In Vivo Quantitative Imaging of Nanoparticles and Cells Using Magnetic Particle Imaging

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Abstract

Magnetic Particle Imaging (MPI) is a new molecular imaging technology capable of unambiguous and quantitative tomographic imaging of the distribution of superparamagnetic nanoparticle tracers in vivo. While the term MPI may be confused with that for Magnetic Resonance Imaging (MRI), the two rely on distinct physics. In MPI, a tomographic image of the distribution of superparamagnetic nanoparticles is constructed by scanning a so-called field free region (FFR) through the domain of interest. Outside the FFR there is a quasi-static bias field strong enough to saturate the magnetic moments of the nanoparticles. But inside the FFR the dipole moments of the nanoparticles are able to respond to a superimposed alternating excitation field. The signal used to construct an image in MPI arises due to the non-linear dynamic magnetization response of the nanoparticle dipole moments to the excitation field inside the FFR. At the field amplitudes and frequencies used in MPI there is no appreciable attenuation in field or signal strength in tissue. Further, while there are magnetic species in the body (e.g., ferritin), they do not contribute an appreciable signal for MPI, allowing for unambiguous imaging of the distribution of one of the superparamagnetic nanoparticle tracers. In this talk I will explain the physics of image generation in MPI, discuss work to understand how imaging performance relates to physical and magnetic properties of the nanoparticles, and discuss our work developing tracers and using MPI to quantify biodistribution of iron oxide nanoparticles in vivo, in the context of tracking nanoparticles and cell therapies.

Keywords: Nanotechnology, magnetic nanoparticles, magnetic particle imaging.

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