IOL Station Software for the OPD-Scan

This wavefront aberrometry system determines corneal, internal, and total-eye aberrations to provide the optimal axis of alignment for toric IOLs.

BY PAOLO VINCIGUERRA, MD; AND ELENA ALBÈ, MD

Accuracy of biometric calculations and, more important, of refractive results depends on three main factors: preoperative biometric data including axial length, anterior chamber depth, lens thickness, and corneal curvature power variables; power calculation formulas; and quality and accuracy of the IOL. In the past 15 years, several million people worldwide have undergone various refractive surgery procedures for the most disparate visual defects. These patients will soon be candidates for cataract removal due to the natural aging process. In this population, corneal curvature is profoundly modified, and obtaining reliable biometry becomes complex. Additionally, patients who have previously undergone refractive surgery are accustomed to a high level of visual quality, translating to high expectations after cataract surgery.

All available biometric devices, even the most sophisticated, are designed for use on normal prolate corneas, for which keratometry measurement based on 4 to 6 points is considered enough to accurately determine corneal curvature. These points are measured several millimeters from the corneal center; however, after refractive surgery, the corneal gradient changes dramatically across the corneal surface, from the pupil center to the periphery. The postoperative course may therefore be full of surprises due to inaccurate determination of corneal curvature using these devices and standard measurements. The same situation tends to occur in individuals whose corneas have been subjected to other surgical treatments that affect corneal curvature, such as corneal transplantation, radial keratotomy, deep anterior lamellar keratoplasty, Descemet-stripping automated endothelial keratoplasty, and phototherapeutic keratectomy.

In comparison, topography can accurately detect the mean pupillary power rather than just 4 to 6 points in the medium periphery. Topography measures the actual power of the entire pupillary area that is involved with visual acuity.

TAKE-HOME MESSAGE

- The postoperative course in cataract patients who have previously undergone refractive surgery may be full of surprises due to inaccurate determination of corneal curvature using biometric devices and standard measurements.
- Preoperative topographic and wavefront analyses can be just as advantageous in cataract surgery as they have proved to be in refractive surgery.
- The OPD-Scan with IOL Station software measures and collects postoperative data and provides a synthetic single-document printout of all essential information that can be hung in the operating room.

INTRODUCTION OF WAVEFRONT TECHNOLOGY

Great attention has recently been given to the accurate analysis of irregular optical systems with the introduction of wavefront analysis, a type of evaluation once belonging exclusively to the territory of astronomy, into common ophthalmic practice. Preoperative topographic and wavefront analyses of the total power of the eye can be just as advantageous in cataract surgery as they have proved to be in refractive surgery in the past decade. Both can be used to analyze the parameters necessary for success with modern IOL technology and therefore answer the increasing demands for optimal postoperative visual quality. These parameters include the following categories, described below.

Total, corneal, and internal spherical aberration. These can be used to select the best aspheric IOL.

Total and internal astigmatism. The latter is determined by the lens that will be surgically removed, resulting in change in the total astigmatic power and axis of the eye. The availability of toric IOLs makes wavefront assessment essential. If the total astigmatism is corrected with a toric IOL, the astigmatic component of the crystalline lens is removed, and the patient will end up with iatrogenic astigmatism.

Angle kappa. Angle kappa (angle K) is the difference

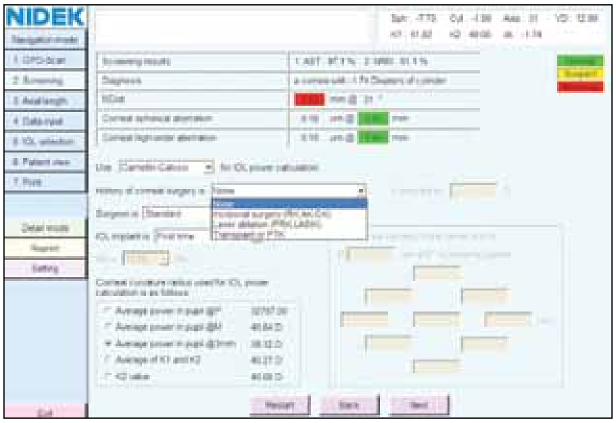

Figure 1. Vinciguerra Summary, obtained with the Nidek OPD-Scan. Red: The MPDist (angle K) provides information on the distance between pupil center and the visual axis in photopic and scotopic conditions. Data are color-coded: normal = green, suspect = yellow, danger = red. In this case, the Mdist value is abnormal (red).

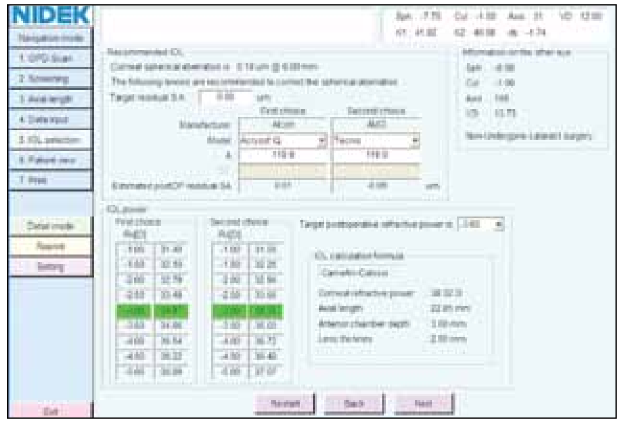

Figure 2. Vinciguerra Summary, obtained with the Nidek OPD-Scan. Presentation of IOL data. Green: the power of two aspheric IOLs for a target refraction of -3.00 D. It also estimates the postoperative residual spherical aberration.

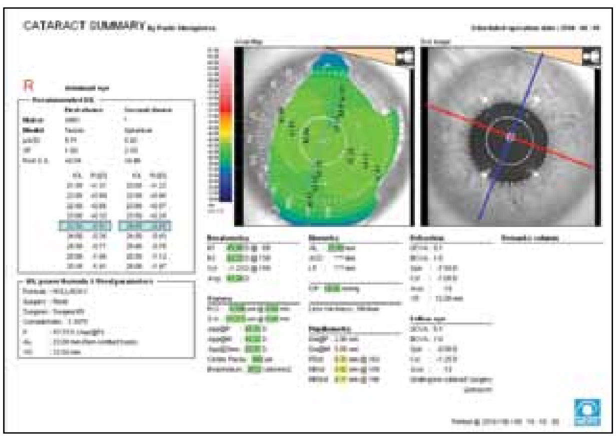

Figure 3. Vinciguerra Summary, obtained with the Nidek OPD-Scan. The final printout is used in the operating room.

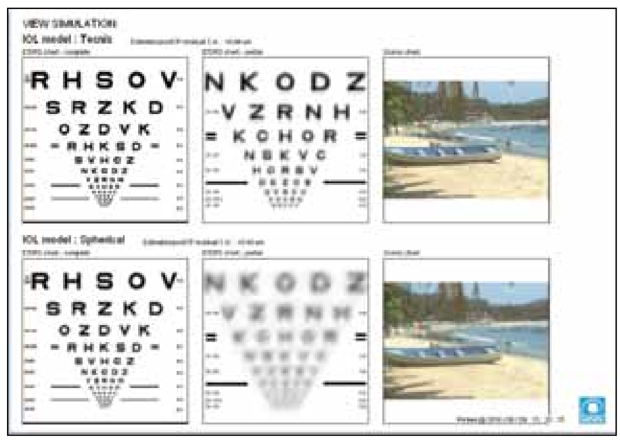

Figure 4. Vinciguerra Summary, obtained with the Nidek OPD-Scan. Presentation of visual quality with various types of aspheric lenses. Residual spherical aberration is also calculated.

between the pupil center and the visual axis. In patients with high angle K, implantation of aspheric, multifocal, and high-toricity IOLs may lead to unsatisfactory results. Even if the IOL is centered in the bag, the optical center of the IOL will be far from the visual axis, with bad visual results. Therefore, a high angle K may be a contraindication for these types of IOLs.

Determination of different refractive powers according to two pupil diameters, corresponding to photopic and scotopic conditions. The refractive power of the cornea varies from center to periphery, often leading to two different refractions in scotopic and photopic conditions. This difference is more pronounced in patients with a large scotopic pupil size, and the information is vital when there is a specific request for optimization of vision in photopic or scotopic conditions.

For these reasons, a topography-aberrometry device allows not only appropriate patient selection but also objective evaluation of the success of the implant.

BIOMETRY INTEGRATED WITH ABERROMETRY CALCULATION

Devices such as the OPD-Scan (Nidek Co.), which combines the functions of an autorefractometer, keratometer, topographer, pupillometer, and aberrometer (based on skiascopy) and measures accommodative amplitude, visual axis, and keratometry, can be used to calculate internal aberrations. Another factor to consider is that biometric calculations are based on corneal power data provided by ophthalmometry. The axial algorithm is the closest to these data.

The OPD-Scan's user-friendly printout acts as a guide for the surgeon in the operating room, as this single document includes all the essential and necessary information for the procedure. Each formula has increased efficiency in a certain range of refraction, but the Holladay 2 and Camellin-Calossi formulas can be adapted to any refractive

TABLE 1. DATA PRESENTED IN THE IOL STATION SOFTWARE: PRINTED SUMMARY FOR CATARACT
1. Two IOL calculations (first and second choice)
2. State of the cornea (eg, after refractive surgery)
3. Pachymetry
4. Endothelial cell counts
5. Refraction, visual acuity, and intraocular pressure of both eyes
6. Axis of astigmatism superimposed onto topographic map and pupillometry
7. Summary of biometric data
8. Type of IOL
9. Keratorefractive indices
10. Position of the surgeon
11. Vision from the point of view of the surgeon

situation by introducing corneal power and lens thickness into the calculation. Moreover, these formulas need numerous other data to be properly calculated.

In the process of patient preparation, mistakes can reduce the accuracy of the assessment, sometimes distorting the results. By using a single tool such as the OPD-Scan for all the necessary calculations, the surgeon can generate a printout that acts as a guide in the operating room. However, surgical errors can originate not only from wrong biometric calculations but also because of an inability to access to all relevant information. Therefore, a unique printout serves as a synthetic single document with all essential information that can be hung, for example, on the operating microscope.

IOL STATION SOFTWARE

One component of the Nidek OPD-Scan is the IOL Station software. This program generates a printout called the Vinciguerra Summary (Figures 1 through 4), providing step-by-step instructions to be used after the acquisition of topography and wavefront data. It calculates the corneal power in both eyes in relation to pupillary area and position, crystalline thickness and anterior chamber depth, corneal thickness (after introduction of pachymetric values to determine refractive index), previous corneal surgery (with separate calculations for incisional refractive surgery, phototherapeutic refractive procedure, and corneal transplant), the power of previous refractive surgery (ie, the surgically induced refractive change), information regarding primary or secondary implantation (with different calculations due to different IOL positions), and basic data (visual acuity, intraocular pressure, endothelial cell counts, previous surgery in the contralateral eye, notes).

The printout (Table 1) orients the map to the surgeon's point of view (superior or temporal approach), overlaps the axis of astigmatism onto the dilated pupil with the arrangement of iris crypts as a more reliable reference for toric IOL implantation, and shows a second IOL choice with appropriate A-constant.

Because the OPD-Scan is also an aberrometer, it determines the spherical total, corneal, and internal aberrations and provides an internal database of the best IOL choice to compensate each patient's spherical aberration. Additionally, the device divides the total astigmatism into corneal and internal components, allowing detection of the optimal axis for toric IOL implantation. It can also simulate the patient's vision with two different IOLs, depicting how each compensates for spherical and cylindrical errors. Finally, the OPD-Scan gives the mean pupillary power for different pupil diameters.

CONCLUSION

The OPD-Scan with IOL Station software is a reliable tool to measure and collect postoperative data, in case any issue arises after cataract surgery. Surgeons finally have one machine that can accurately determine preoperative biometric data, provide IOL power calculation formulas, and determine the quality and accuracy of IOL selection. We believe that the OPD-Scan will improve the accuracy not only of our biometry calculations but also of our postoperative refractive results. ■

Elena Albè, MD, is a Consultant in the Department of Ophthalmology, Cornea Service, Istituto Clinico Humanitas Ophthalmology Clinic, Milan, Italy. Dr. Albè is a member of the CRST Europe *Editorial Board. She states that she has no financial interest in the products or companies mentioned. She may be reached at e-mail: elena.albe@gmail.com.*

Paolo Vinciguerra, MD, is the Chairman of the Department of Ophthalmology, Istituto Clinico Humanitas, Milan, Italy. Dr. Vinciguerra is a member of the CRST Europe *Editorial Board. He states that he has no financial interest in the material presented in this article. He may be reached at e-mail: paolo.vinciguerra@humanitas.it.*

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