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Immobilized Iron Oxide Nanoparticles for Stem Cell Reconstruction in Magnetic Particle Imaging

Authors : Kolja Them, Johannes Salamon, Harald Ittrich, Michael Kaul, Tobias Knopp

Abstract : Superparamagnetic iron oxide nanoparticles (SPIONs) are nanoscale magnets which can be biologically functionalized for biomedical applications. Stem cell therapies to repair damaged tissue, magnetic fluid hyperthermia for cancer therapy and targeted drug delivery based on SPIONs are prominent examples where the visualization of a preferably low concentrated SPION distribution is essential. In 2005 a new method for tomographic SPION imaging has been introduced. The method named magnetic particle imaging (MPI) takes advantage of the nanoparticles magnetization change caused by an oscillating, external magnetic field and allows to directly image the time-dependent nanoparticle distribution. The SPION magnetization can be changed by the electron spin dynamics as well as by a mechanical rotation of the nanoparticle. In this work different calibration methods in MPI are investigated for image reconstruction of magnetically labeled stem cells. It is shown that a calibration using rotationally immobilized SPIONs provides a higher quality of stem cell images with fewer artifacts than a calibration using mobile SPIONs. The enhancement of the image quality and the reduction of artifacts enables the localization and identification of a smaller number of magnetically labeled stem cells. This is important for future medical applications where low concentrations of functionalized SPIONs interacting with biological matter have to be localized.

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