A Novel Wide-Field Peripheral Wavefront Scanner Enables Measurements With Spectacle Lenses

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Purpose

The rapid increase in myopia is a global health concern. To reduce the risk of high myopia and related complications, myopia management lenses are widely used to slow its progression [1]. We developed and assessed an in-vivo optical device (PRx) that measures peripheral aberration. It can take measurements with and without spectacle lenses with the aim to improve myopia control strategies.

Methods

The developed optical instrument measures peripheral refraction (PR) up to ±35° across the visual field. It uses an 830 nm laser beam directed to the measurement point in the eye by relay optics after reflecting from a steering mirror.

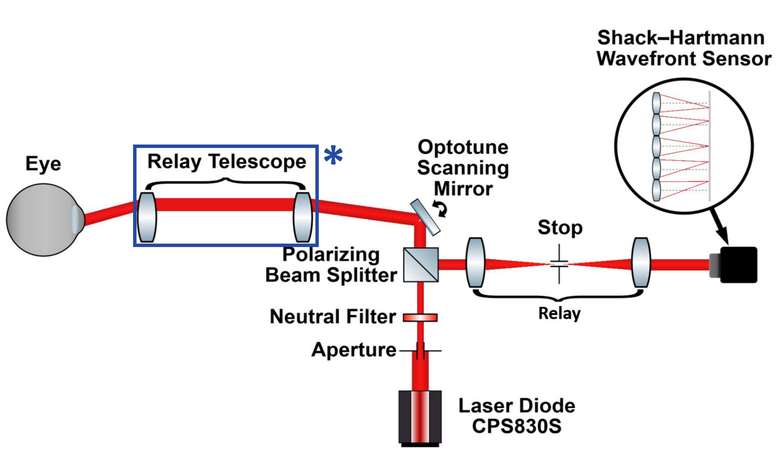

Figure 1: System setup.

PR is assessed in the right eye of 2 participants (p1, p2) under cycloplegia. While participants fixate a target, the instrument measures 5 times per participant, each taking seconds. For validation, central low-order refractive error is compared to a standard wavefront aberrometer (i.Profiler plus, Carl Zeiss Vision GmbH).

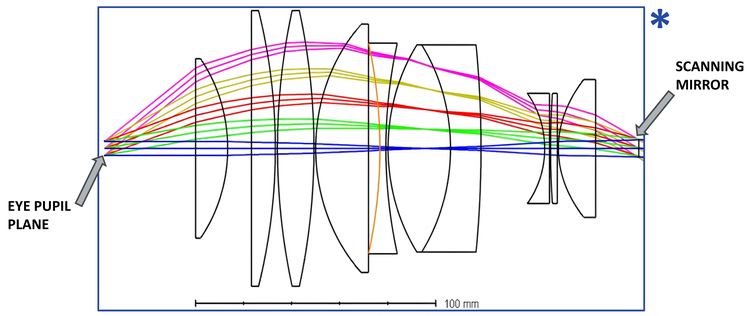

Figure 2: Relay telescope.

Results

A horizontal scan of lower and higher order aberrations was generated for each participant.

As a first step, central lower order refractive error was compared to a gold standard aberrometer.

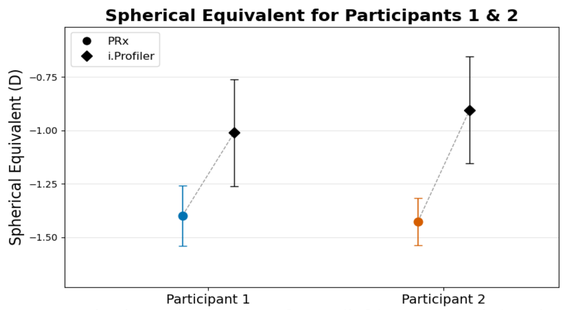

Figure 3: Central spherical equivalent for p1 (left) and p2 (right) with i.Profiler measurement data. i.Profiler standard deviation from literature [2].

Horizontal scans of the participants showed peripheral hyperopia.

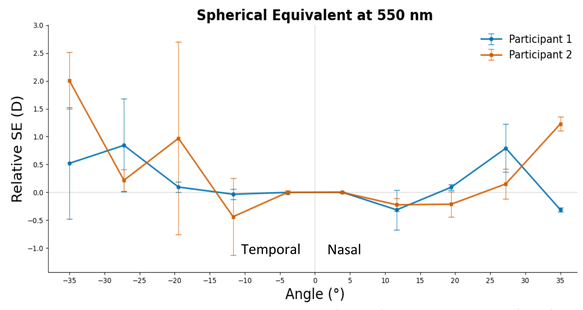

Figure 4: Horizontal scan for p1 and p2. Nasal (right) and temporal (left) indicated.

Discussion

- Measuring peripheral refraction into the far periphery is of interest due to PR's relationship to myopia, making it a promising future biomarker for myopization [3]. We demonstrated a measurement range up to 35° with a single fixation target, enabling rapid assessment of peripheral refractive error and higher-order aberrations.
- While spectacle prescriptions are based on central refractive error, myopia control lens designs may be tailored to peripheral aberrations. Measurements with spectacle lenses provide feedback on the retinal impact of MM lenses [4].
- PRx estimates show an offset of 0.39 D for p1 and 0.52 D for p2 relative to i.Profiler; Further studies are needed to determine their origin. Horizontal scans show peripheral hyperopia: nasally (right), spherical error increases gradually, more in p2 than p1 [5], while temporally (left), variability is higher in both subjects, with future work focusing on improving repeatability.
- Next steps include acquiring full, high-accuracy refraction maps in minimal time and further incorporating spectacle lenses into measurements.

Conclusion

We designed and set up a wide-FOV peripheral refraction scanner. The system measures refraction up to 35° in a single scan, capturing a wide range of refractive errors. A large distance between eye pupil plane and the first relay lens enables measurements with spectacle lenses.

References

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