TORIC IOL ALIGNMENT IN THE DIGITAL ERA

Digitization provides several advantages.

BY ELENA AVRAM, MD; AND FLORIAN T.A. KRETZ, MD, FEBO

Digitization in health care is vitally important because of the number of patients we treat and the amount of information needed to successfully manage even the simplest of cases. In the past 10 years, the digital era has redefined cataract surgery and astigmatism correction because it allows us to analyze the huge amounts of data needed to obtain the best refractive outcomes.

When using toric IOLs, surgeons must adapt their routines and surgical techniques. Calculating the correct IOL power and accurately marking the axis are the most important steps, directly responsible for the final refractive result.

In the classic technique, marking of the steep axis is performed manually, a time-consuming process that is subject to human error.[1] Ink can fade, spread, or even entirely disappear. Surgeons can now benefit from interconnected digital devices that offer a multimodal approach, boosting efficiency, precision, and accuracy so that cataract surgeons can deliver optimal outcomes, and at the same time gathering and processing information from all stages of cataract case management.

PATIENT SELECTION FOR TORIC IOLS

Spectacle independence has become more important for today's patients, and emmetropia after cataract surgery has become the gold standard. Using a toric IOL to correct corneal astigmatism offers economic benefits as well as desirable aesthetics and practical advantages for patients. Toric IOLs are typically considered premium IOLs, but ideally they should be regarded as standard IOLs.

If we consider the minimum corneal astigmatism for toric IOL implantation to be 0.75 D, then more than 40% of patients can benefit from toric IOL correction.[2] These patients are at risk to experience blurred uncorrected distance visual acuity after surgery due to residual astigmatism. To resolve this would require additional surgery, spectacles, or contact lenses if corneal astigmatism is not correctly managed from the outset.

Selection criteria for toric IOLs include a calculated postoperative residual astigmatism greater than 0.75 D cylinder, regular bow-tie astigmatism, no preexisting ocular pathologies that can negatively influence toric IOL efficacy (corneal dystrophy, keratoconus, pellucid marginal degeneration, corneal scar tissue), and no capsular bag instability issues (advanced pseudoexfoliation syndrome or trauma that can induce zonulolysis).

CALCULATING TORIC IOL POWER

Despite the availability of several ways to calculate toric IOL power that are designed to be as accurate as possible, the final refractive result can sometimes still be a surprise. This is why it is recommended to use at least two methods to determine corneal astigmatism, such as keratometric readings, corneal topography, and tomography.

Surgeons must take into consideration several factors:

- Total corneal astigmatism (keratometric and posterior astigmatism);
- Central astigmatism;
- Surgically induced astigmatism (SIA); and
- Effective lens position.[3,4]

All toric IOL manufacturers have user-friendly, web-based toric calculators, and it is advised to have a printout of the axis calculator results in the OR. Additionally there are many toric calculation formulae available to determine the right IOL power.

Toric IOL efficacy decreases with the increase of axis misalignment. Clinical effects can include decreased toric correction,[5,6] hyperopic spherical shift, and change of axis orientation.

INTRAOPERATIVE TECHNOLOGY FOR ALIGNMENT

Several digital technologies can be used to help exclude human error and provide a higher degree of assurance in intraoperative toric IOL alignment. Interconnected devices can measure IOL power, process data, and share information to the surgical microscope.[1] These technologies include real-time eye-tracking technology that compensates for cyclorotation and eye movements to ensure that the

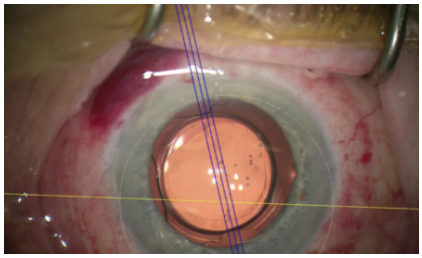

Figure 1. The Z Align function with the Callisto Eye (Carl Zeiss Meditec) allows markerless toric IOL alignment.

superimposed visual templates always remain in the same position in relation to the eye.

The chance to intraoperatively combine systems to increase precision exists, but attention must be paid when matching limbal registration with iris fingerprinting because, for example, femtosecond laser systems tend to alter the conjunctival vascular architecture. Also, the type of anesthesia can influence the recognition, especially if the globe is tilted or conjunctival chemosis limits visualization of the vessels.

There are three main principles used by these technologies:

- Limbal registration (image-guided): An image of the vascularization of the conjunctiva and sclera is captured during biometry and matched with the image obtained by the surgical microscope. An overlay then indicates the steepest axis (Figure 1). The intended axis can be automatically selected from preoperative biometry data or manually entered depending on the IOL calculation formula used.
- Intraoperative wavefront aberrometry: This technology offers the possibility to intraoperatively determine real-time analysis of refraction, astigmatism, and aphakic lens power. The surgeon can instantly adjust the toric IOL to the suggested position based on the data provided.
- Iris fingerprinting (iris detection): Combining this technology with corneal shape analysis ensures

LENSAR STREAMLINE IV:

An Intelligent Way to Address Corneal Astigmatism During Cataract Surgery

In patients with at least 0.75 D of regular bow-tie astigmatism and a stable capsular bag, toric IOLs can be safely and effectively used. In eyes with lower degrees of corneal astigmatism, other approaches such as corneal relaxing incisions or arcuate keratotomies may be considered.

Quality of vision with a toric IOL depends on several factors, including proper patient selection, type of toric IOL chosen, accurate IOL power calculation, correct marking of the steep axis, and a surgical technique adapted to the patient. Inaccurate placement of a toric IOL and postoperative misalignment represent two major causes of decreased quality of vision for astigmatic patients.

Lensar has introduced the Streamline IV enhancements of the Lensar Laser System to address reduction of corneal astigmatism during lens surgery. The system creates an accurate 3D reconstruction of the eye that the surgeon can see on a monitor using technology based on a combination of the principles of the Scheimpflug camera and the concept of augmented reality. An iris registration system preoperatively selects landmarks in a corneal topography image and then identifies the same landmarks on an image taken during docking at the Lensar laser.

Streamline IV includes features such as IntelliAxis-L , IntelliAxis-C, arcuate incision planning, and intelligent incisions. It also provides postoperative data analysis, iris registration, and automatic cyclorotation adjustment. It automatically determines cataract density, classified on a scale from 1 to 5, and determines the location of the nucleus, increasing efficiency and potentially decreasing the amount of laser energy used.

IntelliAxis-L marks the steep axis on the anterior lens capsule independent of vascular details. These marks are permanently stable and enable surgeons to perfectly align toric IOLs during surgery. Capsular markings are accurate, parallel, and can be properly envisioned during the surgery. The images generated can be used for surveillance of toric IOL misalignment, which often occurs in the first 10 days postoperative.

The corneal steep axis can be marked with IntelliAxis, and incision parameters are automatically modified to account for surgically induced astigmatism (SIA) and residual astigmatism entries.

Capsulotomies created with the Lensar are precise, well centered, and correctly sized (Figure).

We have used the Lensar Laser System in our clinic since 2017, and in May 2018 we updated to the Streamline IV system. In our personal experience, the system offers positive results for patients with preexisting astigmatism or SIA following laser cataract surgery.

In our clinic, we have performed approximately 150 cases of laser cataract surgery using

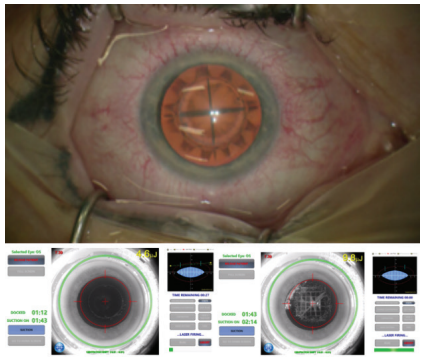

Figure. Capsulotomy and cataract segmentation as performed by the Lensar Femtosecond Laser System.

Lensar. In almost all cases, the outcomes met our expectations. In 2018 we conducted a small study, presented at the ESCRS 2018 in Vienna, in which we compared Lensar capsular markings to those made with the Callisto Eye capsulorhexis template (Carl Zeiss Meditec).[1] The results showed similar accuracy and superposition, with slight and rarely important deviations between the two technologies. In extreme cases, the IntelliAxis showed slighly better repeatability and accuracy.

Our patients respond well to this procedure, and the noncontact corneal docking with fluid-filled interface does not induce high IOP values.

1. Kretz TA. Comparison of different automated approaches for toric IOL alignment: femtosecond laser-assisted capsular markings vs digital visual guidance system. Paper presented at: ESCRS Annual Meeting; September 21-26, 2018; Vienna, Austria.

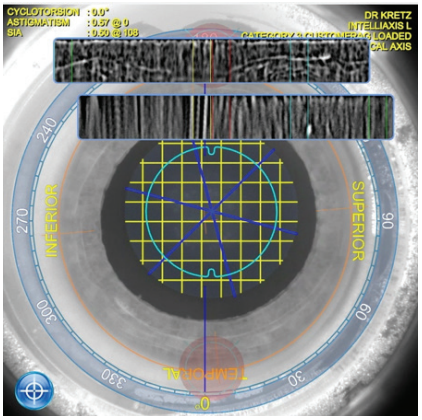

Figure 2. Intelli Axis-L of the Streamline IV software in the Lensar laser system (Lensar) for iris fingerprint detection. Reference image taken with the Pentacam HD (Oculus).

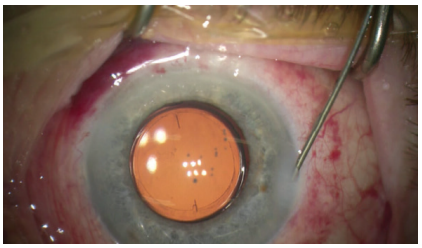

Figure 3. Toric IOL alignment using Lensar capsular markings.

marking of the steep corneal axis by the femtosecond laser in a way that compensates for cyclorotation. It appears to be that using these types of marks can offer better correction of corneal astigmatism during cataract surgery (Figure 2).

The markings can be classified into two categories:

- Virtual markings that are visible only as projections during surgery, making it difficult to monitor postoperative misalignment (image-guided systems or intraoperative wavefront aberrometry); and
- Real semipermanent or permanent markings (intrastromal corneal or capsular markings; Figure 3).

ADVANTAGES OF USING A DIGITAL SYSTEM

The advantages of using a digital system when implanting toric IOLs are many:

- Improved efficiency and refractive outcomes: Preoperative and intraoperative marking is not required, improving workflow and OR efficiency;
- Reduced time per case;
- Lower risk of human error, as automation eliminates transcription errors;
- Increased profit via the ability to treat more patients per day;
- Increased patient and surgeon satisfaction; and
- Photographic and video documentation of surgery and toric IOL alignment.

TIPS AND TRICKS

For perfect keratometry (K) readings, we must ensure that the patient's head is perfectly positioned in order to avoid using a false horizontal axis. The patient's eyelids must be wide open, and the light in the room must not be too bright, to prevent reflections on the sclera. During K readings, the curvature of the cornea is not directly measured, but rather a reflection from the tear film; therefore, it is recommended to do the K reading on an intact corneal tear film, before pupil dilation or topical anesthesia drops are applied, which can degrade the tear film. In severe dry eye cases, preoperative treatment is recommended to ensure good tear film stability during measurement.

When limbal registration is employed, several factors can alter the conjunctival vascular architecture, including pharmacologic mydriasis, increased blood flow, use of balanced salt solution, application of topical anesthesia, conjunctival chemosis, or subconjunctival hemorrhages. Head position in relation to the preoperative image can also influence digital guidance systems.

When intraoperative wavefront aberrometry is used, external factors can negatively influence the intraoperative measurements, including the eyelid speculum, dry eye, IOP, and corneal hydration.[7-9] For precise aphakic power calculation, it is advised to use an OVD or balanced salt solution to moisten the cornea, maintain an IOP of 20 to 30 mm Hg, ensure that there are no air bubbles in the visual pathway, and avoid excessive wound hydration.

CONCLUSION

We believe that the future of cataract surgery is digital and that these technologies offer many advantages for surgeons and patients. Digitization allows rapid, precise, automatic transfer of information and incorporates it all into high-tech, modern equipment.

A surgeon's hands are acknowledged for their remarkable performance in the most complex of cataract surgery cases. Still, those hands, no matter how skillful, are only as accurate as what the surgeon's eyes can see. This is why the benefits of digital technologies are to be embraced. ■

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