A **Editorial**

Importance of Posterior Corneal Astigmatism in Eyes with Keratoconus

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As eye care specialists, we inevitably encounter patients with concomitant keratoconus (KCN) and cataracts. It is known that patients with KCN are more likely to develop cataracts than subjects without KCN and do so at a younger age than the general population.[1] The incidence of KCN is also much higher than what was known in the older literature. A recent review has shown that the incidence of keratoconus is 1:7500 with a prevalence of 1:375. This is 5-10 fold higher than that previously reported in the literature.[2] In addition, new diagnostic modalities such as Scheimpflug imaging tomography and high resolution optical coherence tomography (OCT) have enhanced our capability to identify eyes with subclinical and early KCN much earlier than before. With the advent of potentially new stabilizing procedures such as collagen cross-linking and corneal rings, many patients with mild to moderate KCN will eventually require cataract surgery and most likely demand toric intraocular lenses for less dependency on glasses and contact lenses.

Over the course of the last 15 years, we have become quite familiar with the use of toric intraocular lenses for correction of astigmatism in non-keratoconic patients. We have learned the importance of posterior corneal astigmatism (PCA) on total corneal astigmatism (TCA) for better predictability of toric intraocular lens calculation to avoid under- or overestimation of toricity in intraocular lens (IOL) power calculations. Koch et al have demonstrated how neglecting PCA will lead to overcorrection of astigmatism in eyes with with-the-rule astigmatism (WTR) and undercorrection in eyes with against-the-rule astigmatism (ATR).[3] Most newly adopted toric formulas and calculators have compensated for this error of PCA in normal population. PCA although much less investigated in different stages of KCN, is likely to be of greater impact in IOL calculation for such patients.

In this issue of *Journal of Ophthalmic and Vision Research*, Aslani et al evaluated the magnitude, orientation and correlation of anterior and posterior corneal astigmatism using a Scheimpflug imaging device.[4] This is a retrospective study of the right eye in 161 patients in four subgroups of KCN based on Amsler-Krumeich classification. The authors' observation reflects similar WTR and ATR astigmatism orientation for the anterior corneal surface, and predominantly ATR for the posterior corneal surface. The PCA had a magnitude of 0.86 ± 0.45 D which is significantly higher in magnitude than PCA of 0.30 ± 0.15 D in normal eyes,[3] and again supports the notion that it cannot be ignored when considering toric IOL implantation. The strong correlation between ACA and PCA diminishes with increasing severity of KCN. More importantly, Aslani and coworkers discovered that the ACA was more affected than PCA with an increase in the severity of KCN. On the other hand, PCA was more affected than ACA in the early stages of KCN. As reported by the authors, there is a discrepancy in the literature concerning ACA and PCA patterns and prevalence in eyes with KCN. Undoubtedly, differences in ethnicity is one potential explanation, but there are still large variations among published KCN groups even with similar ethnicity and environmental origins.[5-7] These groups are not necessarily similar in terms of age, topography, tomography, pachymetry, and severity of disease.

The authors are to be commended on their fine scientific manuscript but there are few limitations to the study that can enhance future work on this topic. In addition to its retrospective nature and unequal sample size for subcategories of KCN, investigating subclinical KCN (eyes with KCN index less than 1.05 based on the Amsler-Krumeich classification) and adding a control group of normal eyes will provide a better comparison of the prevalent pattern of astigmatism in terms of magnitude and orientation for both ACA and PCA. Future studies with additional imaging devices rather than one (dual versus single Scheimpflug) and with 4 mm instead of 3 mm central zone may affirm and further validate the authors' findings. It is also not clear to our readers if the authors used Pentacam or Pentacam

HR and what specific software was employed. The interpretation and clinical applicability of the PCA/ACA ratio needs further elaboration. It would have been quite valuable if the authors had analyzed the discrepancy of astigmatism axis between ACA and PCA, and its impact on axis and magnitude of TCA. Calculating such vector shift in magnitude and axis is important since it should be different from the keratometric axis (KA) and important for proper alignment of toric IOLs in such cases. Analyzing the impact of the location of the conus on alignment of PCA and ACA is also important. For example in an eye with a centrally located conus, there is a higher likelihood of vertical alignment of PCA and ACA; on the hand a paracentrally located conus will reduce the likelihood of such vertical agreement.

In summary, intraocular lens calculation in patients with KCN will continue to be challenging due its progressive nature, diminution of the correlation between ACA and PCA with disease severity, and the geometric impact of cone position on the patterns of ACA and PCA with net change in the final power of resultant TCA and its axis. On the other hand, longer axial length and deeper anterior chamber in KCN eyes along with a larger capsular bag will also contribute to the unpredictability of the IOL selection in terms of power, effective lens position, and potential risk of late IOL rotation. In short, PCA is only one parameter of this complex equation deserving further investigation for better predictability of toric IOL determination in this group of patients.

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