Gadofosveset-Enhanced Steady State MRA of the Peripheral Vessels with Dixon Fat-Saturation

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Background

Dixon-based fat-suppression techniques (Dix-FS) allow for a homogenous fat-saturation over the entire field of view but have not reached widespread clinical acceptance due to the longer acquisition times required (1; 2). As steady state imaging after the administration of the intravascular contrast agent gadofosveset typically employs long TR-times Dix-FS can be applied without additional time penalties (3; 4). The aim of this study was to evaluate the feasibility and image quality of peripheral MRA with Dix-FS during the steady state after injection of gadofosveset.

Material and Methods

In this IRB-approved prospective, intraindividual study 10 healthy volunteers (mean age 29.2 years) and 3 patients with PAOD (mean age 63.2 years) were examined at 3.0T (Siemens Tim Trio) 1h after the bolus injection of 0.03mmol/kg BW gadofosveset (Vasovist®, Bayerhealthcare). To achieve an optimal SNR a dedicated 36-element peripheral MRA-matrix coil was used. After localizers a large field of view ranging from the knee to the ankle volume-interpolated breathhold-exam (VIBE) sequence with two-point Dixon fat-suppression (2) (DixFS) and the a VIBE sequence with spectral fat-saturation (SFS) were acquired in a random order. The VIBE sequences were specifically adapted to steady state conditions with a long TR of 7ms and a low flip angle of 12° (3). Apart from the different method of fat-suppression the sequence parameters of the VIBE sequences were equal (Table 1). To allow for SNR calculations despite the application of parallel imaging the sequences were acquired twice. After phase-correction of the VIBE DixFS data a segmentation algorithm produced four different series per acquisition: in-phase, opposed-phase, water-only and fat-only images. Only the water-only images were compared to the VIBE SFS. Image quality was rated by two radiologists in consensus on a 4 point ordinal scale (4-very good, 3 good, 2 moderate, 1 poor-non diagnostic). The criteria included vessel conspicuity, visible noise, and homogeneity of fat suppression. The signal-to-nose ratio (SNR) contrast-to-noise ratio (CNR, vessel-fat) was measured in the volunteers/patients using the difference method. The signal intensities (SI) of the vessels, fat and muscles were measured at three distinct points over the FOV (knee level +20mm, +210mm, +350mm). T-tests were used for statistical analysis.

Results

All MRA exams were diagnostic. In one case the segmentation algorithm produced erroneously images where the water-only image contained fat information and vice versa. The median score for the VIBE DixFS was 4, for the VIBE SFS 3 due to the inhomogeneous signal at the periphery of the FOV. The number of visible small vessels, particularly in the subcutaneous fat was higher with the VIBE DixFS (Figure 2). For VIBE DixFS / VIBE SFS the mean signal intensity of vessels (492 / 496 A.U) and muscle (249 / 269 A.U.) were equal for both techniques ($p>0.4$) while the fat-suppression was significantly ($p<0.0001$) stronger and more homogenous over the entire FOV with the Dixon method (Figure 1). Equally, the SNR and CNR were significantly ($p < 0.001$) higher for the DixFS (145 / 5.8) than with the SFS (99 / 1.9).

Conclusion

Steady state MRA of the peripheral vessels with DixFS yields higher SNR and CNR with a more homogenous fat-saturation over the entire FOV than MRA with SFS. During the steady state DixFS can be applied without time penalty and yields improved image quality and vessel delineation particularly of the smaller vessels.

References

Dixon, W. T. (1984). Radiology 153(1): 189-94.
Ma, J. (2004). Magn Reson Med 52(2): 415-9.
Wang, M. S., D. R. Haynor, et al. (2007). J Magn Reson Imaging 26(3): 580-8.
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	VIBE SFS	*VIBE DixFS*
TR [ms]	7.0	7.0
TE1, TE2 [ms]	2.45	2.45 / 3.675
α [°]	12	12
FoV [mm²]	450 x 405	450 x 405
Matrix	448 x 448	448 x 448
BW [Hz/pixel]	330 / 380	330 / 380
Voxel [mm³]	1.0 x 1.0 x1.0	1.0 x 1.0 x1.0
Slice tickn.	1.0	1.0
Fat-saturation	Q-fat sat	Dixon
PAT	GRAPPA 3	GRAPPA 3
Acq. time [s]	0:58	0:52

Table 1

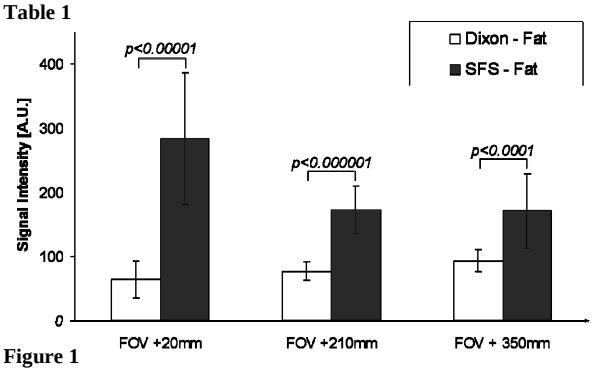

Figure 1

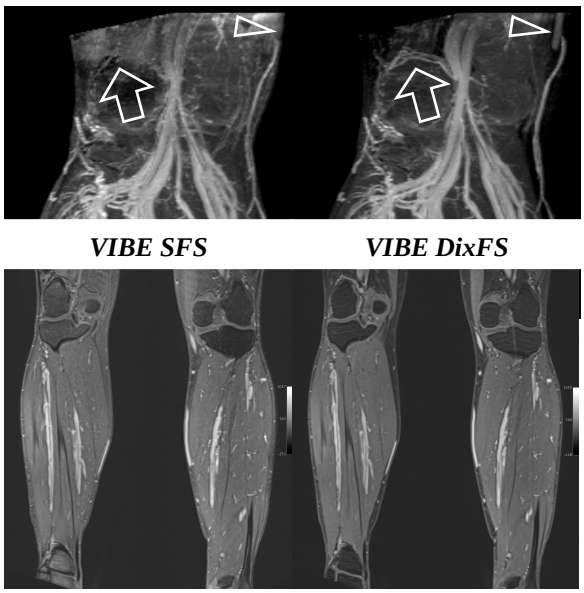

Figure 2