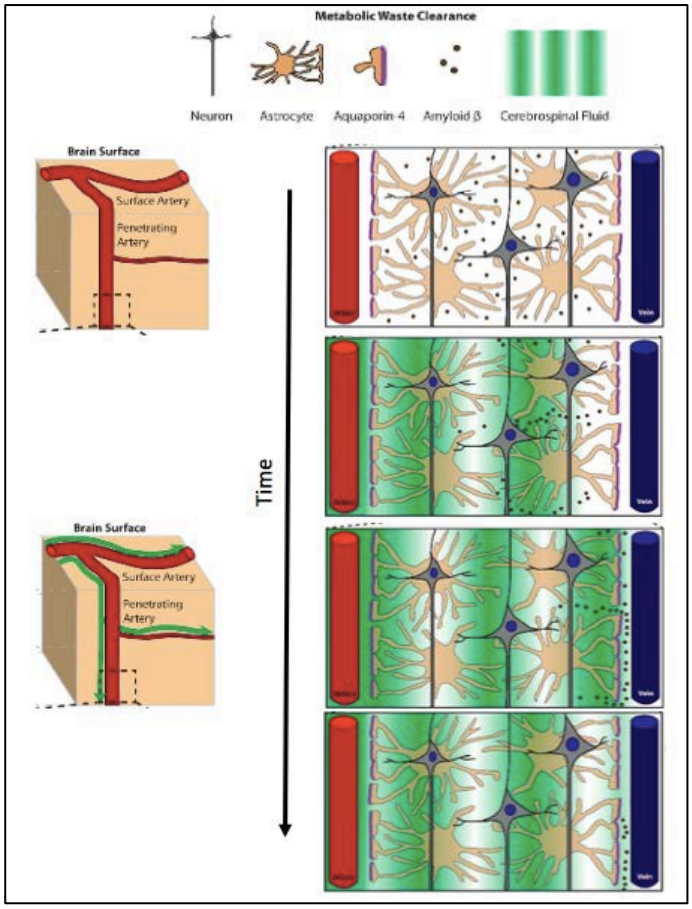
Investigating the glymphatic system in patients with Alzheimer's disease using 7T MRI
Room for multiple project, in cooperation with Maastricht University Medical Center

Background

Alzheimer's disease (AD), the most frequent neurodegenerative disorder and most common cause of dementia in the elderly, is characterized by the accumulation of amyloid-β (Aβ) plaques and neurofibrillary tangles. A waste clearance system called the glymphatic system transports these toxic proteins out of the brain by a network of perivascular spaces and through the interstitial fluid (ISF) in the brain tissue (see figure).



The AD brain shows a reduction in vascular elasticity and increased arterial pulsatility. This affects the perivascular clearance of waste products in the ISF, altering the transport of proteins out of the brain including Aβ. Therefore, a link between glymphatic function and AD has been hypothesized.

Seven Tesla (7T) MRI provides high signal to noise and spatial details, and the unique opportunity to noninvasively assess various features of the glymphatic system by quantifying the volumetric fraction and dynamics of the ISF (using intravoxel incoherent motion imaging, IVIM) and measuring the pulsatility of small perforating lenticulostriate arteries and other supplying arteries (using velocity sensitive MRI). The aim of this study is to discover how these metrics are affected in different stages of cognitive impairment leading to AD.

Project goal

The scan protocol on the 7T is currently being developed and optimized, after which the patients will be scanned. This leaves a lot of room for the student to choose their MRI-method of interest and to help answer questions they are interested in. Students can help with the optimization of the scan protocol on the 7T, setting-up analysis pipelines and analyze high-resolution MRI data.

Amongst others, possible projects in AD patients can focus on:

- Investigating the presence of waste proteins in the perivascular spaces with T2 mapping
- Automatic segmentation of perivascular spaces with T2 MRI
- Cerebrospinal fluid flow using phase-contrast MRI
- Brain activity using high-frequency functional MRI (fMRI)
- Cerebrovascular reactivity mapping using fMRI
- Investigating the ISF volume, microvascular- and other microscopic components using novel methods in diffusion MRI
- Flow of perivascular fluid around the middle cerebral artery using phase-contract MRI

Student profile

- Knowledge of MRI and image analysis
- Experience with Matlab and willing to work with commonly used neuroimaging software
- Preference for working with in-vivo MRI data in a clinical environment

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