Magnetic resonance imaging (MRI) provides a useful noninvasive method to study the long-term migration and fate of transplanted stem cells in the central nervous system *in vivo*. Grafted adult as well as embryonic stem cells (ESCs) labeled with superparamagnetic nanoparticles survive in the host organism and migrate preferentially into a lesion site, where they populate the damaged nervous tissue. The migration is not affected by the route of administration; the lesion is populated with the same number of cells after intracerebral grafting as after intravenous injection. Less than 3 % of transplanted mesenchymal stem cells (MSCs) in a cortical photochemical lesion differentiated into neurons and none into astrocytes, while most ESCs (70 %) differentiated into astrocytes and only 5 % into neurons.

The intravenous injection of MSCs or of the mononuclear fraction of the bone marrow, which includes hematopoietic and nonhematopoietic stem cells, progenitors and lymphocytes (BMCs), as well as the mobilization of endogenous BMCs with G-CSF (granulocyte colony stimulating factor) significantly improved the recovery of hind limb motor function and sensitivity in rats with a spinal cord compression lesion and significantly increased the spared white matter volume in the center of the lesion. The recovery was most pronounced after an injection of MSC, and faster after BMSC injection than after treatment with G-CSF. The functional benefits may not be due to the integration of the transplanted cells into the spinal cord tissue, but due to the synchronized production of many factors and cytokines that lead to increased tissue regeneration and protection from secondary damage.

Stem cells can be labeled with intracellular as well as extracellular magnetic particles. The commercially available contrast agent Endorem®, based on superparamagnetic iron oxide nanoparticles (SPIO), is a suitable intracellular magnetic marker for the monitoring of implanted cells in the host organism. Antigen-specific extracellular magnetic particles, such as MicroBeads®, clinically approved for immunomagnetic cell sorting, can also be used as a magnetic label for *in vivo* MR tracking of selected cells, though the average iron content per cell is 50 times lower than in the case of intracellular contrast agents.

SPIO nanoparticles with the transfection agent poly-L-lysin covalently bound to their surface (PCSPIO), newly developed in the Institute of Macromolecular Chemistry & the Institute of Experimental Medicine, Academy of Sciences of the Czech Republic (Patent application no: PV 1006-120), enter the cell cytoplasm more easily than do commercially available SPIO nanoparticles with a dextran coating (Endorem®). They can therefore be used at a lower iron concentration per milliliter of culture media, thus the viability of labeled cells is markedly less affected. Nevertheless, the efficiency of cell labeling as well as the average iron content per cell is higher, enabling the easier detection of the labeled cells by MRI.