Accurate Keratometry Readings

Understanding current technological limitations and assigning a single instrument for the task of measuring.

BY WARREN E. HILL, MD

A decade ago, the measurement of axial length was commonly felt to be the accuracy-limiting aspect of IOL power calculations. This has since changed. With the advent of the IOLMaster (Carl Zeiss Meditec, Inc., Dublin, CA) and with more ophthalmologists migrating from applanation to immersion biometry (with a few exceptions), the measurement of axial length is now one of the most accurate components.

Despite these advances, the evolution of the technology behind the measurement of central corneal power continues to lag, and questions on how best to carry out these measurements remain a source of uncertainty for physicians and their staff. In a recent study, errors in keratometry were found to be a significant cause for an IOL exchange due to incorrect lens power.[1] Inaccuracies in keratometry have a 1:1 correlation with the postoperative refraction at the spectacle plane. In other words, if the preoperative keratometry reading is off by 0.75 D, the result will be a 0.75 D postoperative refractive surprise, even if all the other components of the IOL power calculation and surgery are perfect.

We ophthalmic surgeons frequently accept, without question, central corneal power values obtained by manual keratometry, autokeratometry, or simulated keratometry. Not all measurements and measurement techniques, however, have the same level of accuracy or are useful for all purposes. Fortunately, some common-sense strategies can improve the precision of our readings.

LIMITING VARIABILITY

To make keratometry as accurate and consistent as possible, we must limit this task to a single instrument for all pre- and postoperative measurements. Autokeratometers, manual keratometry, and the simulated keratometry feature of most topographers estimate central corneal power by different methods. For this reason, we should never expect that these three different approaches will always produce the same value for the same eye. For example, the autokeratometry feature of the IOLMaster measures a central 2.5-mm zone and utilizes a computer algorithm, whereas manual keratometry measures a larger 3.2-mm zone and relies on the operator to set the power difference between principal meridians and their corresponding axes. Furthermore, the simulated keratometry feature of a topographer employs yet another method. If

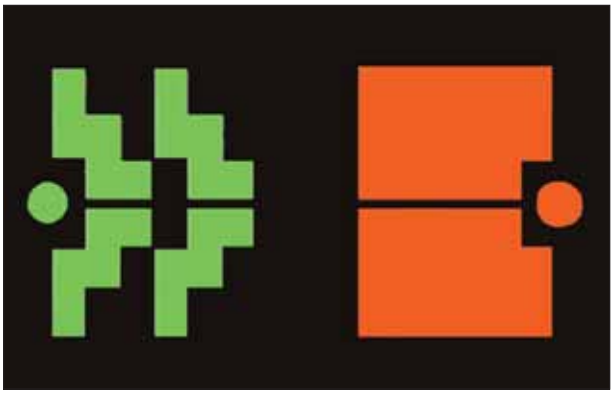

Figure 1. Typical "block and step" mires of a Javal-Schiötz ophthalmometer. Of the various forms of manual keratometry, it is considered by many to be the easiest to use and is highly reproducible. This approach is also the preferred method for measuring astigmatism before the implantation of toric IOLs.

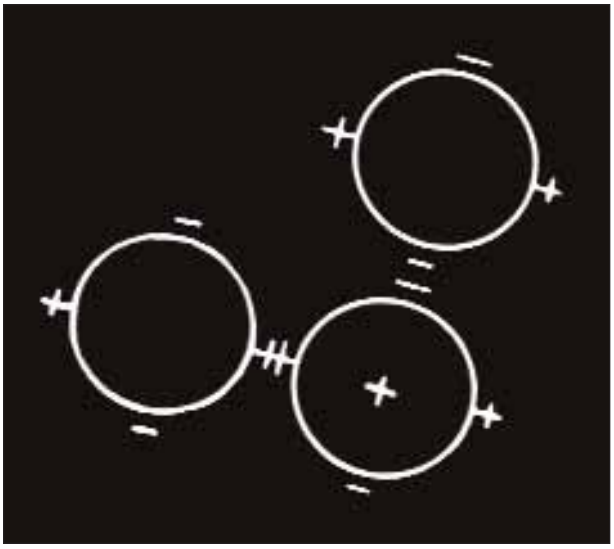

Figure 2. Mires of the standard manual keratometer from Bausch & Lomb.

we can limit preoperative measurements to a single instrument, we can effectively reduce an important source of variability.

WHICH ONE TO USE?

The ideal approach to measuring central corneal power must be reproducible and reliable. Until recently, this meant a skilled operator using a Javal-Schiötz ophthalmometer (Figure 1) or a keratometer from Bausch & Lomb (Rochester, NY) (Figure 2). More sophisticated forms of autokeratometry with very fast computer processors are now gaining popularity. For general IOL power calculations, my preferred method is now the autokeratometry feature of the IOLMaster with software version 5.4 (Figure 3).

In general, we should consider a corneal topographer to be more of a "big picture" instrument (Figure 4) and not a substitute for standard keratometry. The axial map feature of many topographers is an excellent tool for objectively determining the steep axis of regular astigmatism, but simulated keratometry is generally less accurate than manual keratometry or autokeratometry at determining the central corneal power. For this reason, we should not use a standard topographer as our primary instrument for measuring central corneal power prior to cataract surgery. That said, new hybrid instruments that combine a double Scheimpflug camera (Galelei; Ziemer Group, Port, Switzerland) with a Placido-based topographer may one day prove to be the more accurate methodology. Only time will tell, so we must continue to monitor technological advances.

Avg: 43.27/43.77 D			
K1:	43.27 D	@	46°
K2:	43.77 D	@	136°
ΔD:	+0.50 D	@	136°
K1:	43.27 D	@	50°
K2:	43.77 D	@	140°
ΔD:	+0.50 D	@	140°
K1:	43.27 D	@	50°
K2:	43.77 D	@	140°
ΔD:	+0.50 D	@	140°

Figure 3. Autokeratometry feature of the IOLMaster with software version 5.4. The validation criteria for this form of central corneal power measurement are three measurements within 0.25 D in each of the principal meridians.

CALIBRATION

It should be regular practice in every office to check each instrument against a set of standard calibration spheres, and it may be prudent to keep a log of these evaluations (Figure 5). In fact, more recent versions of the IOLMaster software require the user to confirm the accuracy of the instrument against a calibration test block at the beginning of each day.

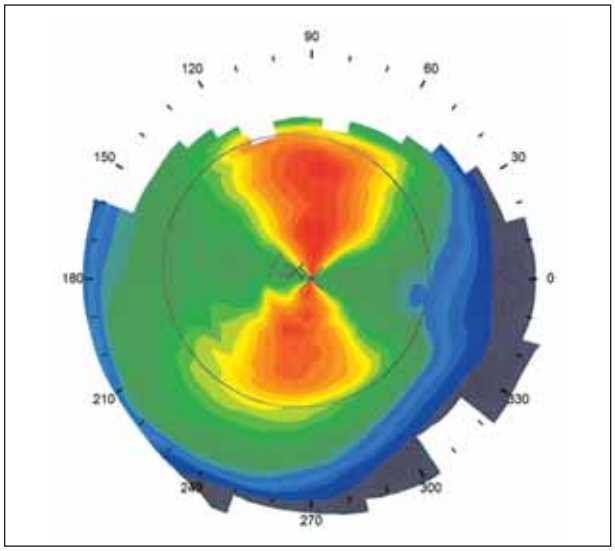

Figure 4. Topographers should be considered "big picture" instruments rather than the primary tool for calculating central corneal power. Regular astigmatism is demonstrated by Placido-based corneal topography using the Atlas 9000 topographer (Carl Zeiss Meditec, Inc.).

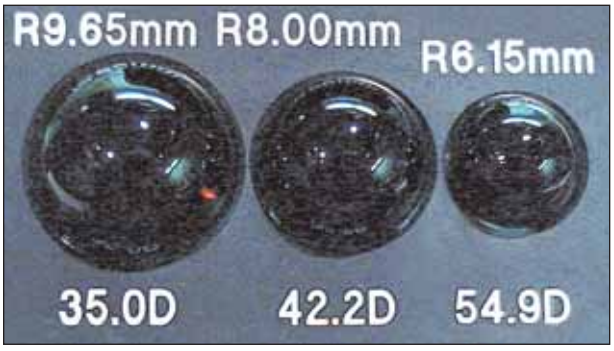

Figure 5. A standard set of calibration spheres (Carl Zeiss Meditec, Inc.). It is important to regularly check the calibration of all instruments used to measure the central corneal power.

VALIDATION CRITERIA

Sometimes, we will need to double-check the numbers produced by keratometry for validity. In general, a second person should confirm the measurement and sign the chart if any of the following occur:

- Measurement-to-measurement inconsistency
- Very flat or very steep average keratometry readings (eg, < 40.00 D or > 48.00 D)
- Differing average keratometry readings between eyes by greater than 1.50 D
- K1 and K2 with a power difference of greater than 3.00 D
- Astigmatism for either eye greater than 4.00 D
- Difficulty in obtaining measurements

If there is something unusual about preoperative measurements, we should take the time to resolve the issue before proceeding. As the carpenters say, "It is always better to measure twice and cut once."

CONCLUSION

Despite advances in technology, a precise and completely consistent method for the measurement of central corneal power for all eyes remains elusive. We can increase the accuracy of our results in normal eyes, however, by paying attention to a few important details and limiting all preoperative measurements to a single instrument. ■

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1. Jin GJC, Crandal AS, Jones JJ. Intraocular lens exchange due to incorrect lens power. Ophthalmology. 2007;114(3)417-424.