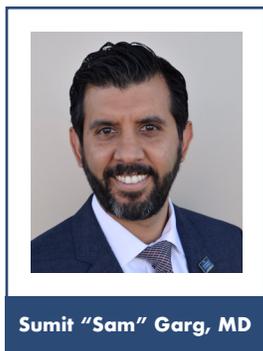


Today's top challenges with toric IOLs



Best practices are key to success in surgical management of astigmatism

Ninety-five percent of 2018 ASCRS Clinical Survey respondents believe patients with clinically significant astigmatism should be offered astigmatism correction during cataract surgery (Figure 1).¹ However, the survey revealed

that an average of 20% of patients with clinically significant astigmatism receive toric intraocular lenses (IOLs).

Sumit "Sam" Garg, MD, explained that surgeons may face several challenges when incorporating toric IOLs into their practices. They include integrating assessments into workups, identifying astigmatism, determining the most appropriate correction method, and achieving optimal results.

Dr. Garg offered tips to help surgeons make the most of toric technologies and deliver optimal visual outcomes.

Identifying solutions

Dr. Garg includes corneal topography in the routine workup of cataract surgery

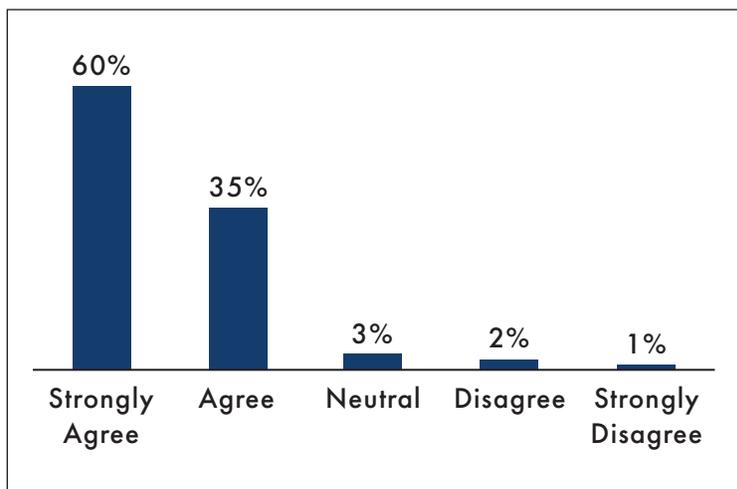


Figure 1. According to the 2018 ASCRS Clinical Survey, 95% of respondents believe patients with clinically significant astigmatism should be offered astigmatism correction at the time of cataract surgery.

candidates, which determines whether astigmatism is regular or irregular and confirms biometry and autokeratometry readings. Topography images also can be shared with patients as the surgeon educates

them about astigmatism management.

He also emphasized the need to examine corneal astigmatism. "Oftentimes, surgeons focus on refractive

continued on page 2 ➔

Accreditation Statement

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education through the joint providership of the American Society of Cataract and Refractive Surgery (ASCRS) and EyeWorld magazine. ASCRS is accredited by the ACCME to provide continuing medical education for physicians.

Educational Objectives

- Outline the importance of and best practices for preoperative, intraoperative, and postoperative planning and execution to improve outcomes in the surgical management of astigmatism.
- Identify steps to mitigate refractive surprises and manage postoperative dissatisfaction to increase postoperative success with toric and presbyopia-correcting IOLs.
- Describe new and emerging technological advances for the treatment of presbyopia and astigmatism.
- Integrate proper patient education and conversation techniques for the astigmatic and presbyopic patient.

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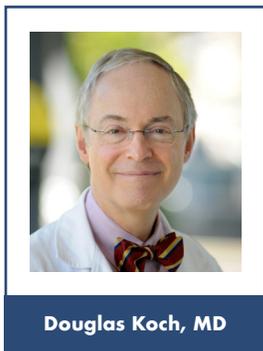
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Astigmatism fundamentals



Douglas Koch, MD

Understanding preop and postop astigmatism management

To surgically manage astigmatism effectively, surgeons need to develop a consistent set of diagnostic and surgical best practices.

Preoperative assessments

Douglas Koch, MD, stressed that a healthy ocular surface is necessary for accurate and repeatable measurements. He prefers a biometer with multiple LED rings and, to confirm the steep meridian, a corneal topographic map, ideally one with Placido mires, to aid in evaluating the quality of the ocular surface.

The refraction sometimes also offers important information. “First pointed out to me by Robert Cionni, MD, some patients seem to have much more with-the-rule (WTR) astigmatism in their topography than in their glasses, or there may be more against-the-rule (ATR) in the glasses. Those could be signs that the

continued on page 3 ➤

continued from page 1

astigmatism, whereas when managing astigmatism in the operative setting we need to look at corneal astigmatism,” he said.

To achieve optimal results, Dr. Garg said that surgeons must manage the ocular surface aggressively.

Incorporating toricity in presbyopic patients

Dr. Garg educates patients about lens options through videos, vision simulators, and extensive discussions. He uses patients’ questionnaire responses to guide them to the correct lens.

Patients may expect spectacle independence, regardless of their IOL, and often compare their results with others’ outcomes. “I explain that each person’s eyes and situation are

independent, and my job is to help the patient choose the right lens for his or her particular situation,” he said.

He discusses femtosecond lasers to treat low amounts of astigmatism but said he gravitates toward toric IOLs for astigmatism greater than 1 D.

“We are lucky that there are several models of presbyopia-correcting IOLs that now incorporate toric correction,” Dr. Garg said.

He follows the Baylor nomogram and tries to undercorrect with-the-rule astigmatism and overcorrect against-the-rule astigmatism. “I also look at the total keratometry reading from an anterior segment tomography device as well as the total corneal refractive power from a swept-source optical coherence tomography biometer to give me a better sense of what

is going on with posterior corneal astigmatism,” he said.

Dr. Garg aims for the lowest amount of residual astigmatism possible (less than 0.5 D), preferring to leave patients with a very small amount of astigmatism and flip the axis rather than leaving a larger amount of astigmatism without flipping the axis.

“You have to be meticulous and aggressive when managing astigmatism in patients opting for presbyopia-correcting IOLs,” he said.

Developing best practices

Surgeons need to develop best practices to surgically manage astigmatism in cataract patients because it is important to be consistent and meticu-

lous, Dr. Garg said. The ocular surface must be optimized, and there must be agreement between preoperative diagnostic tests. Furthermore, painstaking technique and alignment are important to ensure predictable outcomes, he said.

“Certainly, not all cases go as planned, and it is important to understand strategies to figure out what went wrong and how to remedy it,” he said. ■

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Dr. Garg is vice chair and medical director, Department of Ophthalmology, Gavin Herbert Eye Institute at the University of California, Irvine, and chair of the ASCRS Young Eye Surgeons Clinical Committee. He can be contacted at gargs@uci.edu or 949-824-0327.



posterior cornea or perhaps lens tilt may have more influence than we might suspect,” he said.

Assessing the posterior cornea

Before surgery, the anterior cornea provides clues regarding the posterior cornea, Dr. Koch said.^{1,2} “Because of this, we have been able to generate regression formulas based on measuring the anterior cornea to estimate posterior corneal astigmatism. As expected, however, some patients’ corneas do not fit these mathematical models,” he said.

Dr. Koch explained that one swept-source optical biometer provides total corneal astigmatism values and inserts them into a toric calculator with total keratometry. “This is very promising but needs further evaluation for validation,” he said.

Otherwise, he said, regression-based toric calculators such as the Baylor nomogram, Barrett Universal Toric, Abulafia-Koch, and updated IOL manufacturers’ toric calculators are required to incorporate estimated posterior corneal astigmatism into astigmatic planning.

Managing astigmatism

Dr. Koch usually manages

“With-the-rule” astigmatism: + refractive astigmatism at 90

- In virgin eyes almost always because the anterior cornea is steep vertically, with the magnitude reduced by vertical steepness of the posterior cornea and crystalline lens tilt
- Corrected with spectacle lens with vertical axis
 - Plano + 1.00 x 90: the cylinder power is at 180

“Against-the-rule” astigmatism: + refractive astigmatism at 180

- Due to some combination of horizontal steepness of the anterior cornea, vertical steepness of the posterior cornea, and crystalline lens tilt
- Corrected with spectacle lens with horizontal axis
 - Plano + 1.00 x 180: the cylinder power is at 90

The basics: WTR and ATR astigmatism

WTR astigmatism of 1–1.5 D with relaxing incisions; for greater amounts, he uses a toric IOL.

“You want to undercorrect them to leave them with a little bit of WTR astigmatism,” he said. “Astigmatism drifts toward ATR over time, so if you leave a patient with 0.2 or 0.3 D of WTR astigmatism, they will have great vision, and it will last for many years.”

He recommends slight overcorrection of ATR astigmatism because it continues to drift further ATR over time. His threshold for ATR astigmatism is 0.4 or 0.5 D with a toric IOL.

Dr. Koch explained that patients with oblique astigmatism—unless they have always had it—most likely are moving from having WTR to ATR astigmatism. “I treat them fully, but I place the IOL at the alignment or maybe even a little on the ATR side in hope that we will get them a good correction for a longer period of time,” he said.

“We understand what the anterior cornea does in terms of surgically induced astigmatism. We have measured it, and it is on average 0.1 D for a 2.4 mm clear corneal temporal incision,” he said. “However, as Holladay’s paper shows, we just do not have a good handle yet on all the factors that contribute to surgically induced astigmatism, but it is a combination of front of the cornea, back of the cornea, and IOL tilt,” he said.³

Some patients have significant lenticular astigmatism. “Research by our group and others has shown that preoperative crystalline lens tilt predicts postoperative IOL tilt,” Dr. Koch said.⁴ “If we could routinely measure preop crystalline lens tilt, we would improve our outcomes.”

Conclusion

In addition to mastering astigmatism correction, surgeons should know how to manage postoperative astigmatism or refer patients to a colleague to manage it. “If patients are

going to pay upfront to treat their astigmatism, you want to take them across the finish line,” he said. ■

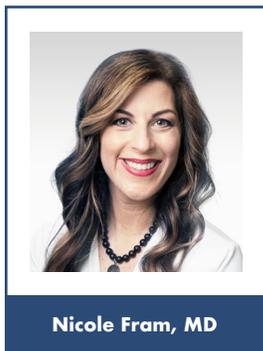
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Dr. Koch is professor and Allen, Mosbacher and Law Chair in Ophthalmology, Cullen Eye Institute, Baylor College of Medicine, Houston. He can be contacted at dkoch@bcm.edu or 713-798-6443.



Planning for success: Pearls for axial marking



Nicole Fram, MD

Accurate preoperative marking is crucial for successful outcomes

Astigmatism significantly influences cataract surgery, affecting patients' eligibility for intraocular lenses (IOLs), vision quality, and postoperative satisfaction.

"Depending on the IOL technology, more than 0.50 D of residual cylinder may leave a patient symptomatic," Nicole Fram, MD, said.

Postoperative astigmatism may be caused by an incorrect lens power, which may result from incorrect measurements or calculations, posterior corneal astigmatism, or surgically induced astigmatism, she explained.¹ It also may occur if the IOL rotates after surgery or is not aligned correctly.

"For every 1 degree of error, you lose 3.3% of astigmatic correction," Dr. Fram said.²

Surprisingly, the ASCRS Clinical Survey shows that some respondents believe 10 degrees of IOL rotation is acceptable.

"This highlights the critical importance of accurate preoperative marking when managing astigmatism," Dr. Fram said.

Axis alignment

Several manual and digital

To minimize postoperative IOL rotation, Dr. Fram offered the following tips:

- Use meticulous measurement and marking techniques
- Use intraoperative aberrometry or a digital marker (Figure 1)
- Remove all OVD from behind the IOL
- Gently push the optic posteriorly
- Perform a balanced salt solution stress test at the end of surgery

methods may be used to mark alignment.

At bedside or the slit lamp, patients should be in an upright position for manual marking to avoid artifacts from cyclorotation, Dr. Fram explained.

She thinks the most precise way to manually mark is at the slit lamp and a level handheld marker can be equally effective. "The key is to make sure the patient is anesthetized, a fine-tip marker is used, and the patient looks in the distance to avoid convergence," she said.

"Robert Osher, MD, has long advocated using iris fingerprinting and scleral vessel imaging to help guide toric IOL placement," she said. "When available, this is an excellent way to provide precise measurements."

Comparing manual marking with a pendulum-attached marker vs. a digital marking system, Elhofi et al. found less postoperative deviation from the targeted induced astigmatism.³ They also found less postoperative IOL misalignment when a digital marking

system was used compared with manual marking.

Dr. Fram explained:

- Digital marking systems, such as CALLISTO (Zeiss) and VERION (Alcon), begin with a preoperative reference image that is transmitted to the oculars for alignment and astigmatic planning.
- The LENSAR IntelliAxis uses a preoperative image from a CASSINI or Pentacam (OCULUS) to reference the steep axis, which is transmitted to the femtosecond laser. Tabs are created in the capsulotomy to allow intraoperative marking of the steep axis.
- Intraoperative aberrometry measures the aphakic refraction and gives a steep axis recommendation based on wavefront aberrometry to allow toric IOL alignment and power suggestion.

"All of these technologies show promising advancements. However, I recommend a manual reference mark preoperatively because digital technology may

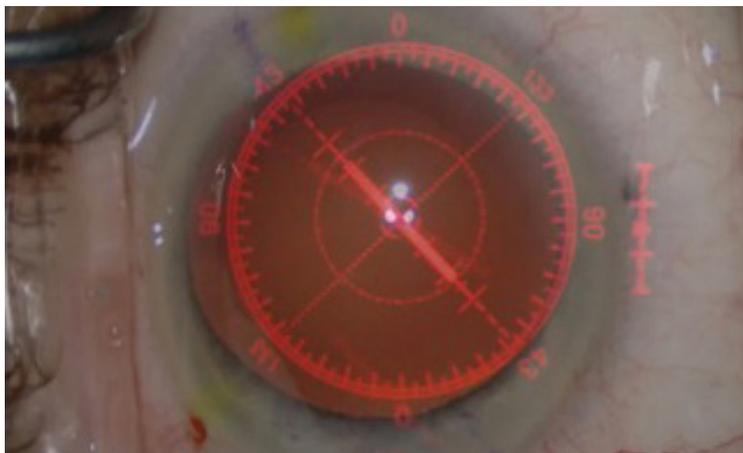


Figure 1. Intraoperative image of intraoperative aberrometry with reticle overlay of steep axis.

continued on page 5 ➤



Power calculations and astigmatic outcomes



Zaina Al-Mohtaseb, MD



Daniel Chang, MD

Daniel Chang, MD, and Zaina Al-Mohtaseb, MD, offer pearls for such optimization.

Focus on precise measurements

Dr. Chang stressed the importance of a good quality biometer and an optimized ocular surface before measurements. This helps determine if the patient is a candidate for a toric IOL and to identify the degree of astigmatism.

He takes the following steps:

1. Biometry measurements are ideally performed before refraction, tonometry, pupil dilation, or other assessments, which may disrupt the ocular surface.
2. Measurements are repeated for consistency, on separate days if possible, or at least after dilation. If they are consistent, he is more confident in their accuracy.
3. Inconsistent results are a sign of ocular surface problems. After treating the ocular surface, if biometry does

not stabilize, he reconsiders a premium IOL approach.

Dr. Chang explained that corneal topography and other tests help the clinician determine the quality of the measurements. “The ocular surface can be a significant source of error,” he said. “While a topographer does not produce the biometry-quality keratometry needed for calculations, it does provide a big-picture overview of the state of the ocular surface.”

Most biometry devices have a number of built-in formulas. He recommended the Barrett II formula, which he said is robust throughout the range of axial lengths. In addition, he said, IOL manufacturers offer toric calculators, some of which account for the posterior cornea and include a nomogram from the IOL clinical trials.

Attaining optimal outcomes

It is important to have a reli-

able way to translate preoperative data intraoperatively, Dr. Chang said. Alignment techniques range from manual marking methods to digital tracking and marking systems.

Dr. Chang takes a “middle-of-the-road approach,” using the topographer’s eye image, along with the biometry data, to calculate the axis of correction. “After determining my desired axis, I transpose that information onto the eye by using the pupil and limbus structures to make sure I line with the intended axis,” he said.

He stressed the importance of a quality, self-sealing wound. “I am meticulous with wound construction, because postoperative hypotony can lead to unpredictable lens movement,” he said.

After IOL implantation, he completely removes the viscoelastic and rotates it at least 180 degrees to make sure it sits well in the bag and the retrolenticular viscoelastic is gone.

continued on page 6 ➤

Optimizing outcomes with available toric IOLs

Obtaining excellent visual outcomes from today’s toric IOLs requires meticulous attention preoperatively, intraoperatively, and postoperatively.

continued from page 4

unexpectedly fail in the operating room,” she said.

Conclusion

Careful preoperative marking and alignment are critical to achieving success in managing astigmatism with toric

IOLs. Residual astigmatism can affect patients’ vision and postoperative satisfaction. ■

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continued from page 5

He carefully aligns the lens on his axis marks and seals the eye, rechecking the lens position and wound seal.

Managing residual astigmatism

An important part of surgically correcting astigmatism is knowing how to manage postoperative astigmatism.

“First, you rule out medical problems from the front to the back. Then, you see if they are correctable to 20/20 and happy with that vision. If they are, then you figure out how to correct the refractive error,” he said.

Targeting sources of error

Dr. Al-Mohtaseb explained that surgeons need to rule out corneal pathology that can cause pseudo-astigmatism or irregular astigmatism. She reviews corneal topography printouts for irregular mires and performs a clinical examination at the slit lamp, looking for epithelial basement membrane dystrophy and ocular surface disease, which she explained should be treated before surgery.

“It is important to look at the quality parameters of the topographers, tomographers, and biometers used in practice to measure preoperatively,” Dr. Al-Mohtaseb said.

She uses two different topographers and at least one biometer for measurements. “I also look at patients’ old glasses prescriptions, which

might point to underlying posterior astigmatism,” she said.

She prefers the magnitude of astigmatism to be within 0.5 D between devices and the axis within 10 degrees. “If not, I check the quality of the scans, quality of the ocular surface, and then repeat measurements,” she said. “If they still do not agree, I consider not treating the astigmatism, especially if it is low, and also have a longer discussion with the patient about the potential for postoperative laser refractive surgery or IOL exchange, if needed.”

Maximizing accuracy

Accurate IOL power calculations depend on the accuracy of the preoperative biometric data and IOL calculations. She noted that the following are the most common sources of error (in order, and excluding manifest refraction):

- Postoperative IOL position (or true effective lens position [ELP])
- Axial length measurement
- Corneal power measurement

She explained that formulas are less accurate with short eyes, long eyes, eyes with variable anterior chamber depth (ACD), and eyes that have had refractive surgery. “It’s important to look even more closely at measurements in those eyes,” she said.

Dr. Al-Mohtaseb explained that vergence and

ray-tracing formulas attempt to estimate ELP, but artificial intelligence-based formulas select IOL power without directly predicting the ELP. “The differences in accuracy between various multiple-variable vergence formulas might result from the difference in the method of pseudophakic ACD estimation,” she said.

Obtaining excellent outcomes

Dr. Al-Mohtaseb recommended the following to optimize toric IOL outcomes:

- **Preoperatively, look at multiple preoperative data points for magnitude and alignment and do not forget about posterior corneal astigmatism.** She explained that she uses a manufacturer’s calculator that incorporates Barrett’s calculator, which accounts for posterior astigmatism. It is important to choose the correct IOL power and toricity, and intraoperative aberrometry can be helpful in confirming the preoperative measurements and choices, she said.
- **Properly align the IOL.** Errors can occur at the reference axis, alignment axis mark, and final IOL alignment. Preoperative and intraoperative marking can be performed manually or with a digital marking system. Aberrometry-based alignment methods can measure corneal astigmatism intraoperatively and

can also guide surgeons in correctly aligning the toric IOL. It is especially useful in patients who have had refractive surgery or have a high magnitude of astigmatism.

Using the Sinsky hook, she aligns the IOL approximately 10 degrees shy of the meridian. She uses bimanual irrigation and aspiration to remove the OVD, and uses irrigation to stabilize the lens and prevent rotation. “I also like to go underneath the lens with the aspirator. Once done, I keep the irrigator in the eye, remove the aspirator, and hydrate the paracentesis as I remove the irrigator. This prevents sudden flattening of the eye and keeps the lens in place,” she said.

Postoperative concerns

If the patient is unhappy after surgery, she recommended ensuring that the refraction is stable and accurate after healing, determining the patient’s goals, and identifying residual astigmatism. She explained that astigmatismfix.com is helpful to see whether IOL rotation will correct astigmatism. “Based on the ocular surface and level of astigmatism, we can decide if LASIK or PRK, corneal relaxing incisions, or IOL exchange are the answer.” ■

continued on page 7 ►►



Impact of ocular surface disease on astigmatic outcomes and toric intraocular lens selection



Cynthia Matossian, MD

An optimized tear film provides the foundation for accurate measurements

Surgeons are less likely to achieve the visual outcomes patients expect from toric IOLs if a patient's tear film is unstable.

The tear film provides two-thirds of the refractive power of the eye. It must be stabilized to obtain reliable and consistent preoperative measurements that are plugged into appropriate for-

mulas, said Cynthia Matossian, MD.

“Relying exclusively on newer formulas is not going to yield the refractive outcome a surgeon wants without having reliable data to input into the formula,” she said.

Tear film impact

Epitropoulos et al. reported that keratometry readings in one in five hyperosmolar eyes varied by at least 1 D between two consecutive preoperative visits.¹ “If the Ks are unstable, the calculated power of the implant is going to be off because the K readings are a critical component in IOL power calculation,” Dr. Matossian said.

In a small pilot study, Dr. Matossian showed that thermal pulsation treatment for meibomian gland dysfunction significantly changed measurements of delta K and axis of astigmatism.² In 40% of eyes,

Dr. Matossian’s protocol for every cataract surgery candidate

- SPEED questionnaire, tear osmolarity, MMP-9, and meibography
- Customized treatment plan, based on the ASCRS Preoperative Ocular Surface Disease Algorithm⁴
- Comparison of measurements from various devices
- If discrepancies are found between devices (more than 10 degrees difference in axis or more than 0.5 D in difference in magnitude of astigmatism), tear film must be reassessed and treated unless further improvement is not a realistic expectation.

either the IOL power and/or the plan for astigmatism management changed after thermal pulsation.

Diagnosing and managing ocular surface disease

Many patients with ocular surface disease may be asymptomatic. The PHACO study by Trattler et al. showed that 77% of cataract surgery candidates had corneal staining; however, 63% of patients never had symptoms of dryness.³

Conclusion

To obtain optimal results from toric IOLs in patients with ocular surface disease, Dr. Matossian optimizes the ocular surface and stabilizes the tear film as much as possible before performing preoperative measurements. She also recommends looking for reliability and consistency

between several devices before performing toric IOL calculations. ■

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continued from page 6

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CME questions (circle the correct answer)

1. **With time, astigmatism _____**
 - a. Drifts with the rule
 - b. Drifts against the rule
 - c. Remains the same
 - d. All of the above

2. **Which factor has been shown to predict postoperative IOL tilt?**
 - a. Corneal topography dropout
 - b. Posterior astigmatism
 - c. Preoperative crystalline lens tilt
 - d. Epithelial basement membrane dystrophy

3. **At the bedside or slit lamp, how should patients be positioned during preoperative manual marking?**
 - a. Upright
 - b. Supine
 - c. With the head tilted
 - d. Either A or B

4. **Which of the following was described to be useful when aligning the toric IOL in patients who had previous refractive surgery?**
 - a. Aberrometry
 - b. Astigmatismfix.com
 - c. Ocular surface disease treatment
 - d. Triplanar incisions

5. **Depending on the cause, what is a potential way to correct postoperative astigmatism after implantation of a toric intraocular lens?**
 - a. Lens rotation
 - b. Lens replacement
 - c. Laser vision correction
 - d. All of the above

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