Multi-modal Optical Coherence Tomography Imaging as Non-Invasive Biomarker of Dementia

Patrick Xiang Ji[1], BSc, MSc, Morgan Koo[1], BSc, Jordana Compagnone[1], BSc, MSc, Joel Ramirez[1], PhD, Peter Kertes[2], MD, CM, FRCSC, Sandra E. Black[1], O.C., O.Ont., MD, FRCP(C), FRSC

1. LC Campell Cognitive Neurology Research Group, Sunnybrook Hospital, Toronto, ON
2. Ophthalmology & Vision Sciences, Sunnybrook Hospital, Toronto, ON

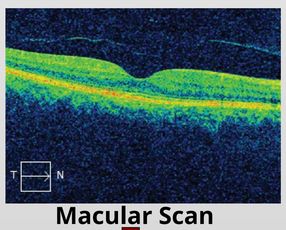
Background & Objectives

Early detection of Alzheimer's Disease (AD) biomarkers may enable prevention measures to slow disease progression. Therefore, the search for reliable techniques to detect and monitor for early biomarkers is very important. The retina is a unique window into the brain, as it shares similar embryological origins. Spectral-domain Optical Coherence Tomography (SDOCT) is a noninvasive system that can provide in vivo high-resolution retinal images and its vessels. This prospective, observational study aims to compare retinal measurements between AD, mild cognitive impairment (MCI) and normal control (NC) cohorts, and between the two eyes acquired within one visit as an estimate of reliability.

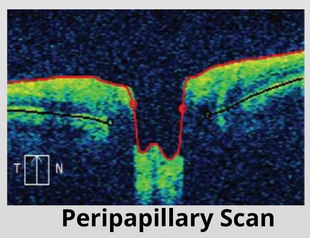
Study Overview

AD/MCI Patients and Normal Controls without known retinal disease

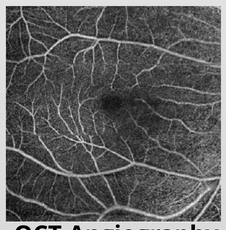
Undergo Cirrus HD OCT



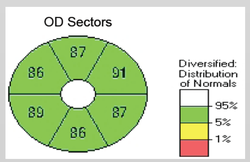
Macular Scan



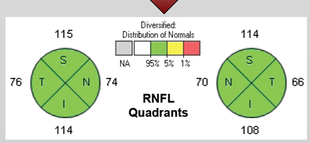
Peripapillary Scan



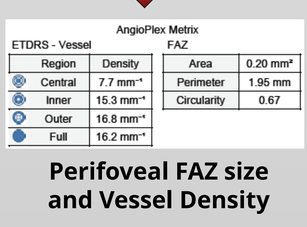
OCT-Angiography



Macular Ganglion Cell Layer Thickness



Peripapillary RNFL Thickness Across 90-Degree Quadrants



Perifoveal FAZ size and Vessel Density

Retinal findings were compared between AD/MCI patients and normal controls with independent-sample t-test and Cohen's *d* calculation, and comparisons between the right and left eyes as estimates of reliability was analyzed with intra-class correlation (ICC) statistics.

Participants

Table 1. Demographics

Cohorts	n	Mean Age (Years)	Age Range (Years)	Males : Females
NC	14	69	62 – 79	6 : 8
MCI	9	74	64 – 81	5 : 4
AD	2	77	74 – 79	1: 1

Results

Table 2. Comparisons between normal control and patient groups

	NC (n = 14)	AD/MCI* (n = 11)	P – value	Cohen's *d*	ICC^ (N = 25)
Superior RNFL Thickness	103.1 µm (14.6)	94.3 µm (15.5)	0.2	0.6	0.58
Nasal RNFL Thickness	70.5 µm (10.7)	65.2 µm (6.7)	0.2	0.8	0.72
Inferior RNFL Thickness	102 µm (25.8)	101 µm (25.8)	0.9	0.04	0.87
Temporal RNFL Thickness	66.6 µm (13.6)	68.6 µm (13.6)	0.7	0.2	0.91
GCL Thickness	74.2 µm (11.6)	69.5 µm (11.9)	0.3	0.4	0.76
Foveal Avascular Zone Area	0.20 mm² (0.09)	0.19 mm² (0.06)	0.7	0.1	0.6

*AD and MCI groups were combined as AD/MCI group for the t-test and Cohen's *d* calculations. ^ICCs were calculated by combining NC, AD and MCI groups.

RNFL

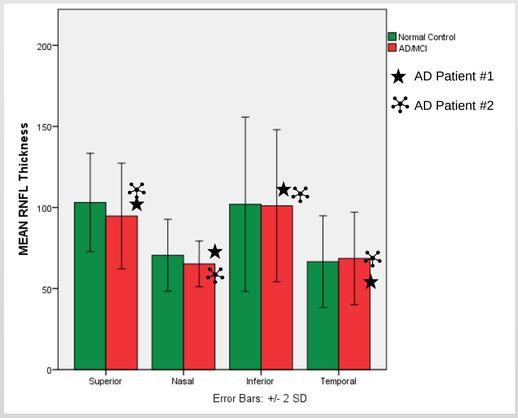


Figure 1. Mean peripapillary RNFL thickness did not show significant differences between patients and normal controls

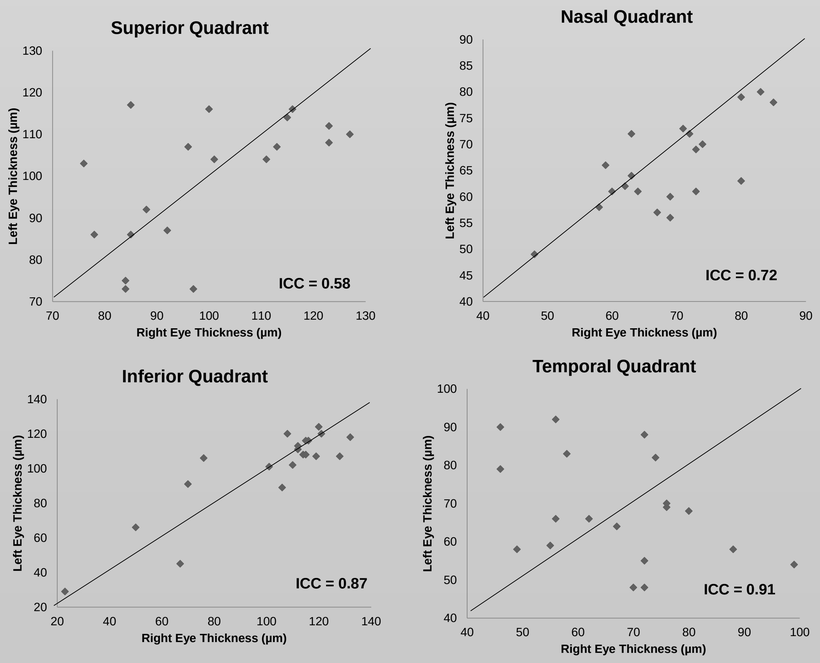


Figure 2. Moderate to excellent estimate of reliability was shown for all quadrants

Macular GCL Thickness

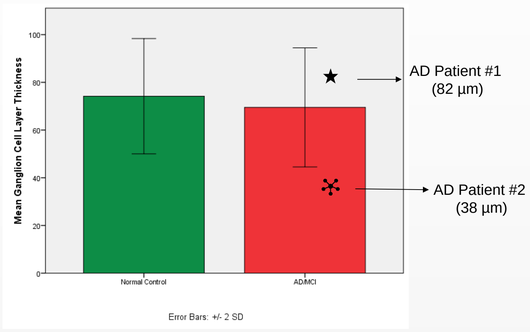


Figure 3. The mean RGC layer thicknesses did not show significantly differences between NCs and patients

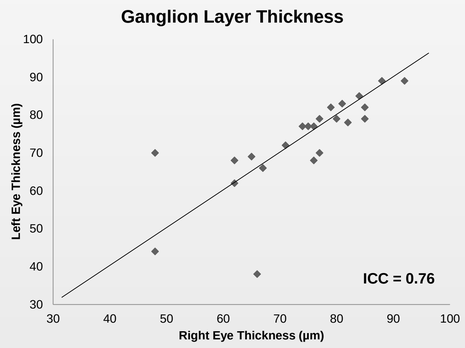


Figure 4. Good estimate of reliability was shown

Foveal Avascular Zone

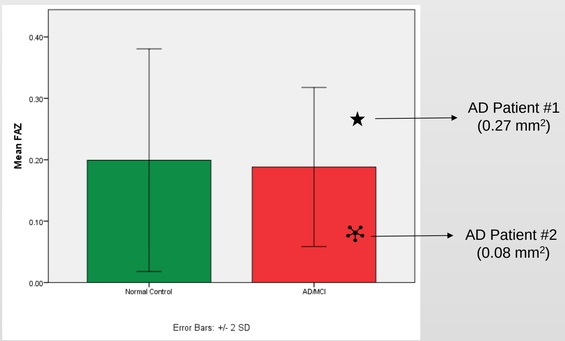


Figure 5. The mean FAZ area did not show significant differences between NCs and patients

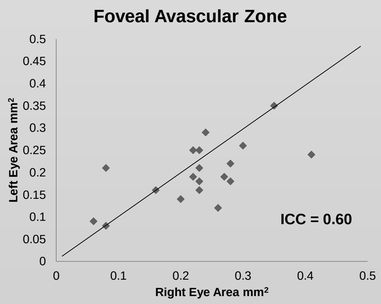


Figure 6. Good estimate of reliability was shown

Conclusions

The preliminary ICC data showed that SDOCT measurements including structural thickness and vascular parameters can be highly reproducible. In addition, the OCT was able to show some RNFL thickness reductions in the superior and nasal quadrants of RNFL, and in the RGCL, albeit not statistically significant given the current limited sample size. The superior RNFL and GCL showed a medium effect size between the two groups, which is consistent with literature. However, the large effect size for nasal RNFL, and the small effect sizes for inferior RNFL and FAZ area, require further studies with a larger sample size and a longitudinal design to confirm whether there are differences between the two groups.

Acknowledgements

Thanks to the Sunnybrook Eye clinic staff for kindly allowing our research team to use their devices including the Cirrus HDOCT C2300