**INTRODUCTION**

- Conventional MRI has limited biological specificity to the subvoxel composition of tissues
- Relaxation spectroscopic (RS) MRI methods map distributions of relaxation parameters like T1, T2, and mean diffusivities (MD), in microscopic water pools in vivo^{1-3}
- Correlation-spectroscopic (CS) MRI methods further improve specificity^{4-6} by assessing how relaxation parameters co-vary in tissue microenvironments
- We design and evaluate a pulse sequence with integrated inversion recovery (IR)^{1} and isotropic diffusion encoding (IDE)^{3} preparations and derive maps of subvoxel T1-MD spectra in healthy volunteers

**METHODS**

- The sequence in Fig. 1 allows the efficient interleaved multisoilce acquisition IR-IDE MRIs with a wide range of joint T1 and MD weightings, by independently controlling the (TI,TR) and b-value parameters, respectively
- Assuming slow exchange between microscopic water pools and an adiabatic inversion efficiency\(^1\), \(\eta\), we can derive the correlation spectrum of subvoxel R\(_g\)=1/T1, and MD properties, \(\rho(\text{R}_g, \text{MD})\), from the net signal attenuation in a repeated IR experiment:

\[
S_0(b,T1,TR) = \int_0^\infty \left(1 - e^{-T1\phi(T1,\text{TR})} + e^{-T1\phi(T1,\text{TR})}e^{-b\phi(D,\text{TR})}dD\right)\rho(\text{R}_g, \text{MD})d\text{R}_g
\]

- We conducted Monte Carlo simulations, and CS-MRI experiments in a polymer diffusion phantom\(^8\) and three healthy volunteers using 16 diffusion weightings \((b=0.05-3.6\text{ms}/\mu\text{m}^2)\) and 19 T1-weightings \((\text{TI}=50-5000\text{ms}, \text{including no-IR}), \text{TE}=98\text{ms}, \text{FOV}=22\text{cm}, 2.5\text{mm in-plane resolution}, 5\text{mm slice thickness}\)

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**RESULTS**

- Due to the long TE needed to accommodate the diffusion gradients, the estimated T3-MD spectra (Fig. 3) are likely T2-weighted (Fig. 4)
- Marginal distributions derived from T1-MD spectra (Fig. 3) are consistent with previous 1D RS-MRI studies in healthy volunteers\(^1\)
- The two WM components (Figs. 3, 4) may reflect effects from magnetization transfer\(^7\) and chemical exchange
- The general signal representation in T1-MD CS-MRI may be able to characterize healthy and diseased tissues with arbitrary subvoxel heterogeneities
- Mapping the subvoxel landscape of T1-MD properties may improve biological specificity in the early detection of neurodegenerative diseases, neuroinflammation, cancer, brain injury, and ischemic stroke

**DISCUSSION**

References:


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