Fat saturation techniques in non-contrast enhanced B-SSFP MRA of the renal arteries.

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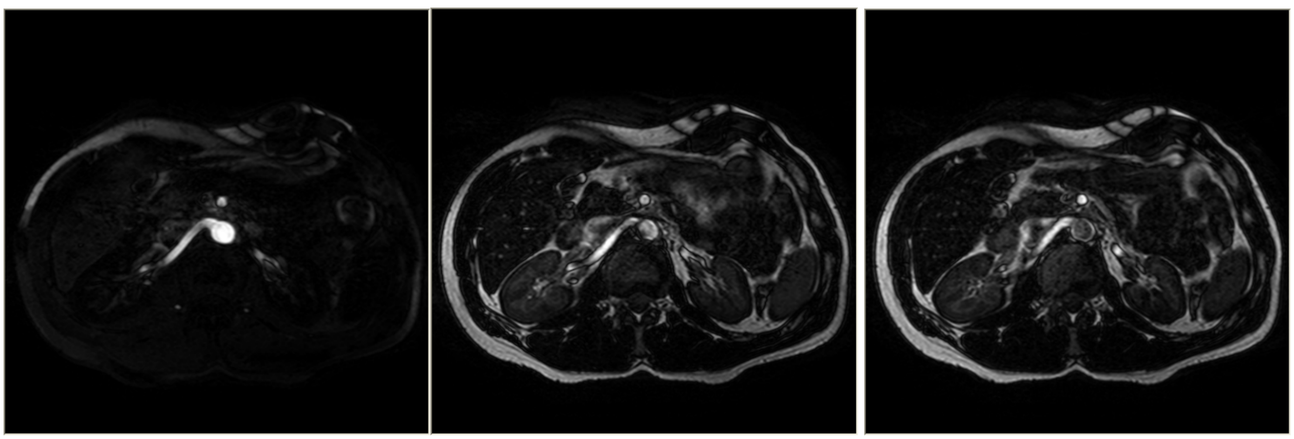
Introduction: Due to the risk for inducing nephrogenic systemic fibrosis (NSF) there is a need for developing angiography without the use of contrast agents, in particular for patients with renal disease. Recently, a balanced steady-state-free-precession (B-SSFP) method with an inversion prepulse has been described (1-3). The contrast between vessels and background is obtained by both the T2/T1 differences between blood and tissue, and by inflow effect. In the current work, three different methods for fat suppression with this sequence have been investigated.

Method: A Philips Achieva 1.5 Tesla scanner with Nova Dual gradients and software release 2.6.3.4. was used together with a 16 elements Torso XL coil .Three different types of fat saturation were compared for renal angiography in two pigs and three human volunteers
The sequence was a 3D B-SSFP sequence with a slice selective inversion pulse. For optimal background suppression, the inversion time was optimized individually by measuring the tissue nulling point using a Look-Locker sequence. The sequence was cardiac triggered with one shot per cycle and navigator gating/tracking was used to compensate for respiratory motion. Sequence parameters: 3D IR B-SSFP, FOV: 320 x 320 x 240 mm^3, slices: 24, acq. resolution: 1.25 x 1.67 x 4.0 mm^3 recon. res.: 0.63 x 0.63 x 2.0 mm^3, TR/TE: 9.5/4.8 ms, flip angle 85°, turbo factor 32, averages; 2, ECG triggering, navigator window of 5mm, slab selective inversion pre-pulse with approximately 325 ms delay, inferior rest slab, scan time 1.38 min.
Three fat suppression techniques were compared: SPIR (Spectral Presaturation Inversion Recovery), SPAIR (SPectrally selective Attenuation Inversion Recovery) and ProSet (water selective excitation with binomial pulses) using a 1-2-1 pulse (21.25^o-42.5^o-21.25^o). All other parameters were kept constant.

Results: The ProSet technique was superior to both SPIR and SPAIR for background suppression (Figure 1). CNR measured as: (Mean(renal artery)-mean(tissue)) /sd (air)) was for ProSet: 275; SPAIR: 108 and SPIR: 59. Furthermore, with both SPIR and SPAIR signal void artifacts were observed in the blood in the aorta.



a) b) c)
Figure 1. a) ProSet 1-2-1, b) SPAIR (TI 150ms) and c) SPIR. (The metal artifact seen at the top is caused by the ECG box.)

Discussion: The standard fat suppression methods SPIR and SPAIR turned out to be insufficient for renal angiography using 3D B-SSFP sequence with a slice selective inversion prepulse . On the Philips scanner, the SPIR method is implemented as a frequency selective 94° pulse followed by spoiling and 15 ms delay before the imaging excitation. The SPAIR method is similar, but an adiabatic pulse is used for improved spectral selectivity, and a 150 ms delay is used. The reason for the poor function of the SPIR and SPAIR pre-pulses could be interference between these and the slab-selective inversion pre-pulse. Bloch simulations showed that for the SPIR sequence, 4% of the fat signal was recovered at the echo time due to the inversion pre-pulse.
Conclusion: The ProSet technique is most effective for fat saturation in renal MRA using B-SSFP with a slab selective inversion prepulse.

References:

1. Katoh M,. Buecker A., Stuber M. et al. Free-breathing renal MR angiography with steady-state free-precession (SSFP) and slab selective spin inversion initial results. Kidney Int. 2004:66(3):1272-8.
2. Potthast S. and Maki JH. Non-Contrast-Enhanced MR imaging of the Renal Arteries. Magn. Reson. Imaging Clin N Am 2008(16):573-84.
3. Wilson GJ. And Maki JH. Non-Contrast-Enhanced MR imaging of Renal Artery stenosis at 1.5 Tesla. Magn. Reson. Imaging Clin N Am 2009(17):13-27