Filtering MRI images to Improve Pharmacokinetic Modeling of GdDO3NI in Brain Tumors

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Introduction

<u>Objective:</u> Model GdDO3NI in Hypoxic and Normoxic Brain Tumors

Hypoxia is a lack of adequate oxygen in cells & tissues[1]. Hypoxia is a critical marker in the progression of diseases including cancer, stroke, and traumatic brain injury (TBI)[1,2]. In cancer, hypoxia initiates a complex cell signaling network resulting in angiogenesis, metastasis, and resistance to therapy[3].

GdDO3NI is a T_1-weighted MRI contrast agent that has been shown to visualize hypoxia in tumors[4] and post-TBI brain[2]. Pharmacokinetic modeling allows extraction of tissue characteristics from time course T1-weighted MR images. K-space filtering can potentially allow improved pharmacokinetic modeling via improvements in signal-to-noise ratio (SNR).

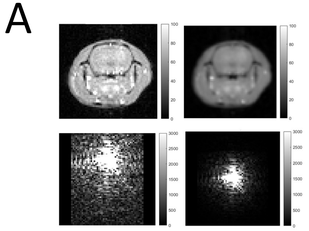
Methods

- Acquisition of T2-weighted, and time-course pre and post contrast (GdDO3NI) T1-weighted images of rat brains with 9L or C6 tumors
- Creation and refinement of fermi filters in MATLAB
- Parsing of raw k-space data and application of filters in k-space
- T1-mapping using the following equation:

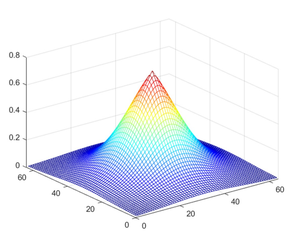
$$M = M_{inf} *)(1 - e^{-\tau/T_1})$$

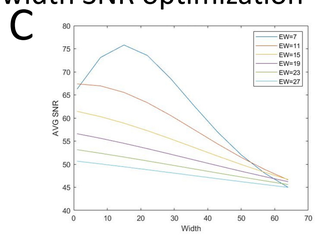
- Pharmacokinetic modeling using filtered images and the model developed for TBI[2]

Filtering

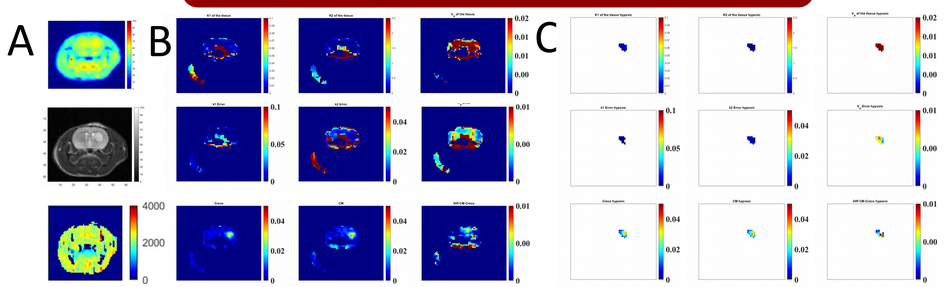


A. Unfiltered (left) and filtered (right) time course images and k-spaces
B. Fermi filter of edge-width 7 and width 15
C. Filter edge-width and width SNR optimization



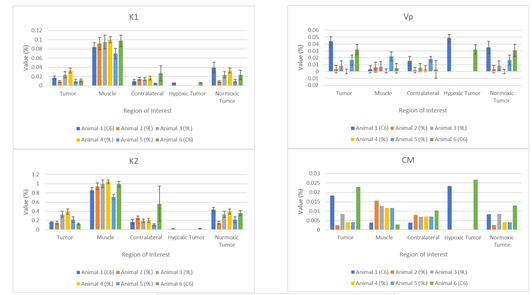


Pharmacokinetic Model



A. Time course image at CM (top), T2-weighted image (middle), and T1 map (bottom) for a representative animal
B. K1, K2, Vp, error, CM, Creco (reconstructed concentration), and Diff (CM-Creco) values across the brain and muscle
C. Hypoxic tumor fraction values

Preliminary Results



Conclusion & Future Directions

- Filtering reduced error for K1 and K2
- Little improvement was observed for Vp and Diff
- Large differences in K1, K2, and CM were observed between hypoxic and normoxic fractions

Analyze tumors of different sizes and hypoxic & normoxic proportions → Cluster data from different tumor types → Optimize for a clinical setting

Acknowledgements & References

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