Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **402** Type: **Oral (Non-Student) / Orale (non-étudiant(e))**

Novel design of instruments to image the retina in a wide field of view

Thursday 10 June 2021 13:10 (15 minutes)

Wide field imaging of the retina at the rear of the eye is recommended yearly for those with diabetes to screen for sight threatening changes. We and others have shown that amyloid protein deposits in the retina appear early in Alzheimer's disease (AD) and predict the severity of amyloid in the brain.
We wish to optimize a scanning laser instrument to image the retina for screening both diabetic complications, and amyloid protein deposits as a biomarker of early AD. We aim to image between 100 and 200 degrees of the retina, with sufficient resolution to detect small, sparse features, either amyloid deposits in AD or changes in blood vessels and small bleeds due to diabetes. Improved optical resolution could be achieved with the use of adaptive optics but this would increase complexity and cost in an instrument, intended for low cost screening in varied settings.
An analysis of individual eye models for over 1200 normal individuals, for whom optical aberrations had previously been measured as a function of age, showed that, as previously reported, these imperfections increase with age. But for each age group, an optimum pupil size could be found which gave the best image quality, defined by resolution. This optimum pupil decreased by on average 30% from the youngest to oldest age group with a 12% loss of resolution, but there was high variability across individuals.
A second approach which predicted the optimum pupil size for each normal individual from a single metric of their ocular image quality (root mean square (RMS) wavefront error), produced accurate estimates of the optimum pupil sizes (on average within 2% of an individual's optimum). The required wavefront measurement would be a relatively low-cost change to the instrument.
Those with diabetes are known to have larger optical imperfections than age-matched normal eyes. This means that, for optimum image quality, they will need to be imaged at smaller pupil sizes, similar to those of older adults. A separate curve of optimum pupil size versus RMS wavefront error may need to be established. Extensions of this research also consider the impact of off-axis optical quality, imaging wavelength and the use of polarized light in imaging. The improved quality in the resulting retinal images will be important to early diagnosis of the retinal effects of both Alzheimer's disease and diabetes.

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Session Classification: R2-3 Biophotonics II (DAMOPC/DPMB) / Biophotonique II (DPAMPC/DPMB)

Track Classification: Physics in Medicine and Biology / Physique en médecine et en biologie (DPMB-DPMB)