

# Optimization of Ultrashort TE Imaging for Angiography and Molecular Imaging of Iron-Oxide Nanoparticles

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## Introduction:

Iron oxide nanoparticles have the potential to be used both as angiographic [1] and molecular imaging contrast agents. Moreover, these nanoparticles can theoretically be imaged with both T2/T2\* and T1 based sequences because of their high r1 and r2 values. Current T1 weighted sequences, however, are corrupted by T2/T2\* contrast, which occurs with iron oxide nanoparticles at even short echo times. We thus sought to investigate the potential of a 3D radial Ultra short TE (UTE) [2] sequence to image iron oxide with pure T1 weighted contrast. We also studied the r1 of iron oxide over a range of field strengths to determine which field strength would produce the optimal combination of SNR and T1 contrast.

## Material and methods:

Six tubes of iron oxide nanoparticles (MION Size 30nm, CMIR, Boston, MA) diluted in water with concentrations of 0, 10, 50, 100, 200 and 400 nanomolar were imaged at 1.5T, 3T and 7T with the UTE sequence with TE set to 70 $\mu$ s. Phantom scanning was performed with a 12 channel head coil at 1.5T and 3T and an 8 channel phased array detunable TEM volume coil at 7T. r1 and r2 were measured at all three field strengths using a multiple flip angle approach for r1 and multi echo spin echo for r2. In-vivo experiments were conducted on Adult Sprague Dawley Rats with a custom single loop coil at 3T. The rats were imaged pre contrast and after sequential tail vein injections of MION at cumulative doses of 2.5, 5, 10mg of iron/kg.

## Results:

The r2 value of MION was approximately 80 (mMSec)<sup>-1</sup> and was similar at all field strengths. The r1 of MION, however, at 1.5T was 11.44 (mMSec)<sup>-1</sup> and at 3T was 8.96 (mMSec)<sup>-1</sup>. In vivo UTE imaging was thus performed at 3T to provide an optimal combination of SNR and T1 contrast. Fig. 1 shows the comparison between the UTE magnitude image of the phantom and its corresponding R1 map at 1.5T. It can be seen that the signal intensity in the UTE magnitude image closely reflects the R1 values in the phantom. This is demonstrated graphically in Fig 2. as a function of field strength and is seen to be similar at 1.5 and 3T. Fig 3 shows post contrast 3D UTE images as 2.5 and 10mg of iron/Kg respectively. Image quality was optimal at 2.5mg of Iron/kg.

## Discussion:

UTE imaging of iron oxide nanoparticles provides pure R1 contrast and is optimally performed at either 1.5 or 3T. Our results suggest that both angiographic and molecular imaging of low doses of iron oxide nanoparticles (2.5mg of Iron/Kg) will be able to be performed with UTE imaging.

## References:

1. Frank H. et.al., AJR 1994, 162:209-213
2. Nielles-Vallespin et al., Magnetic Resonance in Medicine 57:74–81 (2007)

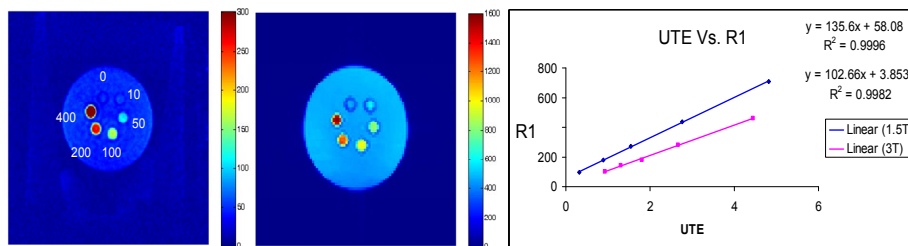


Fig 1. Comparison of UTE magnitude image on the left with R1 map on the right at 1.5T

Fig. 2 Correlation of the UTE values with the computed R1 at 1.5 and 3T

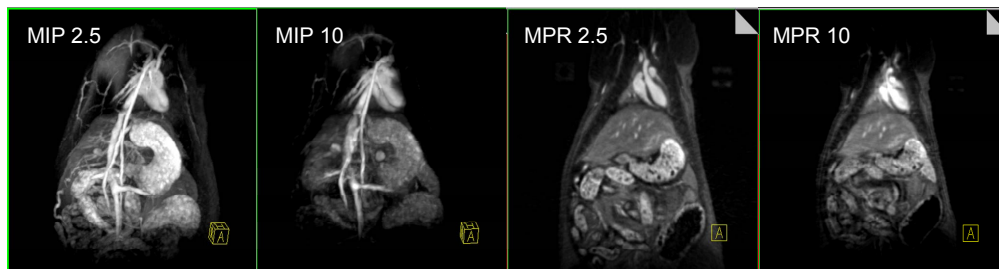


Fig 3. MIPs at (a) 2.5mg and (b) 10mg respectively. MPRs at (c) 2.5mg and (d) 10mg respectively at 3T.