

High Sensitivity Positive Contrast Imaging of Stem Cells in Bone Marrow

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The aim of this work was the development and optimization of a pulse sequence to image SPIO labeled stem cells (EPC) in the bone marrow of the ilium. The detection limit was determined in-vivo at an isolated ilium of a pig.

An approach for positive contrast named IRON, suggested by Stuber et al. [1], was adapted for the application in bone marrow. IRON is based on spectral selective saturation of on-resonant water spins and cancelation of fat signal via an inversion recovery. The remaining signal is attributed to voxels close to the labeled cells which experience a resonance frequency shift caused by the SPIO induced field inhomogeneities.

Instead of saturating fat, our approach utilizes the high concentration of lipid bound protons in bone marrow to detect SPIO induced field inhomogeneities too.

A pulse sequence was developed consisting of two spectral selective pulses to suppress on-resonant signal coming from water and fat. This was done via two concomitant minphase SLR pulses, whereas their flip angles were adjusted so that a zero Mz stage at the excitation of the TSE readout is archived. The SLR pulses were calculated and optimized by using a Matlab-tool and the pulse sequence was implemented on a 3T clinical scanner using a wrist coil (Fig 1). A baseline for the detection limit was determined via the minor signal of the PBS without cells which arose from field inhomogeneities produced by the drill hole. Our results showed a high sensitivity of down to 5000 cells.

Ref.: [1] Stuber M. et al., Magn. Reson. Med. 2007;58:1072-1077

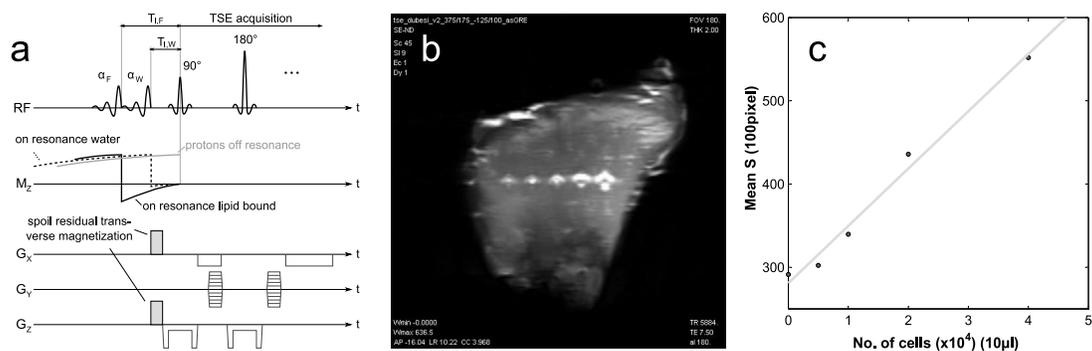


Fig.1. (a) Pulse sequence diagram, (b) final image with five drilled holes containing 10µl of PBS without cells, 5000, 10000, 20000 and 40000 SPIO labeled EPCs. Suppression BW Water/Fat=375/100Hz (FOV/THK=180/2mm, 256², TR=5884ms, TE=7.5ms, TF=20), (c) mean signal intensity within a ROI of 100 pixel vs. no. of cells.