Relaxivity of amorphous manganese oxide at various field strengths

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TARGET AUDIENCE

Researchers with an interest towards paramagnetic non-ferrous nanoparticles with very high relaxivity.

PURPOSE

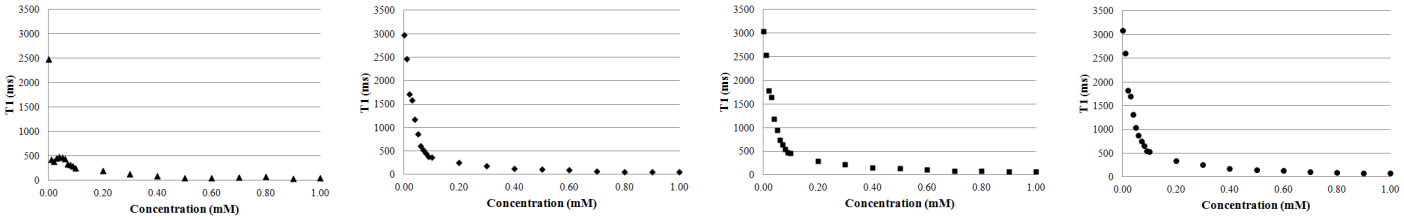
To define the relaxivity of amorphous manganese oxide nanoparticles, a novel substance aimed for modulation of T1 relaxation time, at different field strengths.

METHODS

Manganese oxide (MnOx) nanostructures were produced according to a protocol developed for iron oxide [1] whereby the addition of poly(acrylic acid) as capping agent prevented the formation of crystalline MnO. The thus formed amorphous MnOx was diluted into concentrations from 0.1 to 1 mM with an increment of 0.1 mM, and from 0.01 to 0.1 mM with an increment of 0.01 mM. T1 relaxation times for MnOx samples and water were determined spectroscopically using 4.7T, 7.1T and 9.4T spectrometers (Bruker) using saturation recovery sequence, and 3T clinical scanner (Siemens Skyra, Siemens Healthcare, Erlangen, Germany) using IR-FSE sequence.

RESULTS

T1 relaxation times as a function of MnOx concentration are shown in Figure 1. The calculated relaxivities were 21.4 $s^{-1}mM^{-1}$, 19.1 $s^{-1}mM^{-1}$, 15.2 $s^{-1}mM^{-1}$ and 12.9 $s^{-1}mM^{-1}$ for 3T, 4.7T, 7.1T and 9.4T (Figure 2).



a) b) c) d)

Figure 1. T1 relaxation times of MnOx solutions in water as a function of MnO concentration. a) 3T clinical scanner b) 4.7T spectrometer c) 7.1T spectrometer d) 9.4T spectrometer.

DISCUSSION

The relaxivities of the current clinically used gadolinium based contrast agents are typically between 3 to 5 $s^{-1}mM^{-1}$ at 3T [2]. Amorphous manganese oxide displays substantially higher relaxivity. As expected, the relaxivity decreases towards higher field strengths. High relaxivity and small size (in nanometer scale) allows the use of lower concentrations and makes MnOx a very promising contrast agent for stem cell labeling and dynamic imaging studies. Studies investigating the toxicity of MnO are underway.

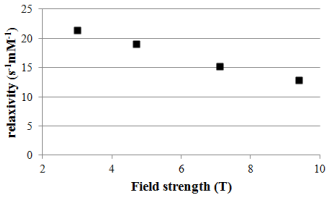


Figure 2. Relaxivity of MnOx as as function of field strength.

CONCLUSION

Amorphous manganese oxide is a novel nanoscaled contrast agent with very high relaxivity compared to clinically used gadolinium based contrast agents. Its properties make it a very promising candidate for stem cell labeling and dynamic imaging studies.

REFERENCES

[1] Xiao W et al. J Magnetism Magnetic Mater. 324: 488-494; 2012

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