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Corneal topography with an aberrometry-topography system

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ABSTRACT

Purpose: To investigate the agreement between the central corneal radii and corneal eccentricity measurements generated by the new Wave Analyzer 700 Medica (WAV) compared to the Keratograph 4 (KER) and to test the repeatability of the instruments.

Methods: 20 subjects (10 male, mean age 29.1 years, range 21–50 years) were recruited from the students and staff of the Cologne School of Optometry. Central corneal radii for the flat ($r_{c/fl}$) and steep ($r_{c/st}$) meridian as well as corneal eccentricity for the nasal (e_{nas}), temporal (e_{temp}), inferior (e_{inf}) and superior (e_{sup}) directions were measured using WAV and KER by one examiner in a randomized order.

Results: Central radii of the flat ($r_{c/fl}$) and steep ($r_{c/st}$) meridian measured with both instruments were statically significantly correlated ($r = 0.945$ and $r = 0.951$; $p < 0.001$). Comparison between the WAV and KER showed that $r_{c/fl}$ and $r_{c/st}$ measured with WAV were significantly steeper than those measured with KER ($p < 0.001$). Corneal eccentricities were statistically significantly correlated in all meridians ($p < 0.05$). Compared to KER, e_{temp} and e_{sup} measured with WAV were greater ($p < 0.05$), while there were no statistically significant differences for e_{nas} and e_{inf} ($p = 0.350$ and $p = 0.083$). For the central radii, repeated measurements were not significantly different for the KER or WAV ($p > 0.05$). Limits of agreement (LoA) indicate a better repeatability for the KER compared to WAV.

Conclusions: Corneal topography measurements captured with the WAV were strongly correlated with the KER. However, due to the differences in measured corneal radii and eccentricities, the devices cannot be used interchangeably. For corneal topography the KER demonstrated better repeatability.

1. Introduction

The measurement of the shape, refractive power and thickness of the cornea is essential for the planning of corneal refractive surgery, for diagnosis of corneal diseases and for fitting contact lenses, in particular speciality lenses. Various diagnostic procedures have been developed for the analysis of the corneal surface. Corneal topographical measurements can be performed by classic Placido-based topographers as well as by tomography systems that produce three-dimensional corneal models from cross-sectional images [1].

Placido-based computerized videokeratoscopy, proposed first by Klyce in 1984 [2], are the most frequently used corneal topography systems in clinical practice [3]. This method of imaging of the anterior corneal surface analyses tear film reflected images of multiple concentric rings projected on the cornea. In contrast, corneal tomography provides an analysis of the shape of anterior and posterior corneal surfaces, as well as the thickness distribution of the cornea [4]. Corneal tomography can be performed by a scanned slit, rotating Scheimpflug cameras or by optical coherence tomography [5].

Recently, a new corneal topography with an integrated aberrometry-topography system named the Wave Analyzer 700 Medica (Essilor, Freiburg, Germany) has been introduced to the market (Fig. 1). The Wave Analyzer is a multifunctional device for performing objective refraction, aberrometry, pupillometry, pachymetry, non-contact tonometry, measurement of anterior chamber depth and angle as well as corneal topography. The instrument combines a Hartmann-Shack aberrometer, an air tonometer, a Scheimpflug camera and a Placido-based topographer. However, the data for the corneal radii and corneal eccentricity is only generated from the Placido-disc measurement without any contribution of the Scheimpflug camera.

Consequently, the aims of this study were (i) to investigate the agreement in the measurement of central corneal radii and corneal eccentricity between the new Wave Analyzer 700 Medica (WAV) and the Placido-based Keratograph 4 (KER) (Oculus Optikgeräte GmbH, Wetzlar, Germany) (Fig. 2) and (ii) to test the repeatability of the instruments.

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Fig. 1. Wave Analyzer 700 Medica (Essilor, Freiburg, Germany).

Fig. 2. Keratograph 4 (Oculus GmbH, Wetzlar, Germany).