Commentary: Moving towards "mark-less" toric IOL alignment

Toric intraocular lens (IOL) implantation is the preferred modality for the correction of regular corneal astigmatism during phacoemulsification. Precise toric IOL alignment is a prerequisite to achieve optimal visual and anatomical outcomes, and even a 1° deviation of the IOL axis from the target axis may reduce the effective astigmatic correction by approximately 3.3%.[1]

Various preoperative marking methods have been reported for determining the reference axis, including free-hand marking, slit-lamp-based marking, and devices, such as the bubble marker and pendular marker. Previous studies comparing various manual marking methods have observed comparable visual outcomes with different devices and a mean rotational misalignment ranging from 1.8° to 4.7°.[2] However, these methods are subject to inaccuracies due to human errors, parallax errors, and the spread of the ink mark on the cornea. Toric IOL misalignment of up to 5° may be well-tolerated and does not adversely impact the visual acuity. However,

significant deterioration in visual quality may be observed despite optimal visual acuity, which may then manifest as a reduction in contrast and optical clarity, and lead to overall patient satisfaction.[3]

With the advent of image-guided surgeries, mark-less toric IOL alignment is being performed wherein the limbal landmarks are used as a reference to accurately align the toric IOL intraoperatively. Various image-guided systems are commonly used for intraoperative toric IOL alignment including the CALLISTO Eye and Z align (Carl Zeiss Meditec, Jena, Germany), VERION image-guided system (Alcon, Fort Worth, Texas), and the TrueVision 3D Surgical System (TrueVision 3D Surgical system, Santa Barbara, California).[4] Use of limbal landmarks as reference in these systems eliminates the impact of cyclotorsion on IOL alignment and enhances precision compared with conventional manual marking methods. However, availability and cost may be a limiting factor for widespread usage of these devices. Preoperative image may not be captured in some cases with dense or white cataracts, and intraoperative registration may not be successful in uncooperative anxious patients or development of conjunctival chemosis.

Titiyal *et al*. compared CALLISTO Eye and Z Align with conventional three-step marking using a bubble marker to align the toric IOL and observed significantly less deviation from the target axis with image-guided surgery.[3] The visual quality was significantly better in the CALLISTO group, even though the visual acuity was comparable in both the groups. Moreover, the deterioration in visual quality correlated with increasing deviation from the target axis.

In today's digital era, smartphones have become a necessity rather than a luxury, and almost all medical professionals have access to smartphones. A variety of medical apps have been developed for use with smartphones, including ECG monitoring, diabetic monitoring, and toric IOL alignment. The various toric IOL alignment apps use the inbuilt gyroscope of the smartphones to determine the corneal reference axis, and thus aid in the placement of manual marks.

In this study by Khatib *et al*., the authors used the reference axis determined by the VERION Digital Marking as the standard.[5] They compared the relative accuracy of manual or smartphone app derived marks with the VERION determined axis, and observed smartphone determined axis to be more accurate than manually determined reference axis. It would have been better to use an objective measure to assess the accuracy of the reference axis, such as the Zaldivar calipers tool on ray tracing aberrometry, as used by Titiyal *et al*.[3] Another limitation of the study is that the visual and anatomical parameters after IOL implantation by different methods were not assessed. A comparison of the visual acuity and quality would have helped to validate the efficacy of Smartphone-based axis marking.

To conclude, a precise toric IOL alignment aided by image-guided systems results in optimal visual quality and a 20/20 visual acuity. Conventional marking methods still play a role in cases where reference image is not captured or in places without access to image-guided systems. Smartphone-based apps serve as widely available, easy to use, and affordable assistive tool to enhance the precision of manual corneal reference marking.

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