Magnetic Resonance Fingerprinting for Target Identification in Deep Brain Stimulation

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assfn American Society for Stereotactic and Functional Neurosurgery 2018 BIENNIAL MEETING DENVER | June 2-5, 2018

Introduction

Traditional MRI acquisitions are restricted to qualitative "weighted" measurements of tissue properties where the signal intensities are dependent upon many factors, including the type and set-up of the scanner. Magnetic Resonance Fingerprinting (MRF) is a revolutionary new approach to collecting and analyzing MRI data that permits simultaneous quantification of multiple tissue properties (e.g. T1 and T2) [Ma et al., 2012].

Methods

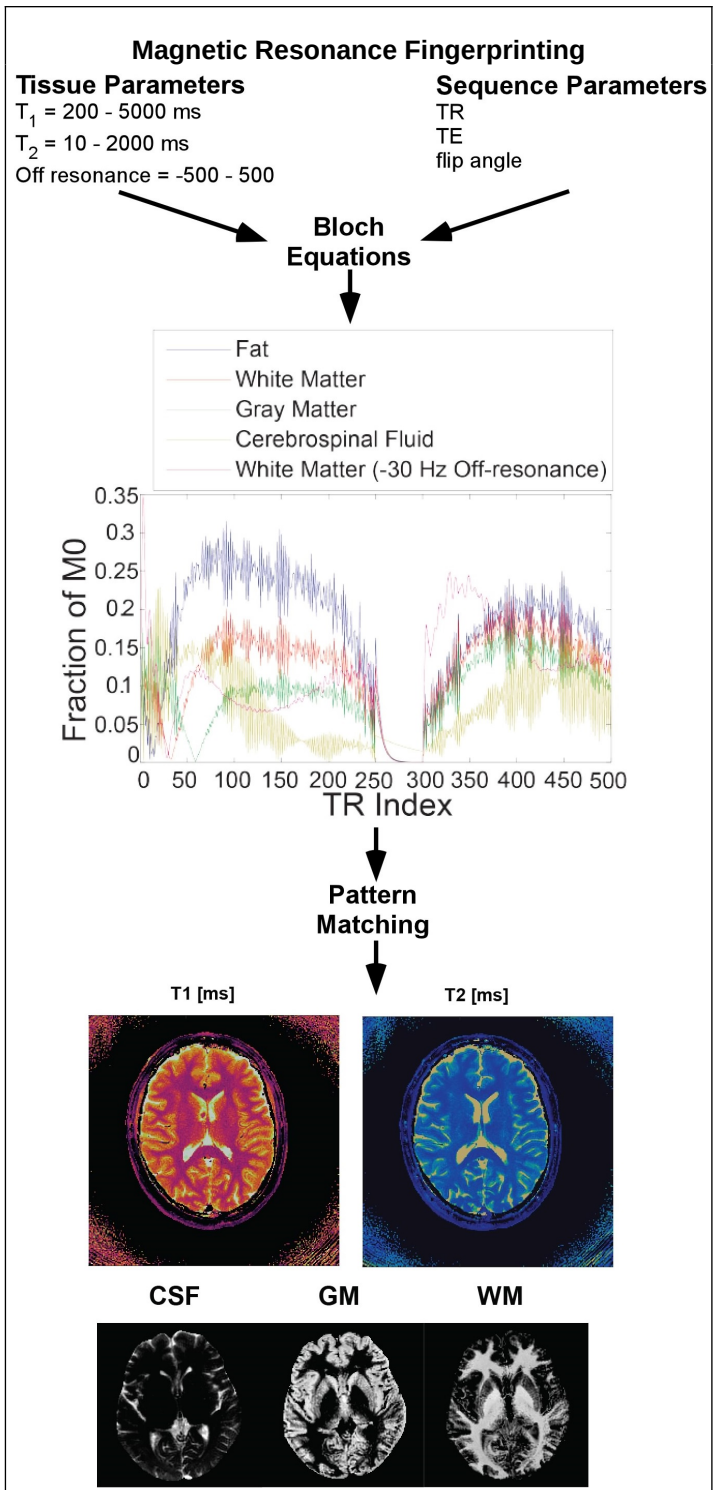
MRF uses a pseudorandomized acquisition that causes the signals from different materials or tissues to have a unique signal evolution or 'fingerprint' that is simultaneously a function of the multiple material properties under investigation. MRF processing after acquisition involves a pattern recognition algorithm to match the fingerprints to a predefined dictionary of predicted signal evolutions. These can then be translated into quantitative maps of the magnetic parameters of interest.

Results

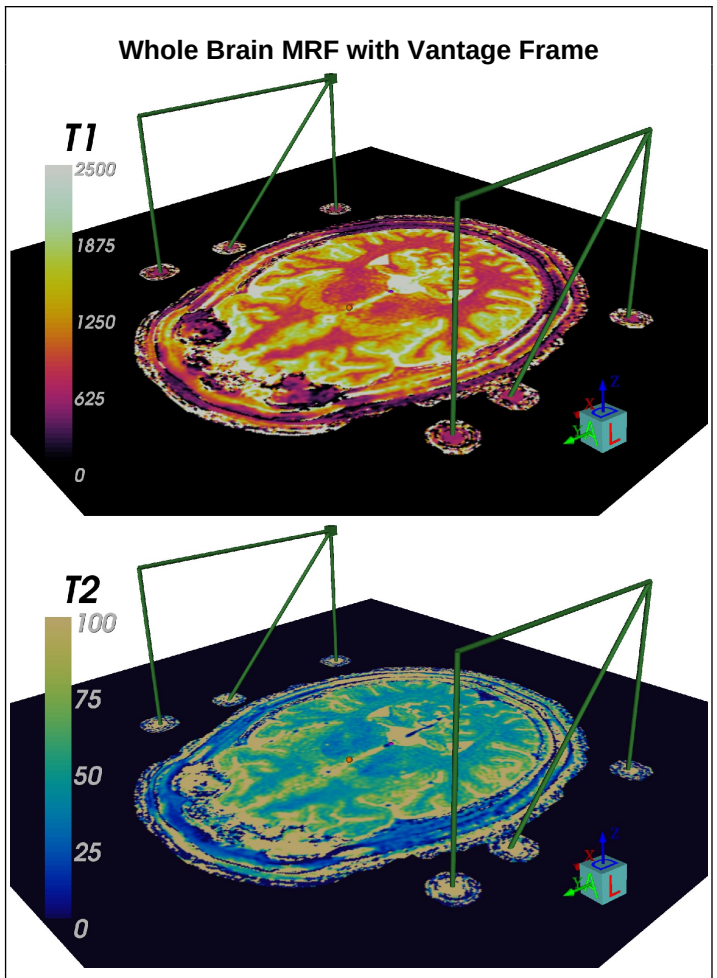
We used MRF in a Siemens 3T scanner to collect a fully quantitative 3D image of a whole human brain [Ma et al., 2018] within a Leksell Vantage MRI compatible stereotactic frame. T1, T2, and proton density maps were created at 1.2 mm isotropic resolution. Basic tissue clusters were then calculated using k-means analysis and used to segment anatomical structures within the subthalamic region. The whole brain MRF scan time was less than 12 min, including a B1 mapping scan to correct for inhomogeneity, making acquisition of these quantitative MRI measurements clinically plausible.

Conclusions

MRF represents a new imaging tool that can quantitatively standardize MRI-based tissue segmentation and surgical target identification. Plus, multiple different tissue properties can be obtained simultaneously using MRF in a single, rapid, completely coregistered acquisition.



The goal in MRF is to generate unique signal evolutions that can be matched to theoretical signal evolutions and subsequently yield underlying quantitative information about the material, tissue or pathology of interest.



Quantitative T1 and T2 maps.

References

Ma et al. Magnetic resonance fingerprinting. Nature. 495(7440):187-92, 2013.
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Acknowledgements

The authors would like to thank Elizabeth Vasconcellos, Merek Gourley, and Balint Varkuti from BrainLab for their assistance with the Vantage frame. This work was supported by NIH R01 EB016728 & R01 EB017219.