Characterizing White Matter in ADRD Tissue Samples With Advanced Quantitative Magnetic Resonance Imaging

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Abstract

Background: White Matter (WM) MRI T2 hyperintensities lack the specificity to map directly to clinical presentations.

Objectives

1) Learn MR histology correlates for WM MRI biomarkers
2) Design an MRI pulse sequence to estimate white and gray matter exchange
3) Explore D-T2 phantom for combined diffusion relaxometry validation

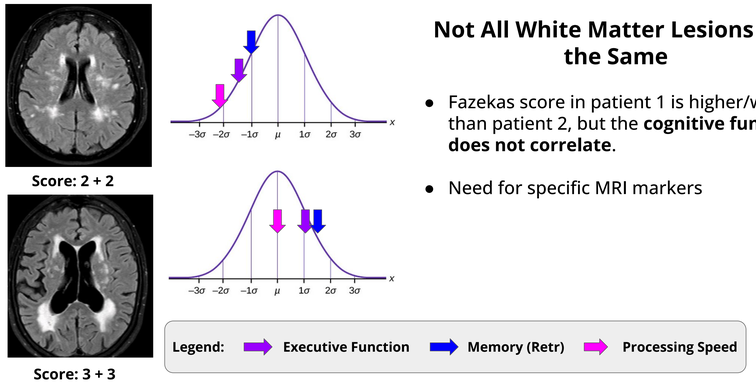
Methods

- Magnetization transfer and multi-echo spin echo were correlated with histology
- Used Cramer-Rao Lower Bound to optimize pulse sequences using Bloch Simulations
- D-T2 protocols were implemented to observe 2D spectral trends in relation to histology

Preliminary Results

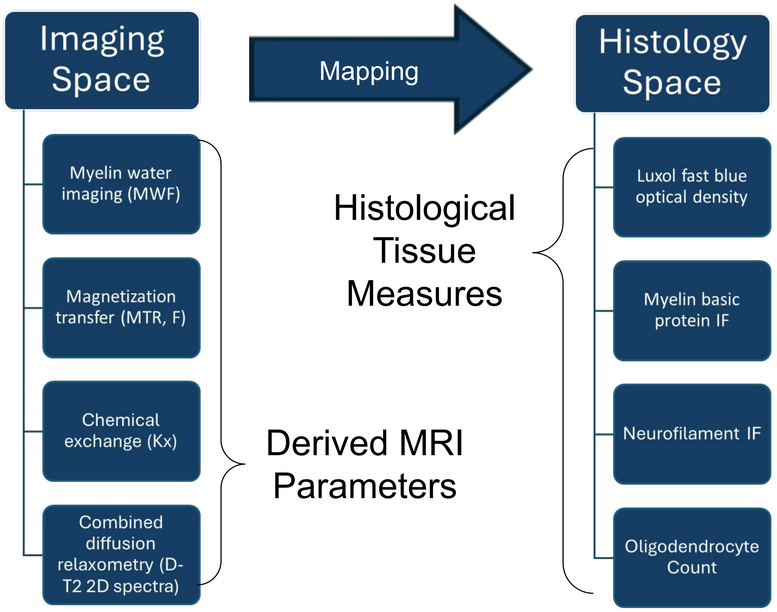
- MWF and MT parameters correlate well with LFB and MBP histology stains
- Can jointly estimate many MR parameters efficiently with a optimized pulse sequence
- Combined diffusion relaxometry (D-T2) 2D spectra follow white matter integrity trends in accordance with histology

Background

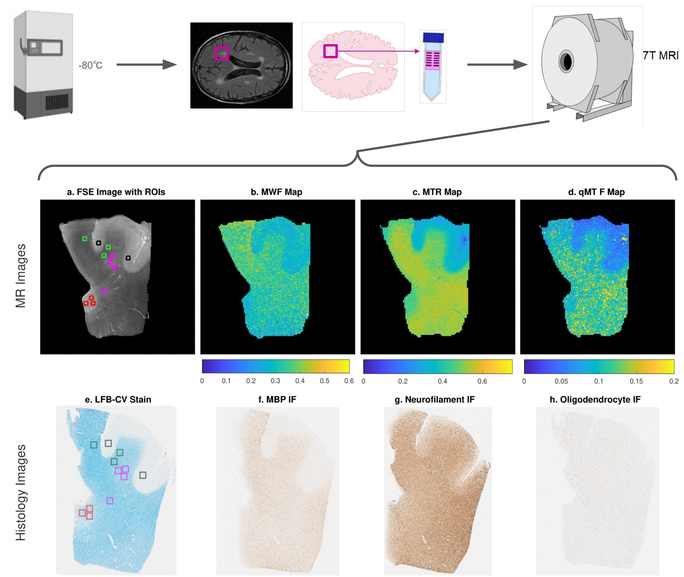


Not All White Matter Lesions Are the Same

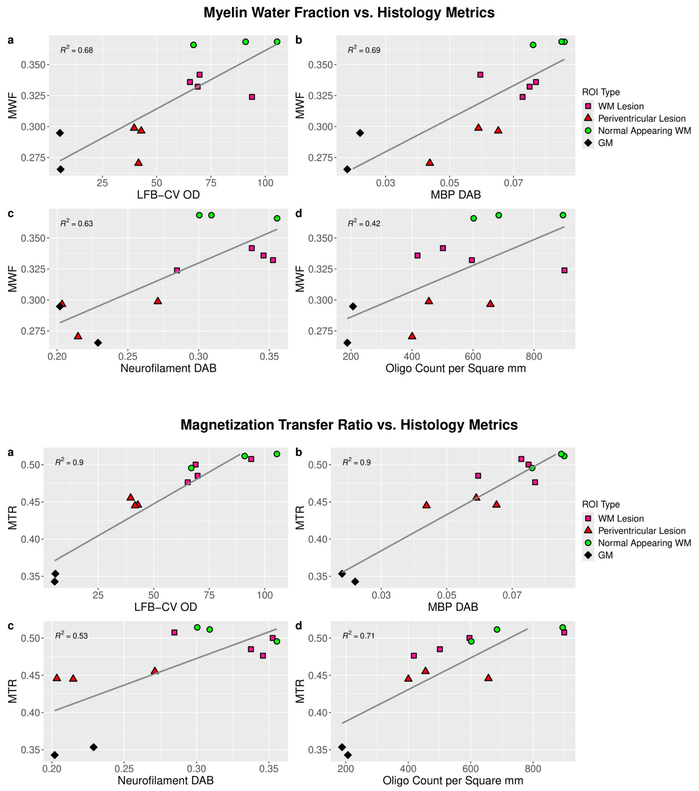
- Fazekas score in patient 1 is higher/worse than patient 2, but the **cognitive function does not correlate**.
- Need for specific MRI markers



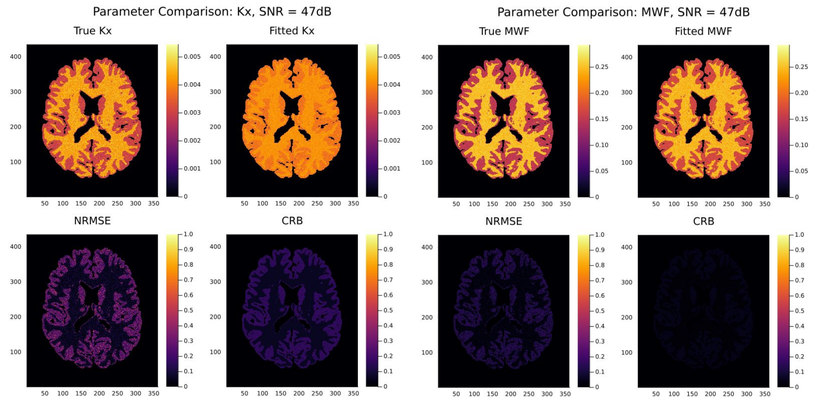
Standard Myelin-Sensitive Quantitative MRI and Histology Metrics



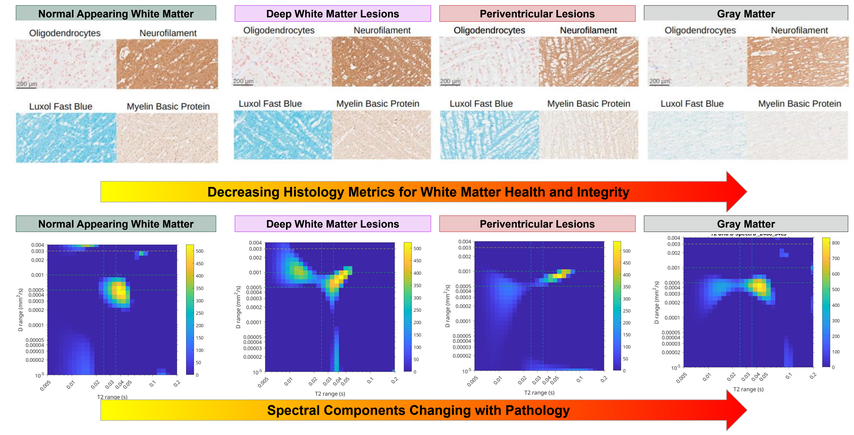
MR-Histology Parameter Correlations



Optimized Sequence Estimation of Myelin Water Exchange and Fraction



Exploration of Combined Diffusion Relaxometry for Alzheimer's



Conclusions

- Myelin sensitive histology stains (LFB and MBP) correlate well with myelin-sensitive qMRI parameters (MWF, MTR, qMT F)
- Optimizing echo spacings and flip angles of a REXSY-inspired pulse sequence can lead to jointly estimating many MRI tissue parameters with fast scan times
- Combined diffusion relaxometry 2D spectra may correlate with histology, and therefore could be indicative of white matter pathology.

Future Directions

- Scan more samples with different types of white matter pathologies and lesions and determine whether qMRI metrics in these regions correlate with various histology stains
- Estimate exchange parameters in human tissue samples and correlate with histology
- Analyze correlations of quantitative diffusion data with histology results

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