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Iron Microparticle Cluster Quantification In Vitro Using Pure Phase Encoding Magnetic Resonance Imaging

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Magnetic Resonance Imaging (MRI) is a non-invasive medical imaging modality that provides excellent soft tissue contrast and resolution. MRI cell tracking effectively monitors cell migration in various immunotherapies where cells are labelled with high susceptibility iron oxide particles to create a negative contrast in the image. However, it is not possible to quantify the number of cells as the number of particles within each cell can vary significantly. Quantitative analysis of the cell migration requires evaluating the number of particles within a cluster. Iron oxide microparticles are also explored in hyperthermic treatments of cancer, where the thermal dose is defined by the particle quantity.

The microparticle quantity correlates with the magnetic field distortions. Severe field distortion leads to image artifacts in conventional MRI. It is therefore very challenging to quantify the particles with such methods. Image artifact can be effectively removed by reducing the signal evolution time in the pure phase encoding (PPE) MRI. The technique can accurately measure the magnetic field distortion around the particle cluster and quantify the particle. PPE methods were successfully employed to correlate iron microparticle cluster mass with magnetic field distribution in vitro using a 1 T small animal scanner. Excellent linearity and theoretical agreement were observed.

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