Multi-spectral imaging for in vivo imaging of oxygen tension and β-amyloid

Applicants
Dr. Tos TJM Berendschot
Prof. dr. Carroll AB Webers
University Eye Clinic Maastricht
PO Box 5800
NL-6202 AZ Maastricht
The Netherlands
t.berendschot@maastrichtuniversity.nl

The retina has an important property that makes it a sensitive biomarker for diseases: Owing to the responsiveness to light, it has high demands for energy and thus the oxygen consumption is one of the highest in the body (Trick and Berkowitz, 2005). As a result, the retina is extremely sensitive to metabolic changes that can display structural and functional alterations at early stages of diseases by affecting blood supply and oxygen consumption. On the basis of these considerations, it can be expected that the retina is highly vulnerable to pathologic metabolic changes. These disorders may be restricted to the retina (such as glaucoma or age-related macular degeneration) but can also be the result of systemic diseases (e.g. diabetes often leading to diabetic retinopathy) or of pathological processes that primarily affect other parts of the brain (e.g. Alzheimer’s disease or Parkinson’s disease). Indeed there are brain disorders, such as Alzheimer’s disease, that are also known to have effects on the retina. The prevalence of Alzheimer’s disease is correlated with the prevalence of glaucoma (Tsilis et al., 2014). Recently, a positive correlation between age-related retinal diseases such as glaucoma and AMD and cognitive deficits in elderly subjects was established (Harrabi et al., 2015). Visual impairments are also correlated with depression and anxiety disorders in elderly subjects (van der Aa et al., 2015). As such, the retina can be a good biomarker for Alzheimer’s disease and other brain disorders (Heaton et al., 2015).

Oxygenated and deoxygenated blood have different absorption characteristics. This makes it possible to determine the oxygen tension by spectral analysis of the light that is reflected at the retina (Olafsdottir et al., 2014; Yip et al., 2014).

Accumulation of β-amyloid leads to neuronal dysfunction and neuro-degeneration. In the brain this has implications in Alzheimer’s disease (Selkoe, 2001). In the human eye it has been reported to be implicated in Glaucoma and Age-related Macular Degeneration (Parsons et al., 2015). Using curcumin, β-amyloid in postmortem retinal samples from Alzheimer’s disease patients could be stained and allowed the identification of the plaques (Koronyo-Hamaoui et al., 2011). Based on these findings it has been shown that direct optical imaging of β-amyloid retinal plaques may be obtained by using multispectral imaging and retinal fluorochrome-staining (Koronyo et al., 2012).

The aim of this project is to build and clinically test a reliable multi-spectral imaging device, that allows in vivo imaging of oxygen tension and β-amyloid in human eyes. Maps showing the possible existence and distribution of β-amyloid plaques will be obtained in glaucoma patients and possibly patients with (early) Alzheimer’s disease. A second goal is to develop software for hyperspectral image analysis for early detection and diagnosis of these diseases, based on existing models developed in our laboratory (Berendschot et al., 2010; van de Kraats et al., 1996).
Qualifications

The University of Maastricht and the University Eye Clinic Maastricht have great expertise in the field of glaucoma research and biomedical optics.

Dr. Tos Berendschot will be the daily supervisor for this project. He studies the functional morphology of the human retina by non-invasive optical techniques (Berendschot et al., 2003) and has developed devices for quickly and easily measuring Macular Pigment in the human eye, based on the objective technique of fundus reflectance spectroscopy (van de Kraats et al., 2006). He further has used time resolved spectroscopy, including the development of femtosecond laser systems. He has published more than 150 papers in peer reviewed journals (H-index: 34).

Prof. Dr. Carroll Webers is director of the University Eye Clinic Maastricht. He is a leading expert on fundamental and applied research in glaucoma and has been involved in a number of intervention trials.

At present two PhD students, Shuo Zhang and Shujin Wang, from the SCS program are working at the University Eye Clinic Maastricht, while a third one, Yuan Tian, has obtained her PhD degree September 17, 2015.

References