PhD15

BIOQIC

Towards quantitative structure-sensitive MPI: Application for sentinel lymph node detection

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Application Area: Cancer **Modality:** MPI, MRI **Related:** PhD 2, 6, 11, 14

Background

The novel Magnetic Particle Imaging (MPI) modality detects and localizes magnetic nanoparticles (MNP) with high sensitivity. MPI has the potential to quantitatify MNP and their interaction with tissue environments, such as adhesion of MNP to macromolecular, ECM-, and cell surface components as well as internalization by phagocytosing cells. Experimental interstitial lymphography (IL) with sentinel lymph node targeting[1,2] offers an ideal model to study interactions of MNP with different environments on a slow time scale and to study how these interactions influence the MPI signal.

Hypothesis

MPI allows quantification of MNPs and their interactions with various environments in models of IL.

Methods

MNPs in various media and environments such as (in vitro models) water, blood, serum, lymph fluid, gel assays, cell cultures, (ex vivo models) lymph nodes and (in vivo models) injection site, lymph vessels, lymph nodes. Correlation with MPI, Magnetic Particle Spectroscopy (MPS), magnetorelaxometry, MRI[3,4], light scattering, iron analytics, histology, transmission electron microscopy (TEM).

Work Packages

WP1: Quantification of MNPs in tissue

WP2: Lymphatic models

WP3: Image-based quantification of MNPs

year 1 — *year 2* — *year 3*

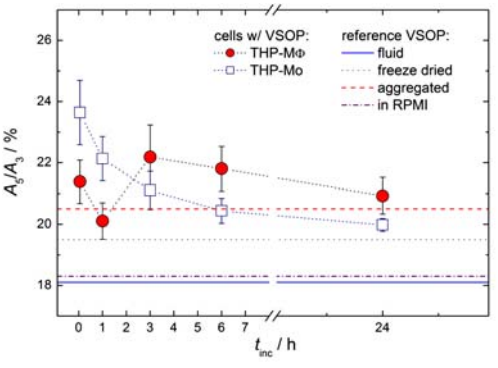
WP1: Investigations of the system function for different MNPs in various media and environments including biological tissues. Tests of the quantification accuracy for different MNPs in various tissues. Tests of the influence of spatial and temporal resolution on quantification accuracy. Tests of x-space reconstruction approaches in comparison to MPI reconstruction using the system function.

WP2: Quantitative measurements of MPI in different environments simulating local distribution of MNP after interstitial injection, transport by lymphatics and accumulation in the sentinel lymph node.

WP3: Imaging of the dynamics of MNP after interstitial injection and analysis of MNP-environment (structure) interactions. Correlation with quantitative MRI. Investigation of how the sentinel lymph node is displayed in MPI and if structural information can be retrieved from the MPI signal.

Clinical Translation

Currently MPI is an imaging method limited to small animal experiments. Findings oft this project will increase our understanding of sentinel lymph node imaging in clinical applications. The project might show how MNPs can be used in clinical MRI for an improved, quantitative and early detection of sentinel lymph nodes. If MPI will be made available for clinical examinations our group can build on wide experiences[5,6] in pharmaceutical development to identify possible MNP candidates towards clinical development and translation.



Figures, left: A preclinical MPI scanner was recently installed in the Department of Radiology, Charité. The scanner is one of the two first commercially available MPI scanners and was made available by funding by the "Major Equipment Initiative" of the German Research Foundation (DFG) after successful application by M. Taupitz (Charité) and L. Trahms (PTB Berlin)

right: Incubation time dependent changes of MNP (VSOP) magnetic behavior during cellular uptake expressed by MPS parameter A5/A3 for THP-Mo (open squares, n = 9) and THP-MΦ (red circles, n = 8). The mean and standard deviation over several cell uptake experiments (n=9 and n=8) are shown for each incubation time. The dotted lines display A5/A3 for VSOP in different environments[7].

Literature

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