Total Corneal Astigmatism Measurement Precision

We read with interest the article by Savini and Naeser[1] on refractive astigmatism following toric intraocular lens (IOL) implantation.

In the group of 40 eyes phacoemulsification was performed through a 2.75-mm temporal incision. In Table 1 it was indicated that surgical-induced corneal astigmatism along the surgical meridian (mean ± SD) was −0.15 ± 0.40 diopters (D; range, −0.81 to +0.79 D) in the whole group of eyes, −0.06 ± 0.35 D (range, −0.56 to +0.79 D) in the group of with-the-rule (WTR) astigmatism eyes, and −0.30 ± 0.37 D (range, −0.81 to +0.51 D) in the group of against-the-rule (ATR) astigmatism eyes. An interesting conclusion that might be drawn from these findings is that the range of the induced astigmatism was much wider than expected, indicating that this could be a significant factor influencing the results in a given eye.

Table 2 showed that values of error in refractive astigmatism along the steeper corneal meridian (ERA KP ϕ) for measurement models 1, 2, and 5, were for all eyes in the study −0.25 ± 0.58 D (range, −1.22 to 0.92) applying model 1 KA. For model 2 TCA and for model 5 TCA they were −0.05 ± 0.49 D (−1.12 to 0.98) and −0.07 ± 0.48 D (−1.28 to 1.06), respectively. Results for WTR astigmatism eyes with model 1 KA were −0.59 ± 0.34 D (−1.22 to 0.02), for model 2 TCA −0.13 ± 0.42 D (−1.10 to 0.98), and for model 5 TCA −0.07 ± 0.43 D (−1.20 to 1.15). For ATR eyes the values were 0.32 ± 0.42 D (−0.87 to 0.92), 0.07 ± 0.59 D (−1.12 to 0.71), and 0.12 ± 0.61 D (−1.04 to 0.87) for models 1 KA, 2 TCA, and 5 TCA, respectively.

The wide range (from overcorrections to undercorrections) in all the groups with the exception of model 1 for WTR astigmatism eyes is noteworthy. Since the ERA polar value along the meridian ϕ was deemed negative for astigmatic overcorrections and positive for undercorrections, the use of a mean of those values, as it was done, could be misleading, because opposite signed values will tend to cancel each other. The use of other measures of central tendency like the median or eliminating the effect of the opposite sings using the absolute values of ERA might yield a more realistic vision of the results. When analyzing separately WTR and ATR eyes some interesting details are evident. Although the arithmetic mean of ERA KP ϕ for WTR eyes applying model 2 TCA (−0.13 ± 0.42 D) was smaller than ERA K ϕ using model 1 KA (−0.59 ± 0.34 D), the range of error was wider with model 2 TCA (−1.10 to 0.98 D with model 2 versus −1.22 to 0.02 D with model 1) and the standard deviation also was higher (0.42 vs. 0.34 D). The same situation presented in ATR eyes: The range of error was wider with model 2 TCA (−1.12 to 0.71 D with Model 2 versus −0.87 to 0.92 D with Model 1) and the standard deviation also was higher (0.59 vs. 0.42 D). Accordingly, the Figure in the article showed that the ellipses using models 2 through 5 had longer axes than those for model 1, which as the authors explained, were related to a larger variance and, therefore, less precision. All these findings suggested that at least some of the values were more dispersed. Knowing the percentage of ERA values ± 0.5 D would be helpful.

Theoretically, measuring the total corneal astigmatism (including the posterior corneal astigmatism) should clearly result in better refractive outcomes than taking in account only anterior corneal astigmatism. The most probable explanation of these results (less precision when including total corneal astigmatism measurements) was, as the authors pointed out, limitations in measuring of the posterior corneal astigmatism using the Scheimpflug camera. Currently, it is difficult to determine whether accuracy of the posterior astigmatism made by Scheimpflug devices available are good enough or not, since, as the authors also stated, a gold standard is not available for posterior cornea imaging.[1,2] However, based on the results of ERA in models 2 through 5 of the study by Savini and Naeser,[1] which are related directly to posterior corneal astigmatism measurements done with the Pentacam (Oculus, Wetzlar, Germany), and since the measures of dispersion (range and standard deviation) were larger than in model 1, we can assert that precision of the measurements was lower than when using model 1.

Moreover differences in alignment of refractive measurements and corneal astigmatism measurements (the former referenced to the center of the pupil, and the latter to the corneal apex), also will affect the accuracy of the postoperative refractive results in these patients.

To advise surgeons confidently to base their calculations on total corneal astigmatism rather than keratometric astigmatism when implanting toric IOLs, undoubtedly additional technological improvements are needed to provide better measurements. We are in the right direction, but results from this and other studies[1,3,4] suggest that there still is a long way to go before we really reach a clinically reliable device to measure total corneal astigmatism in those patients, who usually have high expectations, and in whom surgeons also expect to have very low postoperative astigmatism (smaller than 0.50 D).

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Citation: *Invest Ophthalmol Vis Sci.* 2015;56:5912.
doi:10.1167/iovs.15-17735

iovs.arvojournals.org | ISSN: 1552-5783