Fluorescent Magnetic Particles for Cell Labeling & Tracking

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Various types of superparamagnetic particles have been utilized for cell labeling and subsequant *in vivo* tracking of cell migration via magnetic resonance (MR) imaging techniques. Historically, MRI contrast agents have included iron oxide nanoparticles (e.g. <50nm ultrasmall superparamagnetic iron oxide particles [USPIOs] and >50nm superparamagnetic iron oxide nanoparticles [SPIOs]).

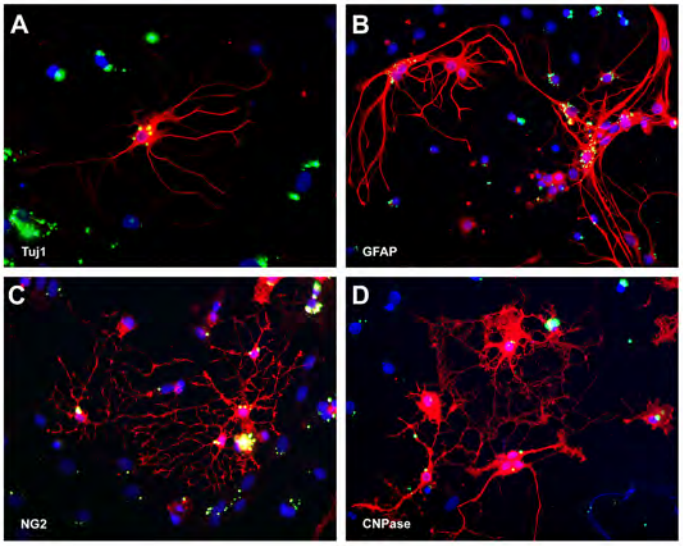
Micron-sized iron oxide particles (often referred to as MPIOs in the literature) offer enhanced sensitivity as even single MPIOs in single cells have been detected via MRI.[1-3] MPIOs may be polymer-based particles that are also internally loaded with fluorescent dyes, thereby enabling confocal fluorescence microscopic detection of histologic samples as well.

The migration of a variety of cell types has been studied using MPIOs including (but not limited to): neural progenitor cells,[4-6] olfactory ensheathing cells,[7] mesenchymal stem cells,[6,8-11] hepatocytes,[1-3] hematopoietic stem cells,[11] lymphocytes,[11,12] macrophages,[13-15] endothelial,[16] embryonic stem cells,[17] smooth muscle cells,[16] and tumor cells.[6,18]

Most of the cell types studied to date endocytose MPIOs readily. However, some cell types are instead surface-labeled with particles via antibody-mediated binding interactions.[12] In many cases, cells are labeled *ex vivo* and then tracked via MRI after transplantation into live animals or tissue phantoms. *In vivo* cell labeling and tracking has also been cited by a few different groups.[4,5,13]

In more recent years magnetic particles have also been used as a means to steer cells to a target region of interest in vascular tissue phantoms.[19-21] Termed magnetic resonance targeting, this technique makes use of the magnetic field gradient inherent to MRI systems to deliver and track the migration of magnetic particle-labeled cells.

A number of our superparamagnetic particles types have been employed for tracking labeled cells via MRI, e.g. fluorescent magnetic encapsulated and classical, [1-18] BioMag[19-21], ProMag[22-23], and COMPEL[2,6,17]. Please note that, our magnetic particles are not manufactured as contrast agents *per se*. They are not supplied as sterile suspensions, and should be washed / sterilized before being exposed to cells (see *Product Data Sheet 726* for sterilization protocols).



REFERENCES:

1. Benedetto S, Pulito R, Geninatti Crich S, Tarone G, Aime S, Silengo L, Hamm J. (2006) Quantification of the expression level of integrin receptor αvβ3 in cell lines and MR Imaging with antibody-coated iron oxide particles. Magnetic Resonance in Medicine. 56(4):711-16.

2. Boulland J-L, Leung DSY, Thuen M, Vik-Mo E, Joel M, Perreault M-C, Langmoen IV, Haraldseth O, Glover JC. (2012) Evaluation of Intracellular labeling with micron-sized particles of iron oxide (MPIOs) as a general tool for *in vitro* and *in vivo* tracking of human stem and progenitor cells. Cell Transplantation;21:1743-59.

3. Deddens LH, van Tilborg GAF, van der Toorn A, van der Marel K, Paulis LEM, van Bloois L, Storm G, Strijkers GJ, Mulder WJM, de Vries HE, Dijkhuizen RM. (2013) MRI of ICAM-1 upregulation after stroke: the importance of choosing the appropriate target-specific particulate contrast agent. Mol. Imaging Biol. 15(4):411-22.

4. Deddens LH, van Tilborg GAF, van der Toorn A, de Vries HE, Dijkhuizen RM. (2013) PECAM-1-targeted micron-sized particles of iron oxide as MRI contrast agent for detection of vascular remodeling after cerebral ischemia. Contrast Medica & Molecular Imaging. 8(5):393-401.

5. Detante O, Valable S, de Fraipont F, Grillon E, Barbier EL, Moisan A, Arnaud J, Moriscot C, Segebarth C, Hommel M, Remy C, Richard M-J. (2012) Magnetic resonance imaging and fluorescence labeling of clinical-grade mesenchymal stem cells without impacting their phenotype: study in a rat model of stroke. Stem Cells Trans Med.; 333-40.

6. Dick AJ, Guttman MA, Raman VK, Peters DC, Pessanha BS, Hill JM, Smith S, Scott G, McVeigh ER, Lederman RJ. (2003) Magnetic resonance fluoroscopy allows targeted delivery of mesenchymal stem cells to infarct borders in swine. Circulation. 108(23):2899-2904.

7. Ebert SN, Taylor DG, Nguyen HL, Kodack DP, Beyers RJ, Xu Y, Yang Z, French BA. (2007) Noninvasive tracking of cardiac embryonic stem cells in vivo using magnetic resonance imaging techniquest. Stem Cells 25(11):2936-904.

8. Economopoulos V, Chen Y, McFadden C, Foster PJ. (2013) MRI detection of nonproliferative tumor cells in lymph node metastases using iron oxide particles in a mouse model of breast cancer. Transl Oncol. 6(3):347-54.

9. Granot D, Shapiro EM. (2014) Accumulation of micron sized iron oxide particles in endothelin-1 induced focal cortical ischemia in rats is independent of cell migration. Magn Reson Med. 71(4):1568-74 2. Shapiro EM, Skrtic S, Koretsky AP. (2005) Sizing it up: cellular MRI using micron-sized iron oxide particles. Magn Reson Med.53(2):329-38.

10. Hill JM, Dick AJ, Raman VK, Thompson RB, Yu Z-X, Hinds KA, Pessanha BSS, Guttman MA, Varney TM, Martin BJ, Dunbar CE, McVeigh ER, Lederman RJ. (2003) Serial cardiac magnetic resonance imaging of injected mesenchymal stem cells. Circulation. 108:1009-1014.

11. Hinds KA, Hill JM, Shapiro EM, Laukkanen MO, Silva AC, Combs CA, Varney TR, Balaban RS, Koretsky AP, Dunbar CE. (2003) Highly efficient endosomal labeling of progenitor and stem cells with large magnetic particles allows magnetic resonance imaging of single cells. Blood. 102(3):867-72.

12. Ramaswamy S, Schornack PA, Smelko AG, Boronyak SM, Ivanova J, Mayer Jr. JE, Sacks MS. (2012) Superparamagnetic iron oxide (SPIO) labeling efficiency and subsequent MRI tracking of native cell populations pertinent to pulmonary heart valve tissue engineering studies. NMR Biomed. 25:410-17.

13. Riegler J, Allain B, Cook RJ, Lythgoe MF, Pankhurst QA. (2011) Magnetically assisted delivery of cells using a magnetic resonance imaging system. J. Phys. D: Appl. Phys.;44(5):1-10.

14. Riegler J, Wells JA, Kyrtatos PG, Price AN, Pankhurst QA, Lythgoe MF. (2010) Targeted magnetic delivery and tracking of cells using a magnetic resonance imaging system. Biomaterials;31:5366-71.

15. Shapiro EM, Gonzalez-Perez O, Manuel Garcia-Verdugo J, Alvarez-Buylla A, Koretsky AP. (2006) Magnetic resonance imaging of the migration of neuronal precursors generated in the adult rodent brain. Neuroimage. 32(3):1150-7.

16. Shapiro EM. Medford-Davis LN, Fahmy TM, Dunbar CE, Koretsky AP. (2007) Antibody-mediated cell labeling of peripheral T cells with micron-sized iron oxide particles (MPIOs) allows single cell detection by MRI. Contrast Media Mol. Imaging. 2:147-53.

17. Shapiro EM, Skrtic S, Sharer K, Hill JM, Dunbar CE, Koretsky AP. (2004) MRI detection of single particles for cellular imaging. PNAS;101(30):10901-6.

18. Shapiro EM, Sharer K, Skrtic S, Koretsky AP. (2006) *In vivo* detection of single cells by MRI. Magn. Reson. Med.55:242-9.

19. Sandvig I, Hoang L, Sardella TCP, Barnett SC, Brekken C, Tvedt K, Berry M, Haraldseth O, Sandvig A, Thuen M. (2012) Labeling of olfactory ensheathing cells with micron-sized particles of iron oxide and detection by MRI. Contrast Media Mol. Imaging.7:403-10.

20. Sumner J, Conroy R, Shapiro E, Moreland J, Koretsky AP. (2007) Delivery of fluorescent probes using iron oxide particles as carriers enables in vivo labeling of migrating neural precursors for MRI and optical imaging. J Biomed Opt; 12(5):051504.

21. Valable S, Barbier EL, Bernaudin M, Roussel S, Segebarth C, Petit E, Rémy C. (2008) In vivo MRI tracking of exogenous monocytes/macrophages targeting brain tumors in a rat model of glioma. Neuroimage. 40(2):973-83.

22. Williams JB, Ye Q, Hitchens TK, Kaufman CL, Ho C. (2007) MRI detection of macrophages labeled using micrometer-sized iron oxide particles. Journal of Magnetic Resonance Imaging. 25(6):1210-18.

23. Wu YL, Ye Q, Foley LM, Kitchens TK, Sato K, Williams JB, Ho C. (2006) *In situ* labeling of immune cells with iron oxide particles: An approach to detect organ rejection by cellular MRI. PNAS. 103(6):1852-7.

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