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Metrological and refractive aspects of retinal shape estimation from 90° field of view OCT

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Purpose

Retinal shape can be derived from distortion-corrected optical coherence tomography (OCT) scans. This parameter is of potential use in myopia research and in retina-related pathologies. The purpose of the study is to evaluate the metrological and myopia-related aspects of retinal shape estimation from OCT images covering a 90° field of view (FOV).

Materials & Methods

Participants

The right eyes of a total of n=20 young adults were scanned. A broad range of axial length and spherical equivalent refractive error was covered (see Table 1).

Table 1: Data of included participants.

	Age (years)	Axial length (mm)	Refractive error (D)
Mean ± St.dev.	28 ± 4	24.73 ± 1.63	-2.74 ± 3.36
Range	21 to 35	22.42 to 28.49	0.00 to -11.00

Scan protocol & ultra-widefield estimation of retinal shape

- Swept-source OCT (PLEX® Elite 9000; ZEISS, Dublin, CA) with a mounted add-on lens for a 90° FOV
- Three subsequent horizontal and vertical B-scans
- Extraction of retinal radius of curvature (RRC) from distortion-corrected OCT scan images by an optical model with individual input parameters[1] (see Figure 1)

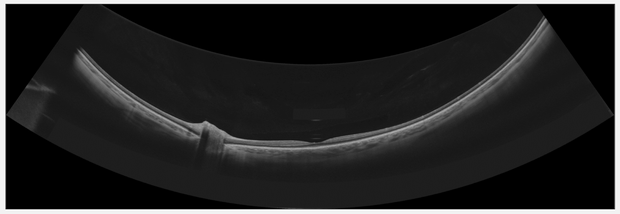

Figure 1: Distortion-corrected OCT scan image, from which the RRC was extracted.

Results

Normative data & repeatability of retinal shape estimation

Table 2 displays the distribution, range and repeatability of RRC calculation from the 90° FOV OCT scans.

Table 2: Distribution and repeatability of horizontal and vertical RRC.

	Horizontal RRC (mm)	Vertical RRC (mm)
Median ± Interquartile range	12.53 ± 1.37	12.83 ± 1.28
Range	11.19 to 15.64	11.15 to 15.44
Coefficient of repeatability	1.11	0.49

Tolerance analysis of the optical model

The tolerance analysis of the optical model for the adjustment of scan geometry is presented in Figure 2 for a variety of input variables and refractive errors.

Axial length was predicted to be the highest source of error in the model, which was compensated for in the correction process. The total root mean square error of the residual variables sums up to 8.34% for a refractive error of 0.00 D.

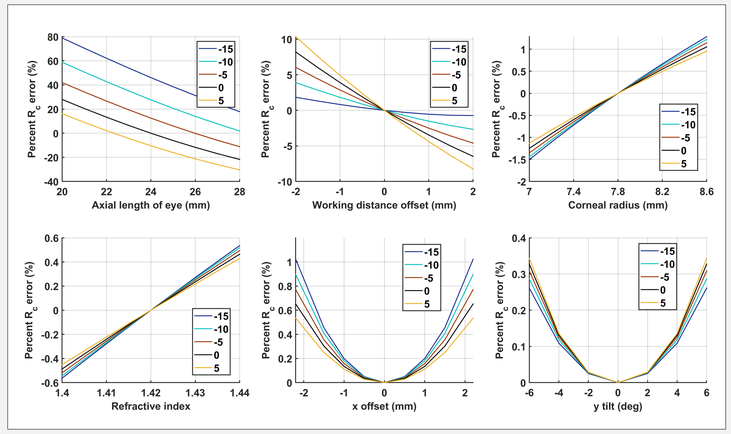

Figure 2: Simulated tolerance analysis for various input parameters of the optical model for the anatomical adjustment of scan geometry.

Results

Correlation to axial length and refractive error

The relationship of horizontal and vertical RRC with axial length and refractive error are presented in Table 3.

Table 3: Spearman correlation coefficient R of horizontal and vertical RRC with axial length and spherical equivalent refractive error..

Spearman "R"	Horizontal RRC (mm)	Vertical RRC (mm)
Axial length	0.74 ($p < 0.001$)	0.61 ($p = 0.005$)
Refractive error	-0.46 ($p = 0.04$)	-0.35 ($p = 0.13$)

Discussion & Conclusion

The study results can be concluded as follows:

- The vertical RRC is larger than the horizontal RRC but falls within the repeatability. Moreover, horizontal and vertical RRC show highly significant positive correlations with axial length. Negative correlations with refractive error are less clear. A previous study using a 53° scan field revealed similar findings[2].
- Repeatability is better in the vertical than horizontal scan direction, probably caused by the presence of the optic nerve head.
- The residual mean square error of the optical model might explain the inter-subject repeatability.
- **Optical modeling of adjusted scan geometry over a 90° scan field of view represents a repeatable and feasible approach for ultra-widefield estimation of retinal shape.**

References

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