Better patient outcomes with toric IOL implantation by accounting for posterior astigmatism

Background
Anterior and posterior corneal surfaces contribute to the total corneal astigmatism. Manual keratometry methods account for only the anterior astigmatism when calculating the astigmatic correction required with toric IOL implantation. Results in several studies indicate that posterior corneal astigmatism contributes significantly to the total corneal astigmatism, with reported values ranging from -0.26 to -0.78 diopters (D). Incorporating posterior astigmatism into the toric IOL calculation might improve refractive outcomes. The purpose of this study was to compare the prediction error after toric intraocular lens (IOL) implantation using corneal astigmatism measurements obtained with an IOLMaster automated keratometer and a GALILEI Dual Scheimpflug-Placido tomographer.

Methods
Thirty-five eyes (21 right, 14 left) (mean age = 68 years) were measured from patients who had undergone phacoemulsification followed by toric IOL implantation between December 2009 and August 2012. The predicted residual astigmatism after toric IOL implantation was calculated using pre-operative astigmatism values from an automated keratometer and the total corneal power (TCP) determined by ray tracing through the measured anterior and posterior corneal surfaces using dual Scheimpflug-Placido tomography (GALILEI). The prediction error was calculated as the difference between the predicted astigmatism and the manifest astigmatism at least 1 month post-operatively. The calculations included vector analysis. The same surgeon performed all surgeries using a 2.4 mm temporal clear corneal incision (CCI) and a standard stop-and-chop phacoemulsification technique. All values were stratified as WTR (steep axis with-in ± 30° of 90°) or ATR (within ± 30° of 0° or 180°) astigmatism. Post-operative manifest astigmatism was classified as corrected (< 0.45 D), overcorrected (> 0.45 D and axis > 45° different from pre-operative cylinder axis), or undercorrected (> 0.45 D and axis < 45° different from pre-operative cylinder axis).

Results
Mean pre-operative astigmatic magnitude and range for the keratometry group was 1.61 ± 0.48 D and 0.73 to 2.83 D respectively, while in the TCP group pre-operative astigmatic magnitude and range was 1.71 ± 0.63 and 0.46 to 3.26 D respectively (NS). The mean magnitude of the pre-operative posterior corneal astigmatism measured by the Galilei was 0.33 ± 0.16 D (vector mean 0.23 × 176) with a mean magnitude of the post-operative manifest refractive astigmatism of 0.38 ± 0.18 D (vector mean 0.26 × 171).

Clinical study

GALILEI
Posterior Astigmatism

Post-operatively, more eyes were corrected to less than 0.45 D of refractive astigmatism using the automated keratometer method than using the simulated TCP values, regardless of whether the pre-operative astigmatism was WTR or ATR. However, there was a statistically significant bias toward overcorrection of WTR astigmatism and undercorrection of ATR astigmatism using the automated keratometer method. This bias was not seen in the simulated results using the TCP method (Figures 1 and 2).

Fig 1. Actual astigmatic outcomes using automated keratometry to determine toric IOL cylinder power (ATR Z against-the-rule; WTR Z with-the-rule); p>0.0001 across all groups.

Fig 2. Simulated astigmatic outcomes using dual rotating Scheimpflug tomographer-derived TCP to determine toric IOL cylinder power (ATR Z against-the-rule; WTR Z with-the-rule); NS across all groups.

The GALILEI G60 Lens Professional is pending FDA approval and is not available for sale in the US. For some other countries, availability may be restricted due to local regulatory requirements. Please contact Ziemer for details.
Conclusions

GALILEI dual rotating Scheimpflug tomography can measure the anterior and the posterior corneal surfaces. This enables calculation of the TCP using ray tracing through the anterior and posterior corneal surfaces, taking into account the effect of corneal thickness on the corneal power. The outcomes of toric IOL implantation depend on accurate estimation of corneal astigmatism, which includes the contribution from the posterior corneal surface. These results demonstrate a statistically significant bias toward overcorrection of WTR astigmatism and undercorrection of ATR astigmatism in the actual outcomes using the IOL Master automated keratometer for toric IOL cylinder power calculation. This bias was not seen in the simulated outcomes using the TCP method with the GALILEI.

The vector mean of the pre-operative posterior corneal astigmatism calculated by the automated keratometer method (0.23 × 176) is almost identical to the vector mean of the post-operative residual manifest astigmatism (0.26 × 171). This suggests that the occult posterior astigmatism remains untreated when the automated keratometer method is used. That the vector mean of the prediction error for the TCP method was smaller than that of the automated keratometer method suggests that the GALILEI accounts for the posterior astigmatism more successfully.

References: