A PARSE-MRI BASED TECHNIQUE TO MEASURE CEREBRAL OXYGEN EXTRACTION FRACTION (OEF)

Rajiv G Menon[1], Edward G Walsh[2], Donald B Twieg[3], and Timothy J Carroll[1,4]

[1]*Radiology Department, Feinberg School of Medicine, Northwestern University, Chicago, IL, United States,* [2]*Neuroscience, Brown University, Providence, Rhode Island, United States,* [3]*Biomedical Engineering, University of Alabama at Birmingham, Birmingham, AL, United States,* [4]*Biomedical Engineering, Northwestern University, Chicago, IL, United States*

TARGET AUDIENCE: Physicians, Researchers, and Scientists interested in stroke and cardiac imaging

PURPOSE: OEF is shown to be an independent predictor of stroke [1]. There is an unmet clinical need for a robust MRI technique to quantify oxygen extraction fraction (OEF) in the brain. A novel, fast, and non-invasive MRI technique to measure OEF is being reported here.

METHODS: We implemented the PARSE (Parameter Assessment by Retrieval from Signal Encoding) [2] sequence on a clinical 3T MR scanner. PARSE uses a more accurate MR signal model and allows the simultaneous estimation of M_0, R_2* and OEF related frequency changes (Figure 1). We performed sensitivity analysis and numerical simulations and concluded that the technique is sensitive to frequency changes of 4Hz and higher [3]. In a series of 5 normal volunteers(M/F 3/2, <age> = 26 ±10 years) and 1 Arterio-Venous Malformation (AVM) patient we acquired single slice, 5.0 mm thick, 220 mm x 220 mm FOV, 64 x 64 matrix, resolution = 3 x 3 x 5.0 mm^3) 2D PARSE data. The frequency change maps calculated from the PARSE reconstruction were processed using ICA analysis to separate static components from the dynamic OEF components.

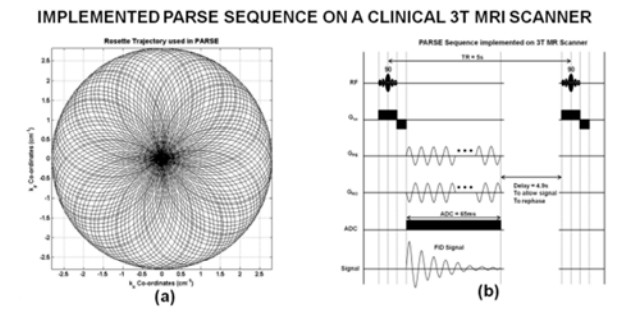

Figure 1. (a) A rosette trajectory is designed for use in the PARSE sequence. (b) The Rosette gradient trajectory is then used in the PARSE sequence implemented on the 3T MRI scanner. Data from a single measurement is 5s and is used to estimate parameter Maps M_0, R_2* and frequency.

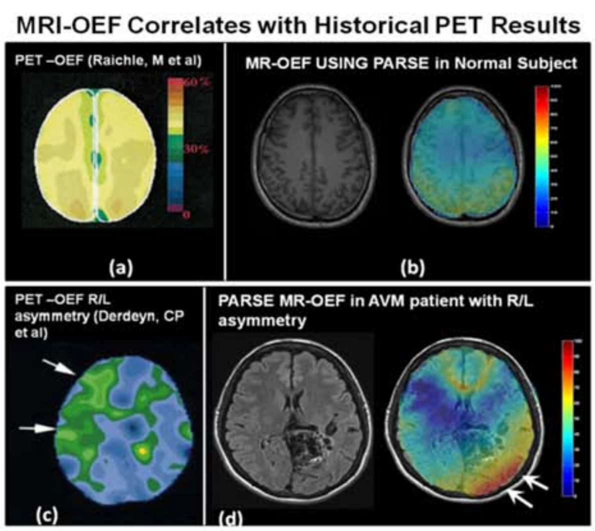

Figure 2: PARSE based MR-OEF images acquired in 5 sec are referenced to anatomic MPRAGE (5:00 min scan) and overlaid (b, d), correlate with expectations based on previously published PET data (a,c)

RESULTS: The mean frequency change for normal subjects was in the range of 15.49 Hz ±2.77. The mean calculated OEF for the 5 normal subjects was 36.87 ± 6.60%. The AVM patient exhibited an area of elevated OEF (84.05 ± 4.54%). Figure 2 shows the plot of OEF for normal subjects and the AVM patient, compared to published Positron Emission Tomography (PET) literature.

DISCUSSION/CONCLUSION: The mean OEF for the normal subjects are in close agreement to literature values of PET-OEF studies of normative values from Carpenter (35±7%), Yamauchi (42±5%), Diringer (41±6%) and Raichle(40±9%) [4]. The AVM patient exhibits elevated OEF proximal to the AVM and "steal" in the distal part of the slice, suggesting that the surrounding tissue may be in distress due to the AVM. The data from PARSE based studies on our cohort suggests a potential MRI-OEF measurement technique. Further patient studies are required to validate the efficacy of this technique as related assessing the risk in stroke patients.

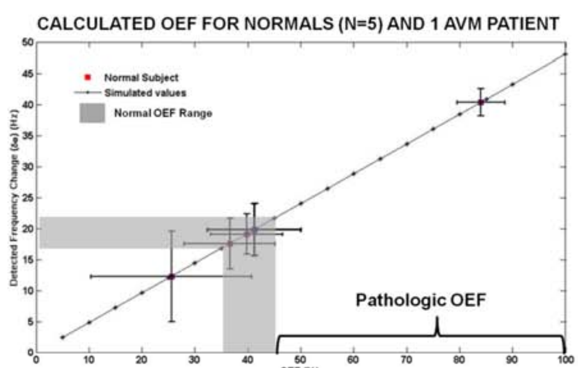

Figure 3: Calculated MR-OEF for 5 normal subjects. The calculated MR-OEF using PARSE lies within the expected range for normal OEF. Elevated OEF is observed in an ROI proximal to the AVM

REFERENCES

[1] Derdeyn CP Brain 2002 125, 595-607;[2] Twieg DB MRM 2002 50:1043-52; [3] Menon, RM et al Proc ISMRM 2012 # 4219 [4] Raichle, et al PNAS 2001 98(2) 676-82

Acknowledgements: NIH/NIBIB T32 EB005170, NIH/NHLBI R01 HL088437