New software makes pseudophakic IOL power calculation for post-refractive surgery eyes simple and predictable

Cheryl Guttmann in Paris

A new software program called OKULIX appears to provide accurate IOL power calculations in eyes that have undergone refractive surgery, according to the results of two studies presented at the XXII Congress of the European Society of Cataract and Refractive Surgeons.

Jochen Wahl, MD, reported on seven formerly myopic eyes that had undergone PRK or LASIK and had axial lengths ranging from 26.1 mm to 32.2 mm. After cataract surgery and IOL implantation using an OKULIX-calculated IOL power, all of the eyes were within 0.3 D of intended refraction.

“Applying standard IOL power calculation formulae in post-refractive surgery eyes typically results in a 1.0 D to 2.0 D hyperopic shift. Use of the Okulix software avoids such large, hyperopic errors and eliminates any need for different procedures to calculate IOL power in normal cataract patients and those who have had prior corneal refractive surgery,” said Dr. Wahl, who is a colleague of the Okulix developer, Paul-Rolf Preussner MD, at the University of Mainz, Germany.

Tanja M Rabsilber, MD, reported similar results from a study undertaken at the University of Heidelberg, Germany, in which the Okulix software was used to calculate IOL power in 12 eyes of eight patients with a mean age of 54 years who had undergone excimer laser surgery between 1985 and 2000. All eyes were implanted with the AR40e IOL (AMO) in powers ranging from 12 D to 22 D.

Mean preoperative spherical equivalent was -3.04 D. By three months after cataract surgery the mean spherical equivalent was -0.49 D. Best-corrected acuity increased in all eyes after cataract surgery, with a mean improvement from 20/60 to 20/32.

The mean target refraction for the group was -1.16 D (±0.9 D). The mean difference between the intended and achieved refraction was 0.85 D (±0.73 D). In most eyes, the difference between the intended and achieved refraction was minor, and in only three cases did the difference exceed 1.0 D, reported Dr. Rabsilber.

“The number of patients who have had excimer laser refractive surgery and present for cataract surgery is sure to increase in the future. For those persons, as for all cataract surgery patients, accurate IOL power calculation is critical to achieve high satisfaction postoperatively. This new software program is easy to use and is able to quickly and accurately calculate IOL power without the need for preoperative biometric data, which is not available for many patients,” she said.

Problems with accurate IOL power calculation in eyes that have undergone myopic refractive surgery occur because of the transformation of the cornea from a prolate into an oblate shape. That change causes errors in the measurement of corneal vertex radii using a standard keratometer. The inaccurate radii measurements translate into overestimation of corneal asphericity, and use of that data in existing IOL calculation formulae leads to an underestimation of IOL power with a hyperopic postoperative result.

“In a normal prolate cornea, standard keratometry tends to overestimate the real radius and the result is a slight myopia after IOL implantation. While the effect may be mathematically significant, it is clinically irrelevant. However, in the case of an oblate cornea, the effect is reversed, and the patient ends up with a hyperopic result,” Dr. Wahl explained.

The Okulix software avoids the pitfalls associated with standard keratometers by extracting vertex radii together with corneal asphericity in a three-dimensional numerical model fit from corneal topographic data. IOL calculation using those data is then performed by a numerical ray tracing of the whole pseudophakic eye.

The complex algorithm that extracts the radii out of the corneal topography produces four parameters that define the cornea — two radii (R1 and R2), the numerical eccentricity (e), which characterises the asphericity, and the angle alpha between the two radii.

“Be careful not to take the radii directly from the topography because what is needed is the corneal model that fits it to the original cornea,” Dr. Wahl said. He illustrated that point with several examples. In a patient who presented for cataract surgery with a history of excimer PK in 10 years earlier for myopia, the radii measured using Littman keratometry was 9.17 mm, which was smaller than the 9.68-mm calculated by the Okulix software.

After implantation of a +1.25 D Senssar AR40 IOL based on the Okulix-determined IOL power, the patient’s achieved refraction matched the target exactly. However, a prediction error of +1.65 D would have resulted using the Littman keratometry radii to calculate IOL power, and use of the SRK-T or Holladay formulae would have resulted in SE errors of +0.36 D and +0.63 D, respectively.

In this series of seven eyes that had undergone previous excimer laser surgery, IOL calculations based on the fraction radius from standard keratometry would have resulted in a mean refractive error of +1.34 D (range, +0.49 to +2.64 D), use of the SRK-T formula would have yielded a mean error of +0.59 D (range, -0.24 to +1.4), and the mean error from using the Holladay formula implemented by the IOLMaster (Carl Zeiss Meditec) would be +0.85 D (range, -0.13 to +1.22 D), Dr. Wahl added.

To use the program for calculating IOL power, corneal topography is measured first and the keratometry data are imported into the software. Next, the IOL to be implanted is selected. The program uses the original manufacturer’s data on IOL radius, thickness, and refractive index, rather than ambiguity-defined powers.

Next, the user enters information about axial length along with the biometry system used for measurement, and postoperative target refraction, and the software calculates the most probable postoperative anterior chamber depth based on a simple approach that has been previously calibrated and verified using data on nearly 200 eyes provided by the Vienna Eye Hospital. It then generates IOL power for the selected implant type.

“A nice feature of the Okulix software is that its database includes information on most of the currently available types of IOLs. However, there is a need to use it in combination with specific corneal topography and biomey system,” Dr. Rabsilber noted.

For axial length measurements, calibrations have been made so far between Okulix and the IOLMaster and AL2000 (Tomay). For topography, the following systems can be used: C-Scan (Technomed), TMS2n (Tomay), Atlas (Carl Zeiss Meditec), Keratograph (Oculus), Easygraph (Oculus), Keratron Scout (Optikon).

“Our calibration studies show there is very good correlation using both the IOLMaster and AL2000 for biometry and either of those devices can be used. We are in contact with other manufacturers to expand options for topography determination,” Dr. Wahl said.

In their patient series, both Dr. Wahl and Dr. Rabsilber used the IOLMaster for axial length determination. Dr. Rabsilber used the C-Scan for topography and Dr. Wahl used both the C-Scan and TMS2n.

In another module, the software is also able to simulate retinal image quality achieved using a specific IOL and allows for comparison of different IOL types and powers as well as the effect of spectacle correction, Dr. Wahl said.

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