Exploring the magnetism of the Huntington's brain with MRI

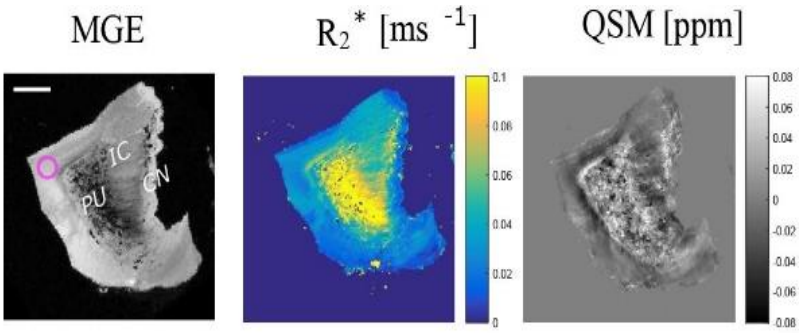
Background

Iron is a crucial bio-metal due to its involvement in many fundamental biological processes. In the brain, cellular iron balance is strictly regulated to avoid neurotoxicity. Many neurodegenerative diseases show brain iron accumulation. An example is Huntington's disease[1,2], a brain disorder characterized by motor disturbances, cognitive decline and behavioural changes. During Huntington's disease, iron accumulates in the brain and the degree of iron load is associated with disease progression[3].

At least 80% of tissue iron is bound to ferritin: a hollow nanoparticle which stores iron in an iron-containing mineral. Since the core of ferritin can accommodate up to 5000 iron atoms, the particle's magnetic moment may reach high values (~ 300 μ_B)[4], which has important implications for imaging, and for the brain's magnetic properties.

Magnetic Resonance Imaging is very sensitive to the magnetic field perturbation caused by superparamagnetic nanoparticles like ferritin. T_2* mapping and magnetic susceptibility examples of parameters which are critically influenced by tissue iron status. However, these methods are also susceptible to other tissue components, like myelin fibres and their orientation[5].

A different approach is to use a technique termed off-resonance saturation (ORS) to obtain iron maps in the post-mortem brain[6]. This method is not influenced by myelin and returns a metrics which is directly related to the absolute amount of ferritin-iron.



Iron assessment on a tissue block derived from a Huntington's patient.

Aims

i) Benchmark the performance of the ORS method against conventional parametric iron mapping;

ii) Assess the ability of ORS to follow brain-iron changes occurring during the progression of Huntington's disease.

What will you learn:

- hands-on experience on a preclinical 7T MRI scanner.
- design of the acquisition protocol and data acquisition on post-mortem material;
- modelling and data analysis.

Where will you work:

You will be conducting your research at the C. J. Gorter Center for High Field MRI, which is embedded in the Radiology department of the LUMC. The Gorter Center is a multidisciplinary research center doing primarily, but not exclusively, MRI research.

What are we looking for:

A student (preferentially Master, but also Bachelor students are encouraged to apply) enrolled in physics/engineering/chemistry/life sciences, with some experience in MATLAB programming. A self-driven student with a critical attitude and who likes to work on multidisciplinary research. You are interested in (and preferentially followed the course) Magnetic Resonance phenomena.

Contact:
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Literature:

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6. Delangre, S., Vuong, Q. L., Po, C., Gallez, B. & Gossuin, Y. Improvement of the Off-Resonance Saturation, an MRI sequence for positive contrast with SPM particles: Theoretical and experimental study. *J. Magn. Reson.* **265**, 99–107 (2016).