High-Resolution MR Imaging of the Foot: Magnetization Transfer Effects in Foot Peripheral Nerves

G. Gambarota[1], R. Mekle[1], and R. Gruetter[1,2]

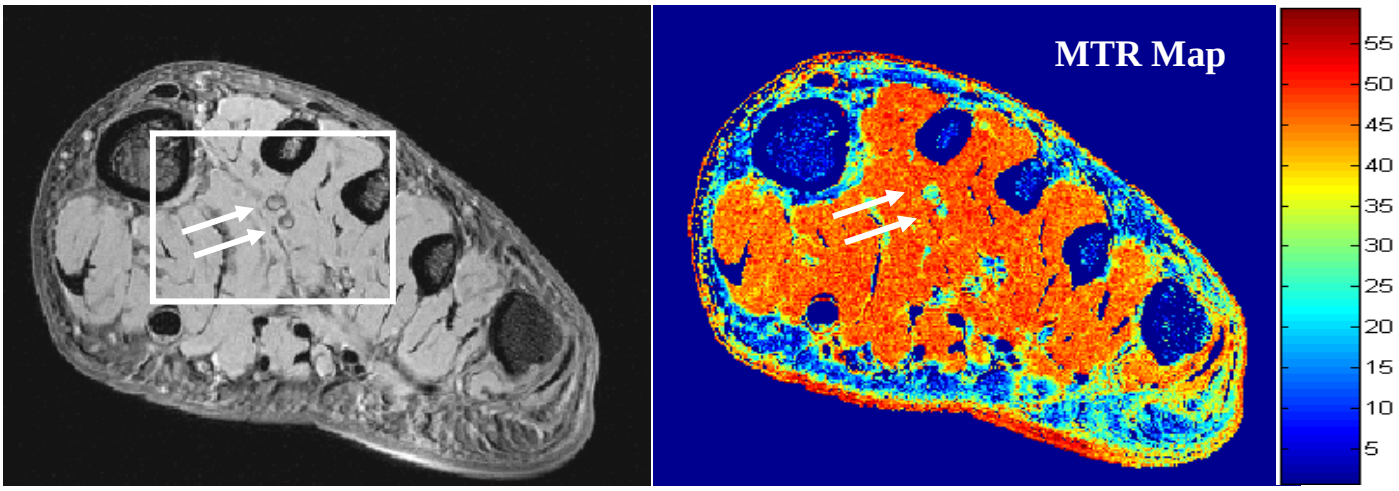
[1]Laboratory for functional and metabolic imaging, Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland, [2]Departments of Radiology, University of Lausanne and University of Geneva, Switzerland

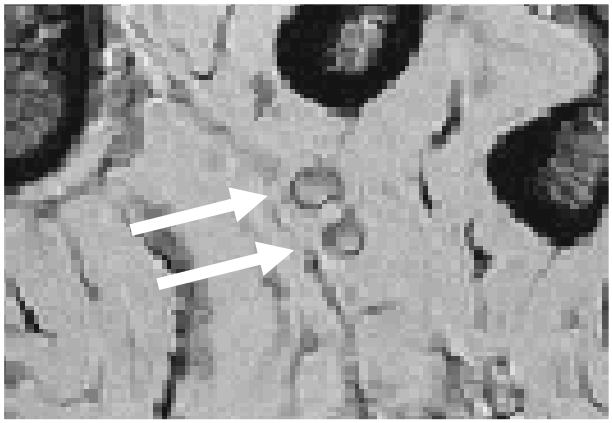
Introduction

MRI of the foot has proven useful in the assessment of soft tissue damage and structural changes in the diabetic foot. In particular, a number of studies have focused on imaging foot muscles and have shown that magnetization transfer (MT) can be used to assess muscle atrophy which is a result of diabetic neuropathy [1-3]. To assess the damage of the peripheral nervous system itself, however, it is necessary to image the foot nerves. This is challenging, because of their small cross-sectional size, with diameters of a few mm. In this work, we sought not only to image foot nerves but also to measure intrinsic MR properties such as MT ratio (MTR), at 3 T.

Methods

MRI experiments were performed on a clinical 3 T Tim Trio Siemens scanner. A dedicated transmit/receive coil was used for all measurements. MT effects were investigated with 3D high-resolution (330 µm x 330 µm in-plane resolution) gradient echo images (TR/TE = 33/7 ms, $\alpha = 10°$), acquired with and without a saturation pulse (8ms gaussian pulse, 500° effective flip angle, applied 1.5 kHz off-resonance). The MT ratio maps were generated according to the equation MTR = 100*(So – Ss)/So, with So and Ss being the signal without and with off-resonance saturation pulse, respectively.





Results and Discussion

Foot nerves could be clearly visualized on the gradient echo images as well as on the MTR maps (in Figure, nerves are indicated by the arrows). A substantial reduction of the MT ratio was observed in the nerves (MTR in 25-35% range), compared to muscle (42-50% range). The results of this study indicate that the high signal-to-noise ratio afforded at the field strength of 3 T and the use of high-sensitivity coils allows not only for the visualization of foot nerves but also for quantitative assessment of their intrinsic MR properties. To date, MRI of the foot has been used to detect muscle atrophy in diabetic foot, since muscle atrophy provides an index of the severity of neuropathy. On the other hand, for early detection of peripheral neuropathy, the peripheral nervous system of the foot should be the primary target for imaging studies. The MT contrast has proven useful in investigations of soft tissue damage. As such, MT contrast in foot nerves could be of interest for early detection of diabetes-induced peripheral neuropathy and can be provide a means for detecting and investigating damage to peripheral nervous system in diabetic foot.

References and Acknowledgements. [1] Bus SA et al., J Magn Reson Imaging. 2006;24:25-32. **[2]** Greenman RL, Lancet. 2005;366:1711-1717. **[3]** Andersen H et al., Diabetes Care. 2004;27:2382-2385. --- Supported by Centre d'Imagerie BioMédicale (CIBM) of the UNIL, UNIGE, HUG, CHUV, EPFL and the Leenaards and Jeantet Foundations.