

Measuring total corneal astigmatism: Why it matters and how to master it

Eric D. Donnenfeld, MD

In the past, when ophthalmologists had to rely on manual amplitude scans, biometry was a significant variable with IOL calculations because of individual variations in patients' eyes.¹ Devices have since improved and taking biometry measurements is dramatically more accurate and no longer as time consuming as it used to be. Now, keratometry has become the issue surgeons face when measuring patients for appropriate IOL choices because although measuring anterior keratometry has improved, access to the posterior surface of the cornea is still lacking with some keratometry devices. Traditionally, ophthalmologists use estimations when measuring the posterior cornea, but using estimations cannot replace the accuracy of obtaining true measurements. Posterior corneal astigmatism is an integral part of determining the patient's refractive accuracy, so it is an essential preoperative measurement to obtain.

Total corneal astigmatism

Ophthalmologists must measure the anterior and the posterior corneal cylinder to find the total corneal astigmatism in their patients. As people

age, the anterior corneal cylinder shifts to against the rule, but the posterior corneal cylinder remains the same. In the past, when surgeons only measured the anterior surface of the cornea, they used estimations of the posterior corneal cylinder based on the anterior reading without taking an actual measurement.

For IOL measurements today, ophthalmologists measure the anterior corneal curvature, the axial length, the anterior chamber depth, lens thickness and corneal diameter. For the posterior corneal cylinder, most surgeons still rely on assumptions. However, in atypical corneas, the posterior/anterior ratio is no longer valid, so errors are more likely. The anterior corneal axis can be considerably different from the corneal axis, resulting in different total corneal astigmatism.

Accurate measurements

Models and nomograms are based on statistical measurements and are estimates that do not compensate for outliers. Devices are available that can be used to measure the posterior cornea, but they are

► Case Study: Missed mark

A 50-year-old man presented to me for a cataract evaluation in his right eye. Years earlier, the patient underwent myopic LASIK in his right eye and had experienced a flap complication with a buttonhole. The patient had a phototherapeutic keratectomy and PRK performed afterward. Six months after treatment, the patient had achieved a good refractive error: $+0.25 -0.75 \times 90$, 20/20. Despite the buttonhole in his cornea, the patient still had good visual acuity. Years later, the patient developed a cataract in the right eye. He underwent topography and all the traditional measurements were obtained — the refraction, the preoperative refraction, the manual keratometry readings, auto keratometry readings, IOL-Master (ZEISS) keratometry readings and biometry measurements. The decision was made to implant a Tecnis ZCB00 IOL (Abbott Medical Optics). A 19-D IOL was implanted and the patient ended up with +1 D of refractive error. The mark had been missed because a true measurement of the posterior cornea had not been obtained. The patient needed a 21-D IOL, so he was off by a significant mark.

not always compatible with trusted IOL formulas and constants. Despite having great nomograms such as the Barrett formula that can help accurately estimate the posterior cornea, not all patients follow nomograms. No standard exists to validate measurements and the existing methods are not satisfactory.

Douglas D. Koch, MD, and colleagues, found that if corneal astigmatism is calculated from measurements on the anterior corneal surface only, then the with-the-rule group has frequent overcorrection of 0.5 D and the against-the-rule group has frequent undercorrection of 0.3 D.² If surgeons do not look at the posterior cornea, then they will probably overcorrect with-the-rule astigmatism and undercorrect against-the-rule astigmatism by a significant margin.

Total keratometry

New technology now allows ophthalmologists to measure total keratometry, which makes measuring the posterior cornea easier. The IOLMaster 700 with swept-source OCT (ZEISS) allows for the measurement of the posterior cornea instead of modeling it, so surgeons can finally replace estimations with actual measurements. This device uses telecentric keratometry to produce measurement of the anterior corneal surface; total keratometry can be calculated by combining the measurement of the anterior corneal surface with the measurement of the posterior corneal surface. Although these measurements can be applied to any formula, the best formulas to use are the ones included with the IOLMaster 700, the Barrett TK Universal II and the Barrett TK Toric. Surgeons can get detailed information on the IOL calculation screen regarding which IOL to place with these formulas. The IOLMaster 700 allows surgeons to look at the information with and without the posterior cornea, so it is possible to see what the results would be with a traditional estimated posterior cornea vs. the actual posterior cornea (Figure).

Swept-source OCT

The IOLMaster 700 with swept-source OCT biometry has enabled surgeons to complete the missing link — being able to look at the posterior cornea. The OCT scans from the cornea to the retina, which allows surgeons to view the entire length of the eye. Ophthalmologists can see the lens thickness when looking at the macula and can get a thickness diagram of the cornea. They can take that information and measure the posterior corneal curvature by looking at the anterior and posterior OCT readings.

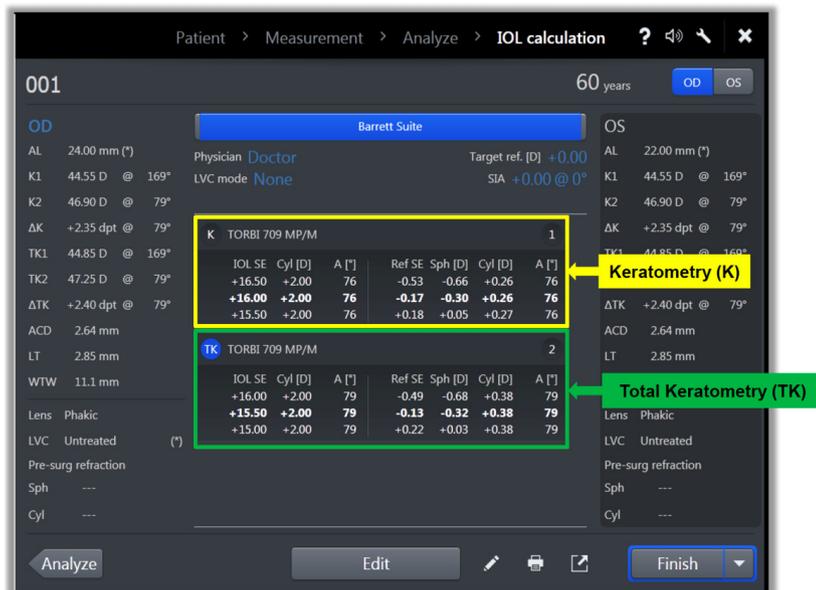


Figure. The IOLMaster 700 display shows the patient would have a 0.5-D change in IOL power, as well as a significant change in the cornea. Source: *Donnenfeld ED*

Because surgeons can measure the keratometry as well as the cylinder, they can obtain a true measurement of the posterior cornea.

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— ERIC D. DONNENFELD, MD

It is crucial to account for the posterior cornea, and ophthalmologists now have the technology that offers more accurate measurements. With the IOLMaster 700, ophthalmologists can now measure total keratometry and replace assumptions with true measurements to achieve better results in cataract surgery.

References

1. Norrby S. Sources of error in intraocular lens power calculation. *Cataract Refract Surg.* 2008;34(3):368-376.
2. Koch DD, Ali SF, Weikert MP, Shirayama M, Jenkins R, Wang L. Contribution of posterior corneal astigmatism to total corneal astigmatism. *J Cataract Refract Surg.* 2012;38(12):2080-2087.