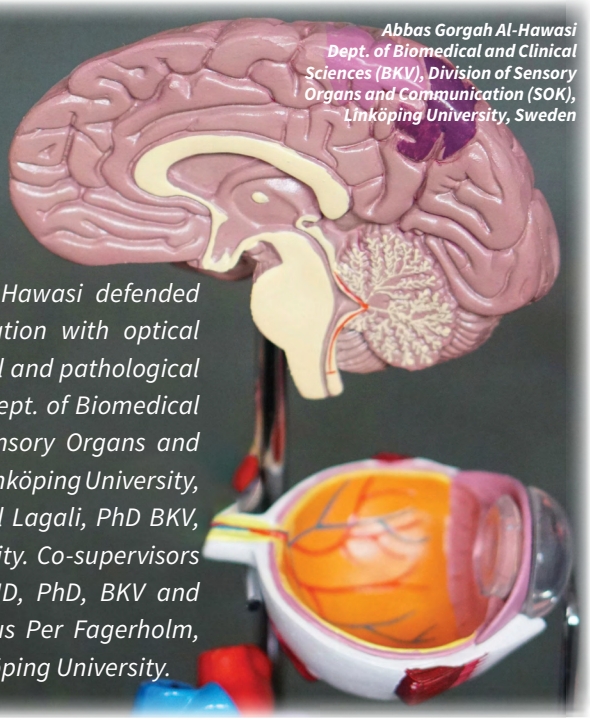
What the eye can tell us about the brain

Abbas Gorgah Al-Hawasi
Dept. of Biomedical and Clinical Sciences (BKV), Division of Sensory Organs and Communication (SOK), Linköping University, Sweden



On December 12, 2023, Abbas Gorgah Al-Hawasi defended his thesis, "Retinal ganglion cell examination with optical coherence tomography reflects physiological and pathological changes in the eye and the brain," at the Dept. of Biomedical and Clinical Sciences (BKV), Division of Sensory Organs and Communication (SOK), Faculty of Medicine, Linköping University, Sweden. The main supervisor was Prof. Neil Lagali, PhD BKV, SOK, Faculty of Medicine, Linköping University. Co-supervisors were Associate Prof. Yumin Huang-Link, MD, PhD, BKV and Division of Neurobiology, and Prof. Emeritus Per Fagerholm, MD, PhD BKV, SOK, Faculty of Medicine, Linköping University.

Future Directions:

- OCT studies are needed to accurately measure the pRNFL and minimize the range of normal values.
- Studies on OCT measurement of the GCL and retinal nerve fiber layer as a screening tool for neurological diseases.

Background

The retinal ganglion cells form the inner retina. Their axons compose the retinal nerve fiber layer (RNFL), which leaves the eye to form the optic nerve. These cells develop embryologically from the forebrain and, later during development, re-establish connections with various parts of the brain serving different purposes. The unique position and connections allow for investigation by various methods. Optical coherence tomography (OCT) is an accessible and easily operated clinical device that can provide a detailed image of this layer at a few-micrometers level of measurement precision. In this thesis, we aimed to determine whether examining these cells with OCT could reflect physiological and pathological changes in the eye and brain.

Key points:

- Ganglion cell layer (GCL) changes examined by OCT reflected similar physiological changes in the eye and brain with age and sex.
- GCL and retinal nerve fiber layer examination with OCT reflected different pathological changes in the brain and the optic nerve.
- The GCL and retinal nerve fiber layer may reflect subclinical neurological changes.

Results

In cases of acute-stage optic neuritis, OCT examination showed early thickening of the peripapillary (pRNFL), which was followed by 6–9 months of thinning to below normal thickness, which could not be distinguished from pseudo-thinning. The ganglion cell–inner plexiform layer (GCL-IPL), however, showed a reduction in thickness within a few weeks to 3 months without pseudo-thinning, allowing for earlier and more reliable monitoring and follow-up. In idiopathic intracranial hypertension, the GCL-IPL remained unchanged, with no difference in pRNFL thickness compared to healthy controls. However, the optic disc parameters of rim thickness, rim area, cup volume, and cup/disc ratio differed significantly. Longitudinal follow-up of idiopathic intracranial hypertension patients on treatment showed a reduction in the pRNFL even if it was within the normal thickness range, which may indicate that normal pRNFL values used by OCT devices need more refinement to reflect more accurate normal values. In cases of benign multiple sclerosis, OCT detected the annual thinning rate of the RNFL and GCL-IPL in eyes not affected by optic neuritis. This was similar to the thinning rate in a healthy population, which may indicate the benign course of the disease. In a healthy population, the OCT examination showed a significant thinning rate of the GCL with age, but the thinning was not significant when sex and axial length of the eye were considered. Men have a thicker GCL volume than women, and, with age, a significant reduction in GCL volume was noted in women but not men. This aligns with previous literature on differences between sexes in the size and volume of the brain. A longer axial length of the eye was associated with thinner GCL volume.

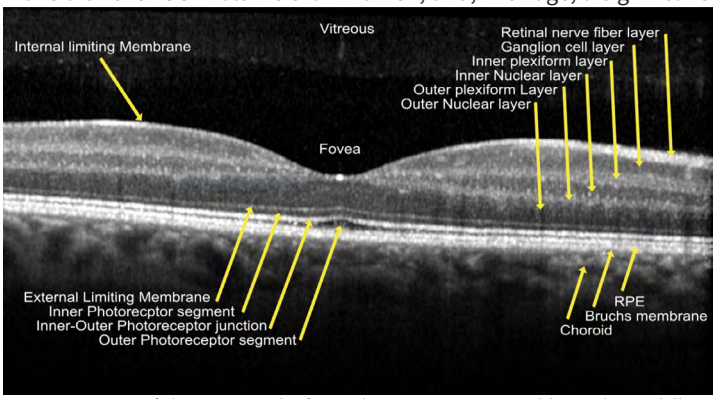


Figure 1. B-scan of the retina at the fovea showing various retinal layers by Heidelberg Spectralis® OCT.

Conclusion

Changes in retinal ganglion cells detected by OCT can reflect physiological and pathological changes in the eye and brain.

References

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