

Quantitative Studies for Molecular Imaging Using MRI

Ali Mohammadi-Rad, Hamid Soltanian-Zadeh, Quan Jiang, Subhash Gautam

Henry Ford health System, Detroit, MI 48202, USA

Objectives: The objectives of our study are: 1) quantify relationship between concentration of iron particles in the object and estimated MRI parameters (T_2 , T_2' , T_2^*); and 2) evaluate reproducibility of the measurements. These are essential for non-invasively estimating the number of labeled cells in target organs using MRI.

Methods: We constructed different phantoms by filling 22 tubes with mixture of gelatin and various concentrations of Feridex (ferumoxides), ranging from 2.24 $\mu\text{g/ml}$ to 112 $\mu\text{g/ml}$. In one of the studies, we also added BSA (Bovine Serum albumin) to generate an environment similar to *in vivo*. After solutions solidified, we acquired MRI of multiple slices through the phantoms using a 3T whole body and a 7T small bore magnets. The imaging parameters were 1) 3T; T_2^* : TR=2s, TE=10,40ms; T_2 : TR=2s, TE=20,60ms; 2) 7T; T_2^* : TR=5s, TE=7.5,15,22.5,30ms; T_2 : TR=5s, TE=7.5,15,22.5,30ms. MRI data were transferred to our image analysis workstation and MRI parameters estimated. The results were analyzed by SAS before and after deleting the outliers, which were found in heterogeneous parts of phantoms. Statistical analysis included estimation of correlation coefficients between each MRI parameter and iron particle concentration as well as between different MRI parameters. To evaluate reproducibility, new phantoms with the same specifications were made, imaged, and MRI parameters estimated and analyzed.

Results: Experimental results show linear correlations between concentration of iron particles and MRI parameters. The correlation coefficients were between 84% and 98%, confirming linear correlation between our variables. R-squares or coefficient of determinants were between 67% and 98%, showing a strong ability to predict Feridex concentrations using MRI parameters. The p values were less than 0.05 (0.02-0.04) for T_2 and T_2^* . The largest p values occurred for T_2' (0.04-0.12) when the outliers were not deleted. Reproducibility of the measurements improved as the concentration of Feridex increased. This may be attributed to lower MRI contrast-to-noise-ratios and inaccuracies in making exactly the same solutions when iron particle concentrations are low.

Conclusion: Using MRI and image analysis methods, concentration of iron particles can be accurately and reproducibly measured.