Spectral diffusion analysis on IVIM in patients with cerebral small vessel disease

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Background

Cerebral small vessel disease (cSVD) is commonly observed on neuroimaging among elderly individuals and is recognized as a major vascular contributor to dementia, cognitive decline, and stroke (ter Telgte, 2018). However, clinical symptoms are often highly inconsistent in nature and severity among patients with similar degrees of cSVD on brain imaging. In 2006, Prof. de Leeuw started the RUN DMC study, which is a prospective cohort study on the risk factors and cognitive and motor consequences of brain changes among 503 non-demented elderly, aged between 50-85 years, with cSVD (van Norden, 2011). In 2020, patients were invited for their fourth follow up, and ca. 220 underwent an advanced neuroimaging protocol. Noninvasive imaging plays an important role in the management of cSVD, as it can provide in vivo pathophysiological information, without having to rely on histopathology (Wiegertjes, 2019). The protocol includes intravoxel incoherent motion (IVIM) magnetic resonance imaging, a diffusion-weighted imaging technique. Traditionally, two diffusion components are considered to be present in brain IVIM, i.e., parenchymal and microvascular components, which arise from water diffusion in the parenchyma and flow-mediated intravascular (pseudo) diffusivity of microvascular blood (Wong, 2017). However, in cSVD more components with distinct diffusion properties can be hypothesized to be present due to affected tissue. We recently developed spectral analysis using a non-negative least squares (NNLS), yielding a diffusion spectrum, and identified a novel, intermediate diffusion component indicative of interstitial fluid, in addition to vascular and parenchymal components (Wong, 2020).

Objective

The objective of this MSc project is to apply the spectral diffusion analysis on IVIM scans from 220 extremely well-characterized cSVD patients form the RUN DMC cohort, in order to obtain a better understanding of the underlying pathophysiology. It will require strong data analysis and processing skills, and an affinity with clinical research.

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