

MR-based tracking of iron oxide labeled mesenchymal stem cells for tissue engineering applications

Karl Saldanha, Ryan Doan, Roland Krug

Research is currently underway investigating the ability to track stem cells with ferumoxide (iron-based) contrast agents and detect cell populations minimally invasively using magnetic resonance imaging (MRI). The contrast agent, a superparamagnetic iron oxide (SPIO), is added to the media used to culture the cells, and cellular uptake occurs via endocytosis. Cell populations containing iron appear as signal voids (i.e., negative contrast) on MRI images. In vitro results of mesenchymal stem cells (MSCs) indicate significant loss of signal intensity for labeled cells, and ex vivo results of MSCs have demonstrated detection in both a rabbit model of osteoarthritis and a rat model of intervertebral disc degeneration. Current research is aimed at encapsulating labeled cells within hydrogels and subsequent magnetic resonance imaging of these constructs. In addition, the effect of iron oxide labeling on differentiation of MSCs into cartilage is also being examined. Finally, sequence development to enhance detection, as well as generate positive contrast, are also being investigated. This research has clinical applications to in vivo detection of transplanted cell populations as well as in vivo longitudinal tracking of tissue regeneration therapies.

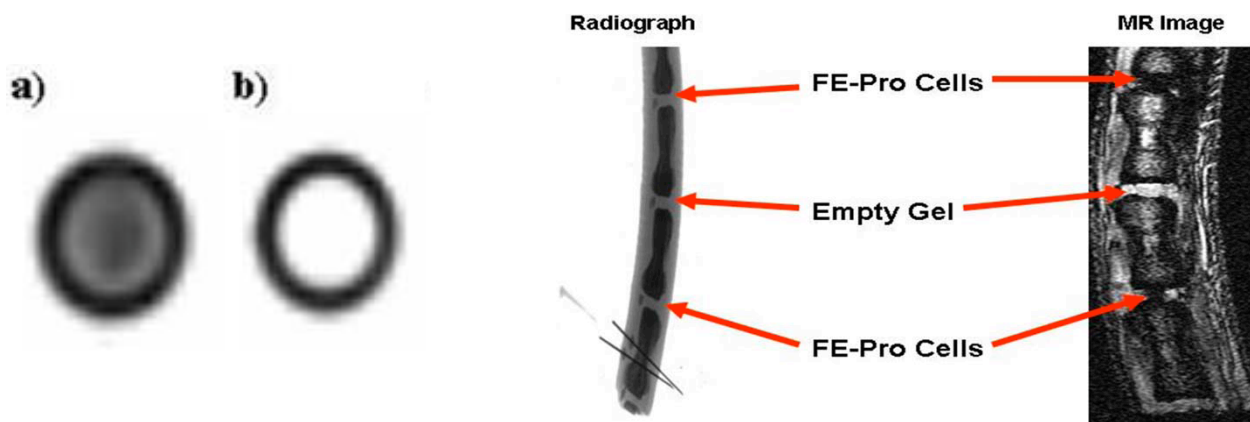


Figure 1. In vitro iron oxide labeling of MSCs (10^6 cells/mL): GRE MR image (TE/TR = 4/34 ms). Labeled cells appear darker on T_2^* -weighted images.

Figure 2. Ex vivo detection of iron oxide labeled MSCs (1×10^6 cells/mL) seeded within a fibrin based gel and implanted within a rat intervertebral disc model. Labeled cells appear as a signal intensity void. An unloaded gel (control) is shown for comparison.