Commentary: Toric intraocular lens alignment: Going markerless

The incidence of pre-existing corneal astigmatism in patients undergoing cataract extraction is >1 diopter (D) in approximately 30% of the eyes, wherein one-third have an astigmatism exceeding 2D.\(^1\) Residual astigmatism results in suboptimal visual outcomes with need for spectacles postoperatively. Thus, there is an increasing need to address the astigmatism during cataract surgery.

Placement of corneal incisions on the steep keratometry axis, paired opposite clear corneal incisions, limbal relaxing incisions, or arcuate keratotomies are easy to perform for lower degrees of astigmatism up to 1.5D.\(^2\) However, outcomes are less predictable and prone to regression over time. Toric intraocular lenses (IOLs) provide greater precision in comparison to corneal-based approach for astigmatism management.\(^3\)

To achieve optimum visual outcome with toric IOLs, accurate alignment of the implant is the most crucial step, as a 1 degree malrotation results in a 3.3% loss of astigmatic correction with a complete nullification following 30 degrees’ rotation.\(^4\) Improper alignment of the IOL may be due to intraoperative misalignment or postoperative rotation.

Different methods are used to accurately align the toric IOLs intraoperatively (manual methods, iris fingerprinting techniques, image guided systems, and intraoperative aberrometry-based methods). Traditional manual marking methods, although cost effective, are less precise and can fade or smudge by the time the patient is on the operating table. Marker-less systems have now been introduced to eliminate potential sources of human error and subjective miscalculations. Newer technologies include the Callisto Eye with Z-Align (Carl Zeiss Meditec AG), Verion Digital Marker (Alcon Laboratories), iTrace with Zaldivar Toric Caliper (Tracey Technologies), and TrueGuide software (TrueVision 3D Surgical, Inc).

Callisto eye with Z-Align is an eye-tracking technology that overlays a previously captured image over the live microscope image. Once Callisto eye has taken the images and relayed them to the Z Align module, the surgeon looking at the touchscreen, can use the images and visualize three parallel lines that represent the target meridian to which the toric lens is aligned.

The Verion Reference Unit is a modified keratometer that takes corneal power measurements and captures high-resolution images of the eye including iris landmarks, limbus, and scleral blood vessels. These serve as reference markers and any change in the position intraoperative determines the extent of cyclotorsion. Intraoperative overlay additionally provides guidance for placement of corneal incisions, capsulorhexis construction, and IOL positioning.

The iTrace system provides auto-refraction, corneal topography, ray tracing aberrometry, pupillometry, and auto-keratometry. It displays the corneal topography data and a reticule superimposed on a photograph of the patient’s cornea and limbus. The Zaldivar Toric Caliper tool can be used to calculate the angle difference in degrees between the steep meridian (intended toric IOL axis) and iris or limbal landmarks. This information is printed and taken to the operating room for intraoperative guidance during toric IOL alignment.

The True Guide software uses a preoperative photograph and intraoperative registration to enable digital intraoperative surgical guidance and alignment of toric IOLs, without the need for preoperative ocular marking.

Intraoperative aberrometry devices such as ORA with VeriEye+ (Alcon WaveTec) and Holos IntraOp (Clarity Medical Systems) provide real-time lens power, sphere, cylinder, axis recommendations, and data validation. This is particularly useful in eyes wherein the IOL power calculation is challenging such as paediatric eyes and post keratoablative procedures.

Sharma et al. demonstrate the use of the Scheimpflug imaging system goniometer as an added tool to check the slit-lamp reference marking, thereby improving the refractive outcome with toric IOLs.\(^5\)
The advantage of digital-guided systems is that the projected meridians are objective and do not require subjective estimation. Also, eliminating the need to take the patient to the slit lamp or use a variety of ink marking instruments improves workflow. A disadvantage is the possibility that registration can fail either at the beginning of the procedure or during the operation.[6] Conjunctival chemosis, ballooning, and bleeding may interfere with intraoperative registration. Registration may also not be possible in extremely uncooperative patients or difficult orbital anatomy including extremely deep-set eyes or narrow palpebral apertures.

Postoperative IOL rotation may be observed as early as 1 hour after surgery, and a majority of rotations occur within the initial 10 days. Retained ophthalmic viscoelastic device causes early IOL rotation, whereas the IOL architecture and design cause late rotation of IOL. Other factors that can compromise rotational stability are cases with zonular weakness, large diameter capsular bags, and reduced equatorial friction in high myopes.[7] Maximum rotational stability is seen with hydrophobic acrylic material due to stronger capsular bag IOL adhesions secondary to increased fibronectin.[8]

Future technological advancements may further refine the outcomes of toric IOL, with more precise visual results and enhanced IOL stability.

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