS recovered by using a magnetic column could be targeted to mitochondria. By coupling this tool to mass spectrometry, the complex intracellular pathway and interaction with proteins could be demonstrated.

Drug and Gene Therapy, Hyperthermia
Nanotechnology-based products are significantly affecting the drug delivery sector, which is looking for safer and more personalized drug development. Similar to other nanosized carriers, SPIONS are used in drug targeting and non-viral gene delivery. This requires strong interaction with various cell compartments. Non-viral gene delivery of plasmids and novel DNA fragments (PCR products) coupled to PEI-coated SPIONS, using e.g. pulsating magnetic fields, has shown a significantly increased transfection efficiency being 40 times higher than in cells not exposed to the magnetic field.

Diagnosis
Inflammatory cells like monocytes/macrophages are involved in numerous pathologies, including myocardial Infarction (MI). FDA-approved for clinical use, iron oxide nanoparticles are potent contrast agents for magnetic resonance imaging (MRI), which is sensitive enough to detect iron-loaded cells in a living animal as well as in humans. It could be demonstrated that monocytes/macrophages can be loaded in vivo by a simple i.v. injection of iron-oxide nanoparticles, and then be tracked by MRI in the very same rodent model with excellent precision.

Results presented on this poster have been gained by the EU project «Magnanomed» funded in the framework of FP5, by research projects funded by the Swiss National Foundation (SNF) and by funding from the Swiss Commission of Technology and Innovation (CTI) and the ESM Foundation. Based on all these projects funded for about 10 years, a new FP7 project «NanoDiaRA» (Grant agreement NMP4-LA-2009-228929) could be launched with 15 partners. NanoDiaRA started in February 2010 and will be active until 2014.

Partners: University of Geneva, CH
ANTIA Therapeutics AG, Bern, CH

Literature:
S. Kamau et al., Nucleic Acids Research 2008

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