Internship Proposal

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Project Title:
Tuning preclinical MRI for glutamate mapping in the mouse brain at 3 Tesla

Level:

Master

Project Summary:

Glutamate is a major neurotransmitter and a crucial metabolic intermediate in the normal brain. From neurodegenerative disorders to brain tumors, glutamate imbalances have been consistently associated with disease progression [1, 2]. While imaging brain glutamate became paramount, it is hampered by the few non-invasive methods available; particularly for preclinical longitudinal studies.

MRI techniques, such as chemical exchange saturation transfer (CEST [3], are available for in vivo assessment of glutamate. However, these methods rely heavily on high magnetic field strengths due to their inherent low sensitivity, which typically limits the translational relevance to the clinic.

Aim of the project: to harness MRI techniques such as CEST, with sufficient spatio-temporal resolution for fast non-invasive mapping of glutamate in the mouse brain at translational magnetic field strength, using a state-of-the art 3 Tesla preclinical MRI scanner equipped with a dedicated cryoprobe.

Work to be developed by the student:

The experimental work will be carried out at the new Preclinical MRI lab of i3S. The student will first become familiar with the MRI terminology and the general work procedures in the Preclinical MRI lab, learning about basic and more advanced pulse sequences, including CEST. Then, she/he will assist in (i) the preparation of phantom solutions, loaded with different metabolites and concentrations, which will be used to (ii) test acceleration techniques and post-processing methods available in the lab - e.g. compressed sensing [4] and tMPPCA [5], respectively - to (iii) maximize the spatio-temporal resolution of techniques such as CEST, for selective detection and quantification of glutamate. Finally, the

student will assist during vivo validation with anesthetized mice, assessing test-retest reliability.

References:

1.Simoes, R.V., et al., Glucose fluxes in glycolytic and oxidative pathways detected in vivo by deuterium magnetic resonance spectroscopy reflect proliferation in mouse glioblastoma. Neuroimage Clin, 2022. 33: p. 102932.

2.Munoz-Moreno, E., et al., Spatio-temporal metabolic rewiring in the brain of TgF344-AD rat model of Alzheimer's disease. Sci Rep, 2022. 12(1): p. 16958.

3.Cai, K., et al., Magnetic resonance imaging of glutamate. Nat Med, 2012. 18(2): p. 302-6.

4.Heo, H.Y., et al., Prospective acceleration of parallel RF transmission-based 3D chemical exchange saturation transfer imaging with compressed sensing. Magn Reson Med, 2019. 82(5): p. 1812-1821.

5.Olesen, J.L., et al., Tensor denoising of multidimensional MRI data. Magn Reson Med, 2023. 89(3): p. 1160-1172.

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