Comparing Corneal Shape Measurements of Four Topographers

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Introduction
When fitting a contact lens, information about the corneal shape is essential. An average human cornea can be approximated by an ellipse, and the e-value describes its shape. A typical human cornea has an e-value of ±0.50 (SD 0.16). Corneal topographers typically express three main descriptors: axial radius R₁, Sim-K, and e-values. (Fig. 1) When fitting contact lenses, the Sim-K value is clinically more meaningful than R₁.

Axial Curvature

Several studies analyzed differences in R₁ and e-value measurements of various topographers, suggesting the Medmont E-300 as reference instrument.³,⁴ One study assessed differences in Sim-K data, but it didn’t compare a e-value.²

Our study looks for statistically significant and clinically meaningful differences in Sim-K and e-value measurements of four topographs.

Methods
We measured each cornea three times per instrument, and used the averages for Sim-K and e-values. Prior to statistical conversion, we converted Sim-K values into vectors |M|, |L|, |J|, using Fourier analysis, as proposed by Thibos et al.⁵

We used the following equations for the conversion into Fourier coefficients:

\[ M = \frac{F \cdot \sin(\theta)}{R} \]
\[ L = \frac{F \cdot \cos(\theta)}{R} \]
\[ J = \frac{F \cdot \tan(\theta)}{R} \]

In this notation, J is the Mean-K, L and J are cross-cylinder components. Following ANSI Z80.20, we considered deviations from MED reference values to be clinically relevant for |J| > 0.250, and |J| < 0.120, e-value > 0.10.

Statistical analysis
We calculated Repeated Measures One-Way ANOVA with post hoc Dunn’s test for multiple comparisons, defining the MED as our reference instrument. A statistically significant difference was confirmed for |J| > 0.250, and |J| < 0.120, e-value > 0.10.

Using these thresholds, we found no clinically relevant differences for the Sim-K values, represented by |M|, |L|, |J|, for any of the topographers tested. However, the Topcon KR-8000 PA measured clinically relevant lower e-values.

Results
Only e-value measurements obtained by the TOP instrument had a clinically relevant difference to MED data. Therefore we further analyzed these e-value data pairs.

Evaluating clinical relevance
In order to be clinically relevant, differences had to exceed the following values: |J| > 0.250, and |J| < 0.120, e-value > 0.10.

Using these thresholds, we found no clinically relevant differences for the Sim-K values, represented by |M|, |L|, |J|, for any of the topographers tested.

Discussion
Measuring Sim-K and e-values for healthy human corneas, three of the tested topographies produced clinically comparable results: Medmont E-300, Oculus Keratograph 4, and Zeiss Atlas 9000.² We propose that data from these instruments can be used interchangeably, when obtaining topographical information from healthy human corneas. Sim-K values obtained by the Topcon KR-8000 PA are also clinically comparable to values measured by the Medmont E-300 reference instrument. A clinically relevant difference exists for e-values, which are generally underestimated by the Topcon KR-8000 PA topographer (Bias 0.17, SD 0.09). This requires consideration when GP lens paramters are determined based on these measurements.

References