EXPLORING THE UTILITY OF THE OPD-SCAN III TO DETECT KERATOCONUS AND CORNEAL ECTASIAS

Take full advantage of this multifaceted screening tool.

BY STEPHEN D. KLYCE, PHD, FARVO

The success of cataract and refractive surgeries depends not only on a surgeon's skill in the operating room but also on thorough preoperative screening and planning using data from a battery of diagnostic tests and imaging. The OPD-Scan III Refractive Power Corneal Analyzer (NIDEK) combines autorefraction, Placido-based corneal topography, keratometry, pupillometry, pupillography, corneal screening software, and wavefront aberrometry in one efficient workstation to facilitate comprehensive analysis and assessment.

The heart and soul of the OPD-Scan III detection scheme is the Corneal Navigator screening program.[1] The Corneal Navigator obtains several indices from a corneal topography examination and classifies the similarity of the topography to one of a number of corneal conditions.

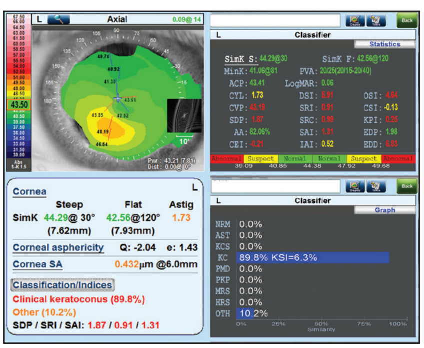

Figure 1. The OPD-Scan III Corneal Navigator program calculates several indices derived from the topography and uses these in a trained and validated neural net to classify topographies for several conditions. Here, a mild keratoconus topography is displayed and is interpreted as such (KC) with a severity index (KSI) of 6.3%. Along with difference mapping, these data can be used to document progression if present from repeat visits.

In this article, I describe how the OPD-Scan III is best utilized to identify subclinical or early keratoconus to reduce the risk of postoperative ectasia after refractive surgery. I also touch on the utility of aberrometry for cataract surgeons both as a preoperative screening tool when premium-channel IOLs are being considered for a patient, as well as for postoperative evaluations.

EARLY KERATOCONUS DETECTION

LASIK, PRK, and SMILE are contraindicated for patients who have corneal structural weakening conditions, such as keratoconus, as the surgery can further weaken the cornea with the removal of stromal tissue. The challenge has been to develop accurate and sensitive methods to detect very mild keratoconus before a patient has compromised vision or undergoes refractive surgery.

The first detection schemes, developed in the 1990s, used Placido-based topography to evaluate corneal shapes.[2] These technologies were expanded in subsequent years to detect several different corneal topographic anomalies, including keratoconus, keratoconus suspects, and other contraindications for refractive surgery, including pellucid marginal degeneration (Figure 1).[2]

Slit-based corneal tomographers have also been used to detect keratoconus, as these systems can produce thickness profiles from the elevation measurements of the front and back surfaces of the cornea. With very early keratoconus, however, there is no measurable focal thickness change, thus limiting the utility of corneal tomographers for keratoconus detection. We learned from Binder that thin corneas per se are not at risk for ectasia.[3]

Keratoconus occurs at the surface of the cornea between the epithelium and the anterior stroma in Bowman's membrane. It starts with a focalized disorganization of the collagen, which is difficult to detect using slit-based technology but is evident with high-resolution OCT.[4] The resulting focal or localized weakening of the biomechanics of the cornea produces a small curvature change that can be measured accurately with reflection corneal topography. This reflection technique is 20 times more sensitive to curvature changes than slit-based technologies.[5] Hence, the reflection technique of corneal topography, such as the Placido topography in the OPD-Scan III, is the most sensitive method to detect the earliest changes of keratoconus.

CORNEAL ECTASIA DETECTED—NOW WHAT?

Once an ectasia is detected, perhaps the most important element in the further evaluation of keratoconus and postoperative ectasia is progression. The expression of keratoconus varies considerably from patient to patient. In some, keratoconus may seem unilateral, resulting in what is termed very asymmetric keratoconus. In others, keratoconus signs are bilateral while still asymmetric. Periodic corneal topography examination and using the difference map display documents progression or stabilization in ectasias or refractive surgeries (Figures 2 and 3). Ectasia can progress rapidly, particularly keratoconus in the teenage years. Hence, repeat examinations every 3 months may be reasonable to demonstrate progression and the need for treatment.

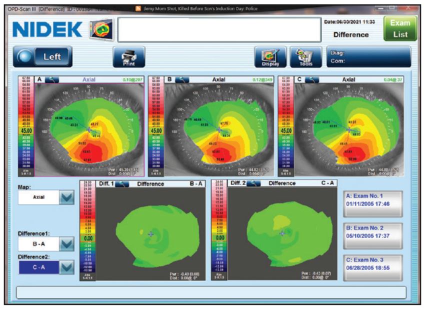

Figure 2. Difference mapping. Moderate keratoconus showing stability for a 6-month period. Management of the case (CXL or not) may depend on functionality of vision. The case also demonstrates the excellent repeatability of OPD-Scan III examinations.

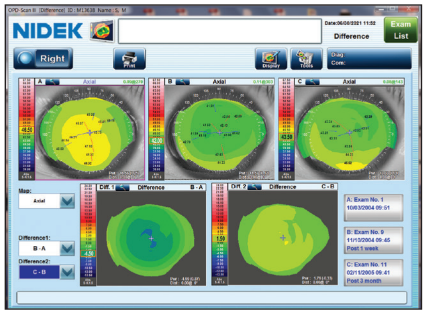

Figure 3. Difference mapping. An uneventful LASIK procedure shows an unusual uniform 1.50 D loss of treatment effect between 1 week and 3 months.

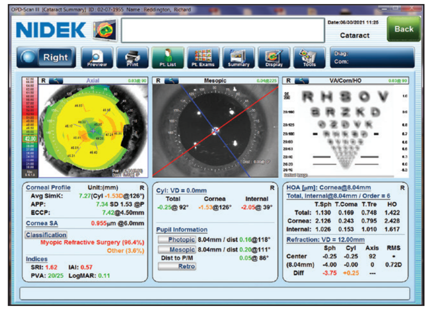

Figure 4. Optical quality display. Unless the corneal defect can be repaired, this patient could experience increased visual distortion with a premium-channel IOL.

Where corneal cross-linking (CXL) is an approved procedure, optimal benefit to the patient is early treatment before significant visual deficit ensues. This is true for both the keratoconus eye as well as for iatrogenic ectasia.

In summary, corneal topography difference mapping is key to determining whether ectasia may progress to a visually significant level requiring intervention. Repeat visits at short intervals make this possible. Patients identified with early ectasia are advised to make an urgent appointment if they notice a change in corrected vision; however, this usually is not a recommended early warning sign of progression, as small, slow changes in vision are difficult for patients to discern.

IDENTIFY THE SOURCE OF REDUCED VISUAL ACUITY

The OPD-Scan III can play an important role in the planning of cataract surgery as well as in postoperative evaluations. A full examination of the eye will separately evaluate corneal optical quality before and after surgery and assess the combined optics of the post-surgical cornea and the implanted IOL.

The OPD-Scan III provides independent measurements of aberrations from the corneal surface derived from Placido topography, as well as the refraction and aberrations from the whole of the eye using the principle of skiascopy. By aligning these two measurement sets along the same optical axis, one can obtain separate measures of corneal aberrations and the internal aberrations of the eye.

The OPD-Scan III has several utilities that assess the optical quality of the cornea; these are important in planning for cataract surgery, as corneas exhibiting abnormal higher-order aberrations can contraindicate use of premium-channel IOLs (Figure 4). If the higher-order aberrations arise from ocular surface disease, this can be treated, often resulting in an eye that will accept a premium-channel lens. Additionally, the incidence of cataract patients who have undergone corneal refractive surgery is on the rise. Using standard keratometry in IOL calculations for these patients can lead to unexpected errors. The OPD-Scan III has several variables that result from an averaging of central corneal curvature to more accurately reflect the true central corneal curvature.

An important feature available from the aberrometry measurements from the OPD-Scan III relates to IOL centration relative to the line of sight. The instrument offers three useful centration landmarks measured relative to the corneal vertex (reflex from the aiming beam): both centers of the photopic and mesopic pupils and the anatomical center of the cornea. These measurements allow multiple centration landmarks including angle kappa (Chord µ), angle alpha, and the photopic and mesopic line of sight. Many hyperopes, for example, have a large angle kappa, and this offset from the resting center of the IOL implant can degrade optical performance.

After cataract surgery, the OPD-Scan III can accurately evaluate residual cylinder and help identify the magnitude, source, and impact of any postoperative aberrations. This information is derived from the independent measures of corneal and ocular aberrations.

CONCLUSION

The OPD-Scan III is a multifaceted corneal topographer and ocular wavefront aberrometer. In this article, I have touched on only a sample of its utilities and displays that include corneal topography, interpretive corneal screening, pupillometry, autorefraction, autokeratometry, and ocular wavefront aberrometry. The instrument is the result of a mature and accurate technology with features that include several utilities guided by published experts in the field. The OPD-Scan III offers clinicians the opportunity to provide excellent guidance in patient care. ■

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