Measuring interstitial fluid volume using DCE-MRI in pathological brain conditions

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Background

Interstitial fluid (ISF) in the brain is fluid between blood vessels and cells, which plays a role in delivering nutrients to the cells and clearing waste products from the brain. The increase of ISF, both within perivascular spaces or between parenchymal cells, is involved in several brain pathologies, including cerebral small vessel disease (cSVD) and Alzheimer's disease. Increased amounts of ISF influences the signal measured in several advanced MRI sequences, such as dynamic contrast-enhanced (DCE)-MRI and intravoxel incoherent motion (IVIM). However, most commonly used biological models for the analysis of the MRI signal do not incorporate the effects that ISF might have on the signal. While prior work on the ISF-fraction derived using IVIM has already shown that it is associated with both cerebrovascular and neurodegenerative markers, it remains to be investigated whether the ISF-volume fraction as derived using DCE-MRI represents the ISF volume in the entire extracellular space or merely the ISF that is present within the perivascular spaces.

Therefore, in this study we want to investigate whether the volume fraction of ISF calculated using DCE-MRI, relates to the number of enlarged perivascular spaces, and moreover, whether it relates to the volume fraction of ISF as calculated with IVIM.

Student task description

1) Perform the analysis for the in-vivo DCE-MRI data
2) Compare the model with the ISF volume fraction to the model without the ISF fraction
3) Relate the volume fraction of ISF calculated using DCE-MRI to the number of enlarged perivascular spaces and to the volume fraction of ISF as calculated with IVIM.

Useful knowledge/skills:

- Programming experience in Matlab and/or Python