Clinically Tested to be the World’s Most Accurate Toric Marking Device

AXsys® Studay Data and Press Release Reference
Electronic Leveling Device for Implantation of a Toric IOL

The senses of sight and hearing indicate where the surgeon should mark the horizontal axis.

BY TAKAYUKI AKAHOSHI, MD

I give my patients the option of having a toric IOL implanted during cataract surgery. As opposed to conventional IOLs, toric IOLs correct preexisting corneal astigmatism during cataract surgery. Achieving the best result with a toric IOL requires properly marking the axis on which the toric IOL should be implanted, which can be determined with toric IOL web-based calculators. For every 1º that the axis is misaligned, a toric lens loses 3% of its corrective effect. I could not achieve an accurate marking with conventional toric IOL markers, because I was unable to confirm that I was holding the instrument perfectly horizontally. In addition, I found it difficult with bubble and pendulum markers to simultaneously focus on the marker and the patient’s eye. I therefore worked with ASICO LLC to design an electronic toric marker that uses my senses of sight and hearing to help me easily and accurately pinpoint the horizontal axis and stay focused on my patient.

SENSORY FEEDBACK

The marker, which is an electronic leveling device, uses green, orange, and red light-emitting diode lights and a beeping sound to indicate the degree to which the marker is aligned on the horizontal axis (Figure). A red light and fast beep indicate that the marker is severely tilted, an orange light and slow beep mean that the marker is slightly tilted, and a green light with no beep signals that the marker is perfectly horizontal.

Two models are available. The first is a one-step axial marker that completes all of the markings in a single step. The surgeon simply turns the dial to the desired (Continued on page 48)

“I could not achieve an accurate marking with conventional toric IOL markers, because I was unable to confirm that I was holding the instrument perfectly horizontally.”

Figure. The electronic toric marker.
“The surgeon should sit at the same eye level as the patient; this position is helpful for placing the marker on the center of the cornea.”

(Continued from page 46)

axis, asks the patient to sit up and look straight, and marks the axis when the light indicator on the marker is green and the beeping stops.

The two-step electronic toric marker is for patients with narrow eyelids or deep-set eyes. This model precisely marks the 0° and 180° positions preoperatively, and the ophthalmologist uses these as points of reference to mark the desired axis during the surgery.

The sensitivity of the device can be adjusted to five settings, ranging from 0.2° to 1.0°. If they wish, surgeons can choose to completely turn off the beeping or program the instrument to beep only when the toric marker is perfectly horizontal.

**DESIGN FEATURES**

The surgeon holds the flat handle with his or her thumb and index finger. The electronic device is attached to the body of the marker by a magnet and can easily be removed for sterilization. The head on both designs may be used for all types of eyes, including those with small orbits.

**TIPS**

When using the toric marker, I apply topical anesthesia and wait until the secretion of tears subsides. I paint the blades of the toric marker with a marking pen, and set the desired axis on the dial. I ask the patient to sit upright while gazing straight ahead with both eyes open. I gently hold the patient’s eyelids with my fingers to prevent the patient from closing his or her eyes as the marker approaches. The surgeon should sit at the same eye level as the patient; this position is helpful for placing the marker on the center of the cornea.

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How to Manage Post-op Residual Astigmatism

Strategies to optimize toric IOL outcomes and manage residual astigmatism after surgery.

BY Jessica Shonfeld, MD, Mujtaba A. Qazi, MD, Jay S. Pepose, MD, PhD

In cataract patients with regular corneal astigmatism, toric IOLs offer the potential for excellent uncorrected postoperative visual acuity. However, the surgeon must carefully consider a number of steps, both preoperatively and intraoperatively, to avoid postoperative residual astigmatism. Despite careful application of advanced tools and techniques, postoperative refractive astigmatism can be unexpectedly high — approximately 10% of patients with more than 1.00 D.1,2 Fortunately, a number of postoperative solutions can address this situation.

Measuring Astigmatic Magnitude and Axis

One of the most critical elements of preoperative planning is the measure of the magnitude and orientation of astigmatism. To minimize measurement errors, one must use multiple sources; for example, by comparing manual keratometry values to automated keratometry and topography.

Videokeratography provides the greatest details of the anterior and posterior cornea and regional corneal pachymetry, and helps assess for corneal irregularity. The IOLMaster (Carl-Zeiss Meditec) extrapolates astigmatic axis from six data points spaced 60° apart.3 This can be helpful if the steep meridian is at 0 or 60°, but if the axis is different, such as at 90° or 145°, you may find inaccuracies in measurement. The Lenstar LS900 (Haag-Streit) surveys two rings of 16 data points spaced 22.5° apart.

Most studies comparing multiple diagnostic modalities have reported close concordance, so readings should not vary by more than 0.50 D and 10° between instruments. This is important because a toric IOL can lose 30% of its astigmatic effect if it is misaligned 10°.4 It becomes more important in the higher-powered toric IOLs; 30% of the astigmatic effect of the AcrySof SN6AT9 (Alcon Surgical) is almost 1.50 D.

Select the Appropriate Patient

When selecting an ideal toric IOL candidate, keep in mind the multiple patient characteristics that may foretell a poor outcome. Patients with dry eye will often manifest discrepancies between keratometry and topography measurements. Poorly managed dry eye disease preoperatively can lead to selecting the wrong axis. Patients with irregular corneal astigmatism — those with anterior basement membrane dystrophy or advanced keratoconus — may not be ideal candidates due to their variable refractive and corneal astigmatism.

When obtaining biometry measurements, we find it helpful to approach the toric IOL patient much like a preoperative refractive patient. Avoid taking measurements if the patient has not discontinued soft contact lens wear for at least two weeks and gas permeable contact lens wear for four weeks before the evaluation. Repeating these measurements a few weeks apart helps to assure that the cornea has reached stability from the impact of contact lens warpage, particularly in patients with an extended history of rigid contact lens use. Additionally, we must pay attention to proper head positioning when obtaining keratometry and topography.

<table>
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<tr>
<th>TABLE: AcrySof toric IOL calculator</th>
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<td>Non-toric IOL</td>
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<td>Toric IOL</td>
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Table: Acrysoft (Alcon) toric IOL model numbers, with corresponding astigmatism power correction in the IOL (center) and spectacle (right) plane.

Nuances of IOL Selection

Practical use of a toric IOL for correcting the refractive effect of corneal astigmatism requires the implementation of a toric IOL calculator that uses surgeon-provided keratometry and surgically induced astigmatism (SIA) to select the correct astigmatic power and calculate the optimal angle of placement. Use of computer-based toric calculators automates adding the two astigmatic vectors (SIA and pre-existing corneal astigmatism) to generate the desired surgical correction. The AcrySof toric IOL calculator (www.acrysoftoriccalculator.com) uses the preoperative steep and flat keratometry, planned incision location, anticipated surgically induced astigmatism, and IOL spherical power to customize toric IOL power and alignment (Table, page 49). However, these measurements do not factor in the posterior corneal curvature.

Typically, the steep meridian of the anterior corneal surface tends to change from vertical to horizontal with increasing age, while that of the posterior surface tends to retain its vertically steep alignment.5 Thus, posterior corneal astigmatism generally adds against-the-rule astigmatism.

For this reason, a good rule of thumb is to overcorrect against-the-rule astigmatism and undercorrect with-the-rule astigmatism. Further investigations are needed to incorporate posterior corneal astigmatism and axis into toric IOL calculation nomograms and methods.
SIA: A Little Can Mean a Lot

Knowing one’s surgically induced astigmatism (SIA) is critical. SIA can affect both the magnitude and direction of the principal astigmatic meridians of the cornea and have a greater impact in cases of smaller amounts of preoperative cylinder. Studies have reported 0.20 D to 1.20 D of SIA depending upon incision size and location.6

The SIA Calculator, an online tool developed by Warren Hill, MD, (www.SIA-calculator.com) can help you customize SIA for clear, near-clear and scleral incisions. You can then calculate the optimal incision angle to minimize the postoperative residual astigmatism, sometimes rendering a change in surgical approach from temporal to superior, or vice versa.

Surgical Tips and Tricks

Once in the operating room, correctly placing the toric IOL can be just as challenging as the preoperative planning. These perioperative steps can help avoid problems postoperatively.

► Mark, remark and reinforce. Mark the cornea twice: once preoperatively with a reference marker in the upright position to compensate for cyclotorsion; and during surgery with a toric axis marker. Markers with either a bubble-level or digital guidance (Figure 1) can facilitate reliable preoperative marking. Reinforcing the reference marks with a sterile marking pen can help prevent fading during surgery. Circumlinear rhexis formation, thorough cortical cleanup, and anterior and posterior capsular polishing are prerequisites for proper toric IOL centration and in-the-bag stability. The astigmatic axis of the toric IOL should be aligned with the steep (Figure 2) corneal meridian. Leaving the lens 20° shy of the target axis can make the final adjustments more precise. Careful removal of viscoelastic from the bag and behind the IOL can prevent later IOL rotation.

► Remove all viscoelastic behind the IOL. As with multifocal IOLs, the ideal location of the toric IOL is centered on the visual axis. This leaves the IOL slightly nasally positioned in the bag to attain proper centration and usually requires haptic placement to be oblique or vertical. Haptics oriented horizontally can cause the lens to shift temporally after surgery. In long myopic eyes, the IOL will have a greater tendency to rotate. In these cases, removing all the viscoelastic behind the IOL is critical to minimize postoperative rotation.

► Do not over-inflate the bag. By the same token, over-inflation of the bag can also facilitate postoperative IOL rotation. A longer-shelved corneal incision can help maintain a stable chamber intraoperatively and postoperatively. Some surgeons have elected to implant a capsular tension ring in highly myopic eyes to further prevent postoperative rotation.

Postoperative Astigmatism: Now what?

A study to evaluate the AcrySof Toric IOL, by Holland et al, reported a mean absolute residual refractive cylinder of 0.59 D and a mean lens axis rotation of less than 4° (range 0° to 20°).2 One year after surgery, 78% of IOLs rotated less than or equal to 5° and 93.4% rotated less than or equal to 10°. The authors concluded the AcrySof Toric IOL demonstrated favorable efficacy and rotational stability. However, 6.7% rotated more than 10°, including 1.2% that rotated between 15° to 20° as assessed at the one-year visit. If the toric IOL patient still has unacceptable postoperative astigmatism, several corrective options are available.

► Rotate the IOL. In the early postoperative period, one option is to reposition and rotate the toric IOL. Instead of manually performing a vector analysis, surgeons can consult an online calculator developed by Drs. John Berdahl and David Hardten (www.astigmatismfix.com). This calculator incorporates the magnitude of IOL astigmatism, postoperative manifest refraction, and current IOL axis. A diagram illustrates the IOL’s current and target locations and quantifies the residual astigmatism if the IOL were to be rotated (Figure 3).

The lens should be rotated no earlier than two weeks after surgery to allow the refraction to stabilize. After four weeks fibrosis around the haptics can make lens rotation more difficult. Thus, two to four weeks postoperatively is the ideal time for toric IOL rotation. Our technique for IOL rotation involves:

- Re-inflating the capsular bag, including along the haptic interface with the bag equator and behind the IOL optic, with a cohesive viscoelastic.
- Rotating the IOL with a Kuglen hook until it aligns with the new axis.
of orientation.

- Using bimanual I/A via small paracentesis incisions to remove the residual viscoelastic.
- Reconfirming correct alignment of the toric IOL with axis markings at the end of the case.

**Limbal relaxing incisions.** LRIIs are safe, easy and relatively reliable for managing residual astigmatism, especially if the postoperative spherical equivalent is close to plano. Several LRI nomograms have been developed, primarily for techniques employing either guarded or adjustable diamond blades. We currently utilize Dr. Louis D. Nichamin’s nomogram,7 which adjusts arc length as a function of refractive astigmatism and patient age with a fixed 600-μm incision depth. The Accurate LRI Calculator (MicroMedical Devices) is pachymetry software that can calculate the depth and incision arc based on patient age, corneal rigidity and IOP. Use an adjustable diamond blade with micrometer depth markings with this method.

AMO’s LRI calculator is a vector-analysis based online tool that allows surgeons to enter keratometry or topography data and receive an individualized diagram showing where to place the LRI incisions. A growing number of studies have shown promising results with femtosecond laser-assisted astigmatism correction and offer options for further customization, including intrastromal keratotomy.8

**Refractive surgery.** Excimer laser procedures can help neutralize residual postoperative refractive cylinder and sphere, as well as higher-order aberrations. We prefer waiting for the refraction to stabilize after YAG capsulotomy before performing excimer photoablation. This minimizes variables related to capsular fibrosis and contraction.

We do not modify our LASIK nomogram for pseudophakes, but do make an adjustment for patient age. Make sure to review the centroid pattern for wavefront-guided ablations to rule out the presence of any artifact from the IOL or capsulotomy edge. Tracking can be affected if the post-cataract pupil is irregular or iris transillumination defects are present. As with toric IOL procedures, horizontal and vertical alignment marks are placed to rule out significant cyclotorsion during the LASIK procedure.

**Glasses or contacts.** With refractive cataract surgery, patients have a goal of spectacle independence, so they can be resistant to this last option. However, in a randomized multicenter trial of the AcrySo toric IOL (n=256 eyes),2 almost 40% of the toric IOL group had some degree of spectacle dependence six months after surgery. In this regard, it is important that surgeons stress to patients during preoperative counseling that they might need corrective eyewear after surgery or need to undergo an additional surgical procedure.

### Achieving Patient Satisfaction

Toric IOL implantation has shown itself to be an effective treatment option in patients with corneal astigmatism, with good rotational stability and expanding ranges of cylindrical power correction. Recent and future advances in IOL design, wound and rhexis construction, intraoperative aberrometry, and postoperative light adjustment of the IOL optic offer further opportunities to reduce residual refractive and astigmatic error. By consistently following recommended guidelines regarding patient selection and intraoperative techniques, the goal of satisfied patients is highly attainable.

Nevertheless, we must educate candidates for toric IOLs about the possibility that they may need additional refractive procedures to improve their uncorrected visual acuity, and that part-time spectacle wear may augment their vision postoperatively. **OM**

### References


Purpose

• Evaluation of 2 different axis marking instruments in clinical practice

Electronic Toric One Step Marker, AE 2929, Asico

Pre-op Toric Reference Marker, AE-2792, Asico
Electronic Toric One Step Marker

• Visual and audio alert when horizontal alignment is achieved
• Colored led guidance
• It has two parts: The electronic and the metallic (autoclavable) part.

(Designed by Dr. Akahoshi)

Preop Toric Reference Marker with Bubble

• Bubble level aids in marking the eye temporally
• Marking pattern is located on both sides for marking the left and right eye

(A later version of this marker is named Nujits-Lane Preop Toric Reference Marker)
Patients - Methods

- 28 eyes (right: 14 - left: 14)
- Each eye was marked with one of the devices
- All eyes photographed at the slit lamp with a narrow slit beam (reference axis)
- The difference in degrees between the reference axis and the marks was calculated from the enlarged photographs.
### Results

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<tr>
<th>Difference in °</th>
<th>R-L eye</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3° (STD:±1.3°)</td>
<td>p&gt;0.2</td>
<td>Right Eyes: + angle CCW turn</td>
</tr>
<tr>
<td>4.1° (STD:±1.6°)</td>
<td>P=0.01</td>
<td>Left Eyes: - angle CW turn</td>
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<tr>
<td>Significance</td>
<td>p&lt;0.001</td>
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Discussion

• Importance of correct axis marking:

  For every 1° misalignment, approximately 3.3% of the cylinder power is reduced

  >10° requires realignment of the IOL

  >30°: increase of preop astigmatism
Discussion

• Both devices have the advantage of marking the axis without requiring a slit lamp.
• The difference in accuracy is related to the led assistance and the coaxial angle of view in the Electronic One Step Marker.
• Handling of the Preop Toric Reference Marker with bubble was somehow difficult and showed differences between the right and left eye, mainly because the surgeon can not look simultaneously at the eye and at the bubble of the instrument.

Conclusion

• Both devices could mark the axis within 5° of intended axis.
• Astigmatism axis marking was more precise with the Electronic One Step Marker.
• The temporally-held Pre-op Toric Reference Marker with Bubble showed significant difference in marking between the right and left eye.