Multi-modal retinal scanning for diagnostic and therapeutic biomarker discovery in multiple sclerosis

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Aim

This project aims to determine the feasibility of using multi-modal retinal scanning as a method to diagnose, prognose and track multiple sclerosis.

Background

Multiple sclerosis (MS) is a chronic neurodegenerative disease which causes the demyelination and damage of axons in the brain. Scotland plays host to the highest MS prevalence rate in the world (402 cases per 100,000 in Orkney and Shetland) [1]. A quick diagnosis is advantageous as patients are more responsive to treatments when intervention is early[2], however this can be difficult as the disease varies widely between individuals and accurate diagnosis can require MRI, clinical and neurological assessments. Thus, the advent of a novel technique which can identify MS biomarkers at an early stage of the disease is widely sought. Retinal scanning offers an inexpensive, quick and non-invasive method for observing anatomical changes to the central nervous system (CNS) and retinal vasculature caused by MS[3].

Methods

	MS participants	Healthy volunteers
Number	**72**	**80**
Female	53	61
Male	19	19
Age range (years)	20-80	23-72
Mean age (years)	45	39
# with follow up scan	31	1

72 patients with MS were recruited and scanned in the Anne Rowling Regenerative Neurology Clinic with Optos Daytona and Heidelberg Spectralis devices. Scanning laser ophthalmoscope (SLO), ultra-wide field (UWF) SLO, UWF autofluorescence (AF) and optical coherence tomography (OCT) images were acquired alongside visual acuity score for each participant. Follow-up scans are to be taken in accordance with each participant's scheduled clinic returns (every 3, 6 or 12 months) to provide longitudinal data. 80 age and sex matched controls were also recruited, with follow up scans to be acquired at 6 month intervals for a maximum of two years.

Analysis

Semi-automatic segmentation of blood vessels will allow the analysis of vessel widths, tortuosity, bifurcation angles etc. Analysis will be performed regionally and globally to assess whether blood vessels are affected to a greater degree in peripheral regions of the retina. Data from OCT will be used to measure the longitudinal effect of MS on the CNS. Manual analysis of UWF AF images will determine any common areas of geographic atrophy, and low contrast visual acuity score will also be used as a measure of retinal function.

Summary

Semi-automatic/automatic segmentation of retinal images will allow longitudinal assessment of the effect of MS on the retinal vasculature, the CNS, retinal function and regions of cell atrophy.

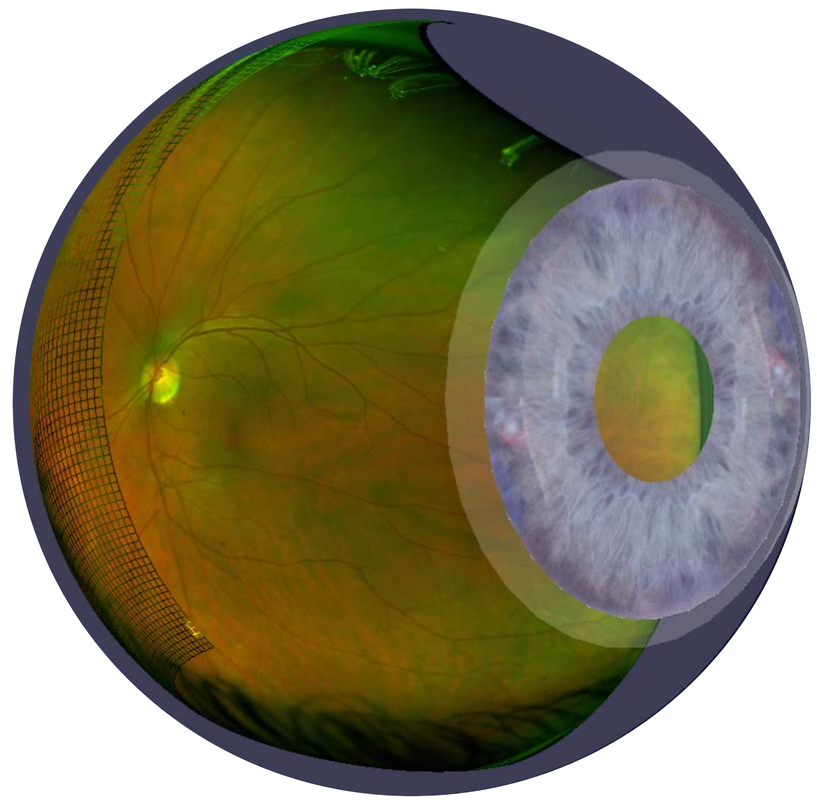

Figure 1: 3D Optomap from Optos Daytona. The retina is an extension of the CNS, sharing pathological and anatomical similarities to the brain.

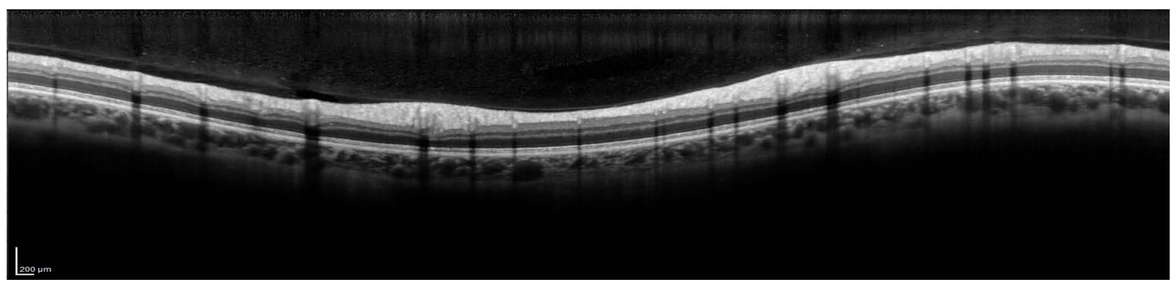

Figure 2: Peripapillary OCT scan taken with a Heidelberg Spectralis. This allows precise measurements of retinal nerve fiber layer thickness.

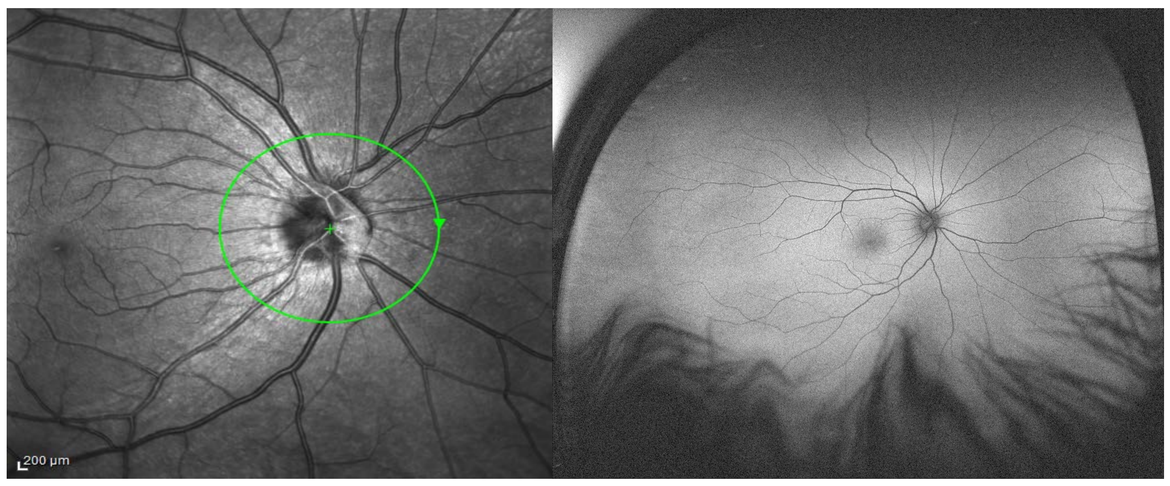

Figure 3: SLO image on the left tracing a peripapillary OCT scan. The UWF AF image on the right is used to assess areas of geographic atrophy.

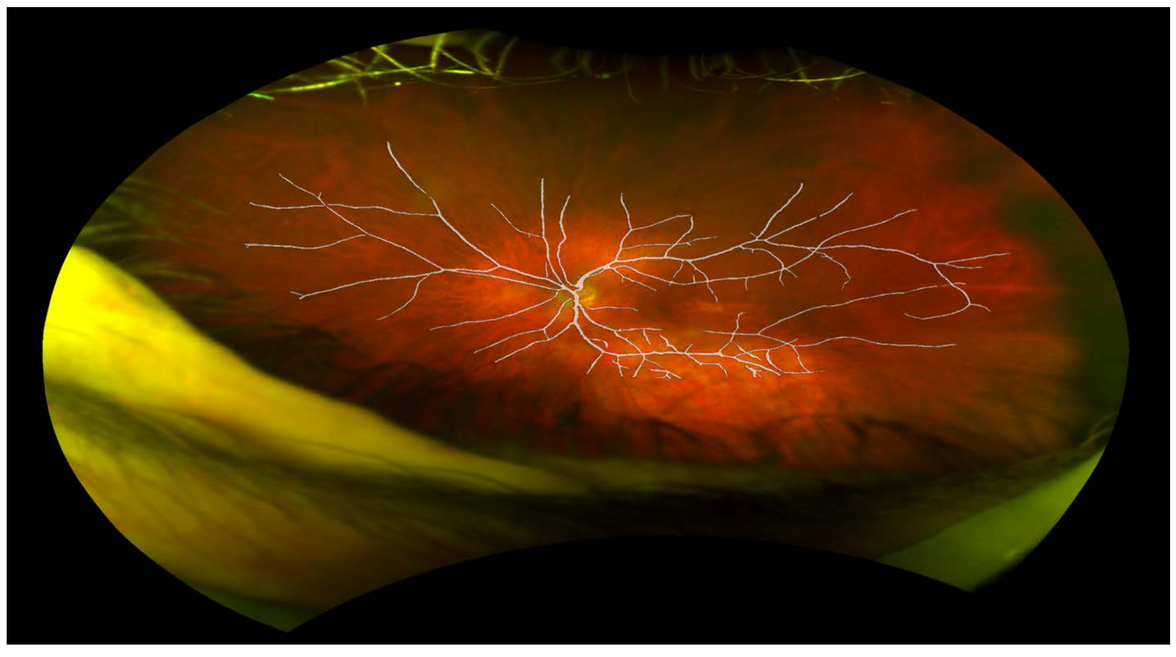

Figure 4: Semi-automatic segmentation of UWF SLO blood vessels[4].

References

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