Precision of NIDEK OPD-Scan Measurements

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ABSTRACT

PURPOSE: To evaluate the repeatability of wavefront measurements using the NIDEK OPD-Scan.

METHODS: A total of 179 eyes from 90 healthy volunteers (57 women and 33 men) with no corneal or lenticular pathology and normal visual acuity were enrolled in this study. Mean patient age was 39 years (range: 17 to 85 years). All patients underwent four consecutive measurements by one examiner with the NIDEK OPD-Scan. Total, corneal, and internal wavefront errors were measured and calculated with the device, using slit retinoscopy. Repeatability of the measurements was evaluated for spherical aberration, coma, and trefoil.

RESULTS: The repeatability test revealed a good result for all three higher order aberrations evaluated. The best repeatability values were found for total aberrations, followed by internal and corneal aberrations.

CONCLUSIONS: The NIDEK OPD-Scan has good precision in the wavefront measurement of total, corneal, and internal optical aberrations. [J Refract Surg. 2006;22: S1021-S1023.]

The innovation of measuring wavefront errors of the eye was an important step in improving treatment plans and surgical outcomes for patients undergoing refractive surgery.¹ Today the examination of wavefront errors of the eye is an important factor in preoperative work-up of candidates for refractive surgery. Customized treatments are becoming more popular, and the success of these treatments relies on a superior excimer laser system as well as on accurate and reliable wavefront measurements.²³ Another important treatment for wavefront errors is intraocular lens (IOL) surgery and wavefront-corrected IOLs such as aspheric IOLs.⁴ Total wavefront errors of the eye can be evaluated using different systems; however, only a few analyze corneal and internal aberrations. Among these is the NIDEK OPD-Scan (Optical Path Difference Scanning System; NIDEK Co Ltd, Gamagori, Japan).

Most wavefront analyzers are based on Hartmann-Shack aberrometry, whereas the OPD-Scan is based on slit retinoscopy. This provides a total of 1440 measured refractions within a 6-mm pupil.⁵

The purpose of this study was to evaluate the NIDEK OPD-Scan for repeatability of total, corneal, and internal wavefront measurements (Fig).

PATIENTS AND METHODS

A total of 179 eyes from 90 healthy volunteers (57 women and 33 men) with no corneal or lenticular pathology and best spectacle-corrected visual acuity of at least 20/25 were enrolled in this study. Mean patient age was 39 years (range: 17 to 85 years). Prior to enrollment, informed consent was obtained from all patients. All patients underwent four consecutive measurements with the OPD-Scan under dim light conditions by one trained examiner. All patients enrolled

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had a pupil size of at least 6 mm. For patients with pupils <6 mm, one dilating drop (neosynephrine 5%) was used to reach a minimal pupil size of 6 mm. Patients were not permitted to use topical drops or ointment prior to the study.

After careful alignment of the pupil, individual measurements were performed. An infrared light source within a rotating drum was projected onto the entrance pupil, producing a scanning slit on the fundus. A special photo diode array detected the timing of the fundus reflex while scanning. To obtain information for each meridian, a chopper wheel was used to change the direction of scanning and the orientation of the photo sensor. The measured refractive errors were then converted into wavefront errors and a wavefront map. In addition, the OPD-Scan evaluated corneal topography and corneal wavefront calculation simultaneously, which minimized alignment errors associated with eye movements that can affect the accuracy of the measurements.

Corneal, internal, and total wavefront errors were calculated as Zernike polynomials for a 6-mm pupil and the data exported to Microsoft Excel (Redwood City, Calif). Repeatability was then tested for coma, spherical aberration, and trefoil higher order aberrations as mean values of the standard deviations for all measurements.

RESULTS

The precision tests revealed good repeatability for all aberrations investigated (Tables 1-3). For spherical aberration, the best repeatability was found for total aberration, followed by internal and corneal spherical aberration. A similar distribution was found for coma with best values for total coma, followed by internal and corneal coma. Similarly, trefoil aberrations showed the best values for total aberration, followed by internal and corneal aberration. The lowest repeatability values overall were found for trefoil measurements of the cornea.

DISCUSSION

Wavefront sensors are important devices in the evaluation of refractive surgery and the calculation of cus-
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The OPD-Scan used in this study combines different measurements: wavefront analysis, corneal topography analysis, pupillometry, and autorefraction. When comparisons of the location of higher order aberrations are performed, it is important that the visual axis is well aligned among the different measurements. If a wavefront analyzer and corneal topographer are used separately for the measurements, exact alignment of the eye may be difficult. If one instrument combines these measurements and performs calculations within a short time frame, potential errors can be minimized.

The repeatability test of the OPD-Scan showed a similar distribution for the different aberrations investigated. Total aberrations always revealed the best repeatability values, followed by internal and corneal aberrations. This could be because the wavefront sensor is based on the retinoscopy principle and measures the dioptric changes precisely, whereas the corneal wavefront is based on calculations of topography data.

Rodriguez et al6 reported good reliability for different wavefront-measuring devices. They compared measurements from five young patients using the Zywave Hartmann-Shack wavefront sensor (Bausch & Lomb, Rochester, NY), laser ray tracing (Tracey Technologies, Houston, Tex), and their own laboratory laser ray tracing prototype. They also emphasized the importance of good pupil alignment, good examiner skills, appropriate accommodation targets, and good subject cooperation. In another study by Cheng et al,7 the test-retest reliability over time for Hartmann-Shack measurements was evaluated. Four healthy eyes were measured on five consecutive days and on five days on a monthly basis. In this study, variability over a short time was low but increased over time.

The reliability with different corneal topographers has also been reported.8-10 In general, it seems to be important that the examiner is well trained in the use of the device.11

The current study showed good repeatability in consecutive measurements from healthy volunteers for total, corneal, and internal wavefront measurements performed with the NIDEK OPD-Scan.

REFERENCES