In the optical system of the human eye, total refractive power consists mainly of corneal and lenticular components. Approximately two-thirds of the eye's converging power is at the air–cornea (tear film) interface; one-third is in the lens. Total corneal power is determined by corneal anterior and posterior curvature, corneal thickness, and the corneal refractive indices. Traditionally, anterior corneal curvature is measured with keratometers or computerized videokeratographers that compensate for the posterior corneal surface using a modified refractive index to convert measurements of anterior corneal curvature to the refractive power of the entire cornea by empirical estimations of the corneal thickness and posterior surface curvature. Currently, posterior corneal curvature can be examined by Purkinje images, scanning-slit imaging, Scheimpflug imaging, and optical coherence tomography. With these tools, total corneal refractive power can be determined by measuring anterior and posterior corneal curvatures as well as corneal thickness. Methods for calculating total corneal power include ray tracing and the Gaussian optics thick-lens formula.1

Astigmatism is an important and often visually significant optical aberration. In an optical system with astigmatism, rays that propagate in 2 perpendicular planes result in 2 different focal lines. To determine the contribution of posterior corneal astigmatism to total corneal astigmatism, Koch et al.2 performed a study using a Scheimpflug tomographer combined with a Placido disk topographer. They found that in 715 corneas of 435 consecutive patients, the mean magnitude of posterior corneal astigmatism was 0.30 diopter (D). The study showed that with increasing age, the steep anterior corneal meridian tended to shift from vertical to horizontal, especially in eyes with low degrees of astigmatism, while the steep posterior corneal meridian typically did not change. The magnitudes of anterior and posterior corneal astigmatism were correlated when the steeper anterior meridian was aligned vertically but not when it was aligned horizontally. Koch et al. also examined the error in estimating total corneal astigmatism from anterior corneal measurements only and found that anterior corneal measurements underestimated total corneal astigmatism by a mean of 0.22 D and exceeded 0.50 D in 5% of eyes. Similar values were found by Ho et al.,3 confirming that neglecting the posterior corneal surface measurement may lead to significant deviation in the corneal astigmatism estimation in a proportion of eyes.

In this issue, Koch et al. evaluate the impact of posterior corneal astigmatism on the selection of toric intraocular lenses (IOLs) (pages 1803–1809). The study measured corneal astigmatism using 5 devices (IOL-Master, Lenstar, Atlas corneal topographer, a manual keratometer, Galilei Placido dual Scheimpflug tomographer) before and 3 weeks after cataract surgery. The actual corneal astigmatism was calculated based on refractive astigmatism postoperatively, and the effective toric power was calculated with the Holladay 2 formula. The prediction error using vector analysis was calculated as the difference between the astigmatism measured by each device and the actual corneal astigmatism. The magnitude of total corneal astigmatism was overestimated in corneas that had with-the-rule orientation by all devices and underestimated in corneas that had against-the-rule (ATR) orientation by all devices except the Placido–dual Scheimpflug analyzer. These findings are attributable to the vertical orientation of the steep posterior corneal meridian, which creates net refractive power horizontally; ie, ATR. This explains some of the unexpected astigmatic outcomes that can occur with toric IOL implantation. Koch et al. therefore proposed a new toric IOL nomogram that incorporates their landmark findings of posterior corneal astigmatism.

For years, corneal power calculation has been based on anterior corneal measurements, assuming a fixed posterior–anterior curvature ratio to estimate both the spherical and astigmatic contributions of posterior corneal power. The new options of measuring the power of the posterior corneal curvature may allow us to more precisely measure corneal power and achieve even better results in cataract and refractive surgery.

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REFERENCES