CME Monograph

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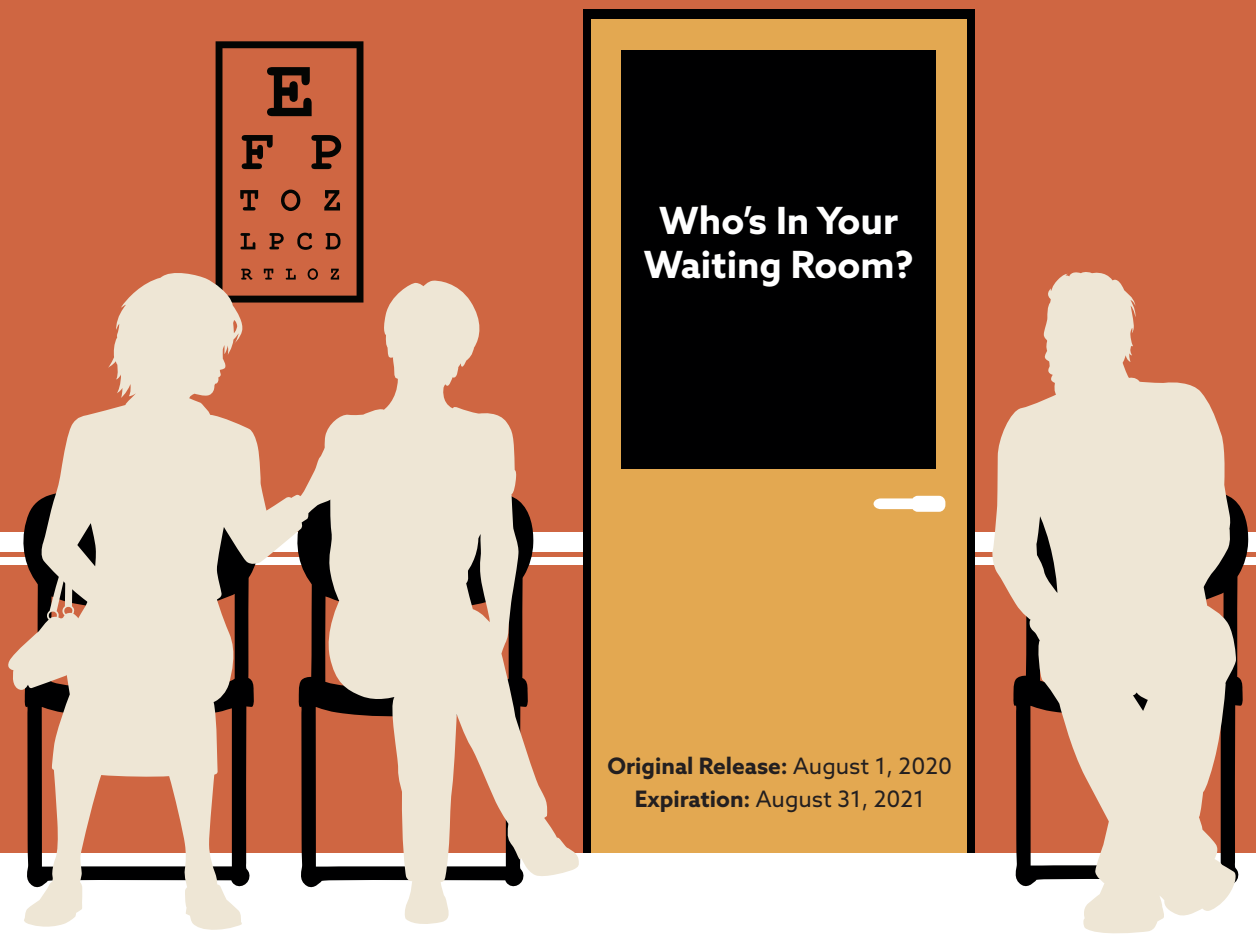
A DAY IN THE LIFE OF AN OPHTHALMIC SURGEON™

CHALLENGING CASES IN REFRACTIVE CATARACT SURGERY



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Eric D. Donnenfeld, MD (Chair) • Neel R. Desai, MD • Preeya K. Gupta, MD • Mitchell A. Jackson, MD




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This educational activity was developed and implemented in collaboration with **MedEdicus LLC**.

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ACTIVITY DESCRIPTION

Cataract surgery has been recognized as one of the safest and most effective surgical procedures for many years, and innovations for preoperative, intraoperative, and postoperative care are enabling improved outcomes in all settings. In this case-based program, experts provide insights on planning and performing refractive cataract surgery to achieve success and patient satisfaction in challenging situations. The desired results of this activity are the optimization of outcomes of cataract surgery.

TARGET AUDIENCE

This educational activity is intended for ophthalmologists.

LEARNING OBJECTIVES

Upon completion of this activity, participants will be better able to:

- Review appropriate preoperative assessments in all patients undergoing cataract surgery
- Use evidence-based medication regimens for inflammation and infection control in patients undergoing cataract surgery
- Select the optimal intraocular lens for individual patients
- Review advances in femtosecond cataract surgery technology

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A DAY IN THE LIFE OF AN OPHTHALMIC SURGEON™

CHALLENGING CASES IN REFRACTIVE CATARACT SURGERY

Who's In Your Waiting Room?

CASE 1: CATARACT SURGERY AFTER HYPEROPIC LASIK

From the Files of Eric D. Donnenfeld, MD

A 67-year-old man presented with complaints of decreased vision OU (worse OD) and poor vision when driving at night. He had hyperopic LASIK (laser-assisted in situ keratomileusis) OU 15 years earlier. His refraction prior to LASIK was +3.25 -0.50 × 90 OD, +2.75 -0.75 × 85 OS.

Examination showed visually significant nuclear sclerotic cataracts, with best-corrected visual acuity (BCVA) of 20/40- OD and 20/30 OS. **Figure 1** shows topography images of the patient's right eye. He wanted cataract surgery and said he does not want to wear glasses for distance postoperatively.

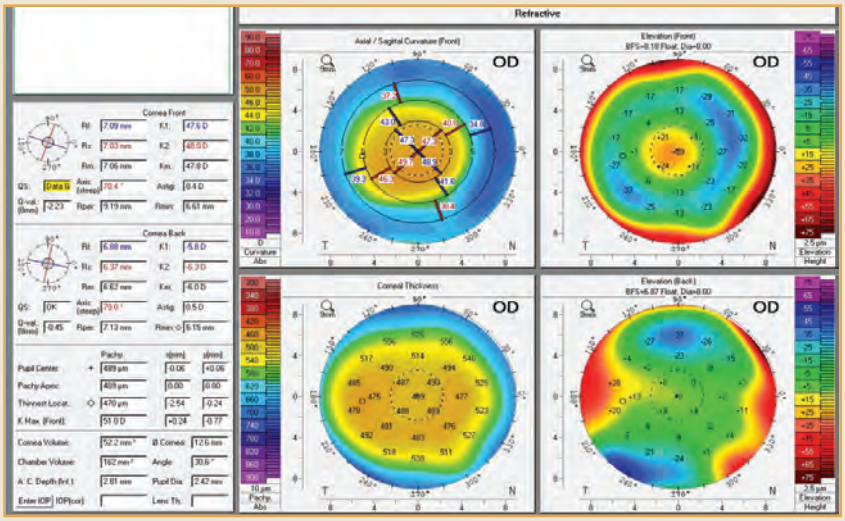

Figure 1. Topography images of the right eye of the patient presented in Case 1

Intraocular Lens Selection

Dr Donnenfeld: LASIK was first approved more than 20 years ago, and now there is an influx of post-LASIK patients presenting for cataract surgery. There are several considerations for surgical planning in these cases. What do you notice when you look at the topography images from the patient in this real-world case?

Dr Gupta: Topography should be part of the preoperative evaluation for any cataract surgery patient. Specific to patients who had LASIK, it can tell us if the procedure was for hyperopia or myopia.

The central cornea steepening seen in the axial/sagittal map of this patient is consistent with a history of hyperopic LASIK, which flattens the midperiphery.

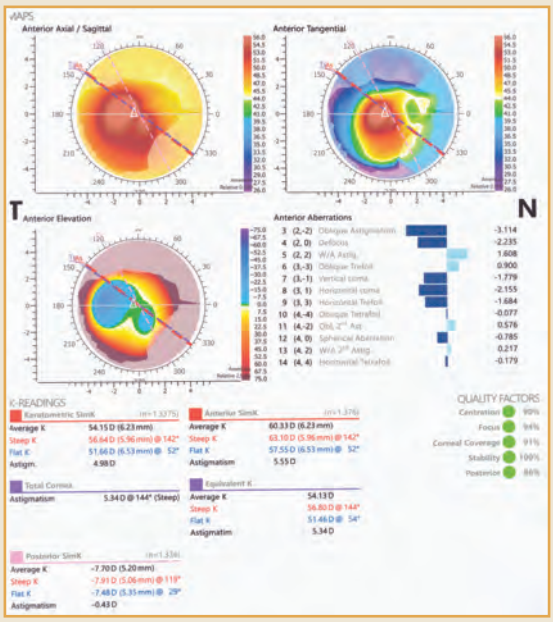

Figure 2. Topography images from an eye with a history of hyperopic LASIK (laser-assisted in situ keratomileusis) show a decentered ablation

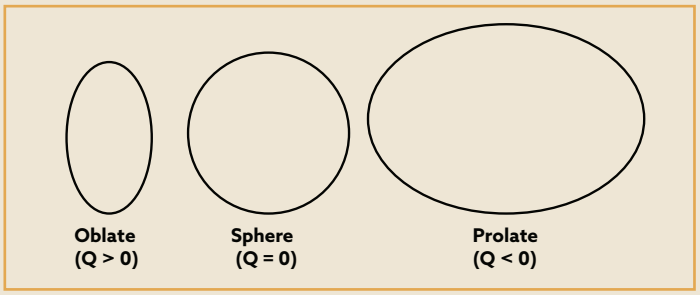

Figure 3. Corneal asphericity is measured as a Q value and is defined as the steepness or curvature of the central cornea relative to the peripheral cornea. A spherical cornea has the same steepness in the center as in the periphery and a Q value of 0. An oblate cornea has a flatter center than periphery and a positive Q value (ie, status postmyopic LASIK [laser-assisted in situ keratomileusis]). A prolate cornea has a steeper center than periphery and a negative Q value (ie, status posthyperopic LASIK or keratoconus).

Dr Desai: Preoperative topography in any patient is useful to screen for ocular surface disease (OSD), such as dry eye disease (DED) or epithelial basement membrane dystrophy (EBMD).

Dr Donnenfeld: Topography is also important in a post-LASIK eye for determining if the ablation was decentered, which has implications for intraocular lens (IOL) selection **(Figure 2)**.

The topography report for the patient in this case shows a well-centered ablation **(Figure 1),** but the front surface Q-value (corneal asphericity) of -2.2 is noteworthy because it is indicative of a very prolate cornea **(Figure 3)**. The average virgin cornea is prolate, with a positive spherical aberration (SA) of +0.27 µm.[1] By inducing central steepening, hyperopic LASIK makes the cornea more prolate and induces negative SA.[2]

The amount of SA is a consideration for choosing the IOL. Aspheric IOLs with negative SA were developed to offset the positive SA of the average cornea. Taking into account the surgically induced shift in SA, you would not want to use a negative SA lens in a posthyperopic LASIK eye.

A conventional spherical IOL that adds positive SA to the eye might be reasonable, but I prefer an IOL with zero SA because it is a do-no-harm lens in any situation involving decentration. We have to consider that the average corneal refractive procedure is associated with 0.2 to 0.3 mm of decentration, which is not insignificant.[3] If the ablation is decentered, a negative SA or positive SA IOL that is centered will induce high levels of coma, and the patient will experience disabling nighttime glare. A zero SA IOL will not induce higher-order aberrations—specifically coma and astigmatism—in the setting of an irregular cornea associated with a decentered ablation or keratoconus, or if the IOL decenters.

Dr Jackson: I would also choose a zero SA IOL.

Dr Donnenfeld: Patients who have had hyperopic LASIK can have a near-vision benefit from their corneal SA that increases depth of focus.[4] In my experience, they seem to have approximately 1 to 1.5 D of pseudoaccommodation and can usually see well without glasses up to an arm's length distance and sometimes even closer.

Let us talk more about astigmatic correction. According to available data, approximately three-fourths of patients presenting for cataract surgery have at least 0.5 D of cylinder, and approximately one-third have between 0.5 and 1 D of cylinder.[5] In the past, I would have done limbal relaxing incisions to correct low astigmatism. Toric IOLs, however, provide more predictable astigmatic correction.[6] With the enVista toric IOL, I can now correct as little as 0.8 to 0.9 D of astigmatism. At what level of astigmatism do you consider a toric IOL?

Dr Jackson: Most toric IOLs in the United States correct a minimum of 0.77 D of cylinder at the corneal plane. I will use a toric IOL for as little as 0.75 D cylinder if it is against-the-rule astigmatism because it will not create a problem if the axis is flipped slightly.

Dr Donnenfeld: Are there any conditions that would prevent you from using a toric IOL for astigmatism correction?

Dr Gupta: Assuming the astigmatism is regular, a toric IOL can be used in the setting of many ocular comorbidities that might exclude patients from using a multifocal IOL, such as glaucoma, macular degeneration, or an epiretinal membrane. If a patient is using gas permeable contact lenses, it is important to discontinue lens wear and let the cornea recover from lens-induced warpage before getting biometry measurements. A toric IOL should not be used, however, when the rigid gas permeable lens is being worn to correct astigmatism related to keratoconus and the patient is expected to return to contact lens wear because the astigmatism of the IOL will become manifest after cataract surgery.[7] I would not use a toric IOL in anyone with very irregular astigmatism.

Dr Desai: I would be concerned if I thought the patient might need glaucoma surgery in the future because some glaucoma procedures induce astigmatism.[8]

Intraocular Lens Power Calculation

Dr Donnenfeld: Getting good refractive results with a toric IOL always depends on careful preoperative planning. Measurements should be obtained with multiple instruments, and they should show good agreement in astigmatism magnitude and axis. What do you do if the numbers do not match?

Dr Desai: It depends on the situation. Certainly, I would consider if OSD is the cause. If that is not an issue, I typically use the topography data.

Dr Gupta: I like to use the keratometry values from the biometer to plan toric IOL cases, but it is a red flag for me if the axis measurements from different instruments are not within 10° and if the magnitude values are not within 0.15 to 0.25 D. In that situation, I would reevaluate the cornea to ensure there were no confounding conditions, such as dry eye. Additionally, I would perform repeat testing to establish consistency.

Dr Jackson: Ocular surface disease affects the accuracy of keratometry readings.[9] In my experience, OSD is usually the cause when the numbers do not match, and I do not proceed with surgery until I treat the ocular surface. I find that the easiest way to identify OSD is by looking at the topography mires. I show patients their image alongside a normal topography image to illustrate that they have a problem, so that they understand the need to delay surgery.

Dr Donnenfeld: Intraocular lens power calculation also presents a challenge in eyes that have had corneal refractive surgery. What are the issues affecting accuracy of this calculation?

Dr Gupta: Refractive surgery changes the anterior corneal surface keratometry dramatically over small regions, but some of the instruments that are used to acquire keratometry data measure only in the central 1- to 3-mm zone of the cornea.[10] In addition, the ratio between the anterior and posterior corneal surfaces is altered. Fortunately, by using modern biometry tools and advanced formulas, we can narrow the margin of error in the power calculation.

Dr Donnenfeld: What IOL formula do you use in post-LASIK eyes?

Dr Gupta: I usually enter the patient's data into the online ASCRS (American Society of Cataract and Refractive Surgery) calculator (iolcalc.ascrs.org). The software for the IOLMaster 700 also runs calculations for a post-LASIK eye, and I usually look at the result using the Barrett True-K or Haigis-L formula. Some surgeons wonder if they need to know the patient's refraction prior to LASIK. Some formulas use the historical data, but, in my experience, outcomes are better using the formulas that do not.

Dr Desai: Before the Barrett True-K formula was available, I liked using the Haigis-L for IOL power calculations in a post-LASIK eye, and then I used intraoperative aberrometry for confirmation. Because my results with the Barrett True-K are so good, I no longer do intraoperative aberrometry in post-LASIK cases.

Dr Jackson: When using the Haigis-L or Barrett True-K formula, you need to know if the patient had LASIK for myopia or for hyperopia. If it is not obvious from the topography images, you can determine it by asking the patient if he/she was nearsighted or farsighted prior to LASIK or photorefractive keratectomy. Pentacam topography measures an axial/sagittal (back to front or B/F) ratio as a percentage. The ratio measures the relative flattening or steepening of the anterior corneal surface to the posterior corneal fixed surface. A normal ratio is 80% to 83%; patients with a history of myopic LASIK have < 80%, and those with a history of hyperopic LASIK have > 83%. This is helpful in determining whether patients had prior myopic or hyperopic LASIK or photorefractive keratectomy.

Dr Donnenfeld: The percentage of patients who achieve 20/20 uncorrected visual acuity (UCVA) increases 15% using the Hill-RBF (Radial Basis Function) or Barrett True-K instead of the SRK/T. Anecdotally, the accuracy of my refractive outcomes in toric IOL cases has also improved using the actual posterior cornea keratometry value measured with the IOLMaster 700 rather than a population average. In the future, other biometers will also provide posterior cornea data. The Holladay 2 and Haigis are still good formulas and have a role. I, too, have stopped using intraoperative aberrometry in most post-LASIK cases because the results are so good using the newer IOL formulas.

Surgical Technology

Dr Donnenfeld: I still find intraoperative aberrometry helpful in some situations. For example, I used it to guide realignment of a rotated toric IOL in a patient whom I saw on referral. The patient had 3.5 D of cylinder preoperatively and 3.25 D after surgery. For every degree of misalignment, there is an approximately 3.3% reduction in a toric IOL's effectiveness for reducing astigmatism.[11] Because the astigmatism in this case was essentially unchanged, I knew the toric IOL had rotated approximately 30°. As an alternative to intraoperative aberrometry, surgeons can also use https://www.astigmatismfix.com to plan realignment.

Dr Jackson: If using intraoperative aberrometry for toric IOL alignment, it is important to enter the anterior corneal keratometry readings into the aberrometer, not the total K that incorporates the posterior cornea measurement. I typically enter the anterior keratometry reading from the IOLMaster 700.

Dr Donnenfeld: There are some other steps surgeons need to follow to get reliable results using intraoperative aberrometry. These include filling the anterior chamber to pressurize the eye, making sure the speculum is not too tight to avoid inducing cylinder, and avoiding any corneal edema.

I like to use the femtosecond laser. Available evidence does not show that femtosecond laser-assisted cataract surgery (FLACS) has a definitive benefit for improving final visual outcome, reducing surgically induced astigmatism, or reducing the risk of capsular tears.[12–14] Compared with a conventional approach, however, it reduces the amount of ultrasound energy put into the eye, which can reduce corneal endothelial cell loss.[12–14] In addition, FLACS improves the consistency of capsulotomy, which can have implications for reducing IOL tilt or decentration,[13,15] and it can provide precise markings for toric IOL alignment.[16]

Case Conclusion

The patient underwent FLACS with implantation of a monofocal zero SA toric IOL. At 1 month postoperatively, UCVA was 20/20.

CASE 2: CATARACT SURGERY IN A PATIENT WITH GLAUCOMA AND DRY EYE DISEASE

From the Files of Preeya K. Gupta, MD

A 65-year-old man presented with complaints of glare and blurry vision. He had glaucoma that had been medically managed for many years with timolol; he reported using artificial tears.

Examination showed 2+ meibomian gland dysfunction, 1-2+ punctate epithelial erosions, tear breakup time of 5 seconds OU, and tear osmolarity of 328 mOsm/L OD and 310 mOsm/L OS. Topography map showed a crab claw pattern with inferior steepening **(Figure 4)**.

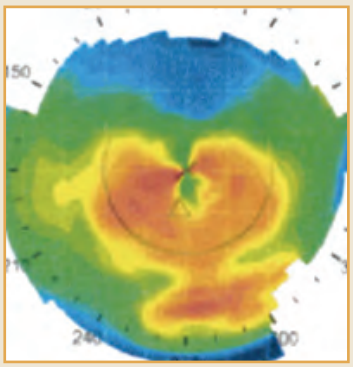

Figure 4. Topography map of the patient presented in Case 2 showing a crab claw pattern with inferior steepening

Screening for Ocular Surface Disease

Dr Gupta: The crab claw pattern on topography is typical of pellucid marginal degeneration, but it can also be seen with keratoconus.[17] Is there anything else you would include in a differential diagnosis?

Dr Jackson: Salzmann nodular degeneration and DED are also possibilities. To make the diagnosis, you have to consider the topography images in relation to the findings from the clinical examination.

Dr Desai: Retroillumination using the retinoscope or slit-lamp beam can help with the diagnosis. If you direct the light straight in, scissoring on retinoscopy when you look at the retroillumination reflex suggests keratectasia. If there are nodules or islands, then EBMD or Salzmann nodular degeneration is likely.

Dr Gupta: The corneal staining indicates the patient in Case 2 has DED, but if the topography images do not change after the DED is treated, I would consider pellucid marginal degeneration or keratoconus. Salzmann nodular degeneration is usually associated with an area of flattening rather than steepening, and there will be raised gelatinous-like nodules on slit-lamp examination.[18] Anterior basement membrane disease is another consideration.

This patient is at risk for DED because of his chronic use of topical timolol. I believe that some clinicians do not appreciate the high prevalence of DED in patients being medically treated for glaucoma. One study reported that up to 59% of patients using glaucoma drops had OSD, and found a 2-fold increase in the likelihood of developing OSD with each additional medication containing benzalkonium chloride (BAK).[19]

When getting a medication history, it is important to ask patients specifically about their use of artificial tears. A history of artificial tear use tells me that dry eye symptomatology is significant because the patient is motivated to do something about it, and the patient may be using a product with a preservative that is exacerbating the ocular surface damage.

The patient reported blurry vision. Although this is a sign of cataract, I would ask the patient if the blurriness is fluctuating, constant, or noticeable during a certain activity. If the patient says the vision is blurred only when reading, it is a sign of DED.

Ocular surface disease, including DED and other ocular surface conditions, can affect the refractive outcome and quality of vision after a refractive procedure. Therefore, the ASCRS Corneal Clinical Committee developed an algorithm to screen for OSD before refractive surgery.[20] I was a member of the Committee, and I think the approach we proposed is relatively simple. We developed a questionnaire that assesses symptoms and incorporates items on lifestyle and postsurgical visual goals. Tear osmolarity and matrix metalloproteinase-9 tests are recommended to look for signs of OSD.

For the clinical examination, we developed the mnemonic LLPP that highlights the need to[20]:

- **L**ook at blinks, lids, lashes, and the interpalpebral surface
- **L**ift the superior eyelid and examine for signs of OSD
- **P**ull to identify lid laxity and to see into the fornices
- **P**ush the meibomian glands to assess meibum quality and flow

Then, vital dye is used to check for ocular surface staining.[20] For corneal staining, I like to use a fluorescein strip instead of drops because pathology can be missed if the drops have flooded the ocular surface.

Dr Desai: I also like to use the fluorescein strip for 2 other reasons. It is a great way to test for corneal anesthesia. This is important because patients with longstanding DED may have developed a neurotrophic cornea and therefore be asymptomatic. In addition, the fluorescein strip helps uncover conjunctivochalasis, which can be a mechanical cause of DED. To identify conjunctivochalasis, I look for what I call the "Morse code" meniscus, which is an interrupted tear meniscus lining the inferior margin.

Dr Jackson: Fluorescein staining also helps identify EBMD that is recognized by the appearance of negative staining. EBMD is a relatively common finding that is often overlooked.[21]

Managing Dry Eye Disease

Dr Gupta: The uncontrolled OSD in this patient was determined to be due to topical medication toxicity, and the ocular surface had to be optimized before proceeding with surgical planning. It is important that patients such as this one truly understand that they have 2 disease processes so that they do not later think the surgery caused their OSD. It can be very frustrating for surgeons when a patient has 20/25 UCVA after surgery but is miserable because of dry eye and consequently has a negative attitude toward the surgeon.

For rapid rehabilitation of the ocular surface, I prescribe a short course of a topical corticosteroid to treat the inflammation. I like to use loteprednol etabonate because it is effective and less likely to increase IOP compared with some other topical steroids.[22,23] I typically reassess patients after 2 weeks to determine if they are ready for surgery, but the treatment may need to be continued longer if a patient has more significant OSD. I also start topical anti-inflammatory/immunomodulatory treatment with either lifitegrast or cyclosporine if I think the patient is at risk for having problems with DED postoperatively.

Dr Donnenfeld: We published an article in 2014 showing that loteprednol etabonate, 0.5%, used 4 times a day rehabilitated the ocular surface after just 2 weeks.[24] Topical fluorometholone has also been shown to provide rapid improvement and, similar to loteprednol, has lower potential to increase IOP than some other corticosteroids.[25,26]

Case Continued

The patient was started on loteprednol etabonate, 0.38%, gel 4 times a day for 1 week, then twice daily for 1 week. When the patient returned, he no longer had corneal staining, and his topography image had regularized **(Figure 5)**.

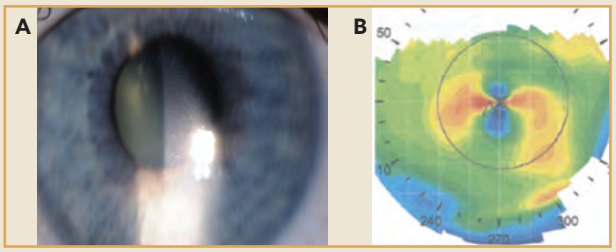

Figure 5. Slit-lamp photograph (A) and topography image (B) show improvement of ocular surface after treatment of ocular surface disease

Managing Postoperative Pain and Inflammation

Dr Gupta: I also like to use loteprednol for my corticosteroid postoperatively because of its safety. We have 2 newer advanced topical formulations containing loteprednol that were approved for the treatment of pain and inflammation after cataract surgery: loteprednol etabonate gel, 0.38%, and loteprednol etabonate suspension, 1%.[27,28]

The gel formulation uses submicronized particles to improve bioavailability, which enables efficacy with its lower concentration of active ingredient and 3 times daily dosing.[29] The suspension product incorporates proprietary mucus-penetrating technology to improve drug delivery to target tissues and is recommended for twice-daily administration.[30] Results from clinical trials showed both formulations had minimal risk of causing IOP elevation.[29,30]

Dr Donnenfeld: A study sponsored by the European Society of Cataract & Refractive Surgeons that analyzed rates of postoperative clinically significant macular edema showed that a nonsteroidal anti-inflammatory drug is more important than a steroid for controlling inflammation after cataract surgery, but that the combination of the 2 is optimal.[31]

Managing Comorbid Glaucoma

Dr Gupta: What would you do when a patient needing cataract surgery has OSD and mild to moderate glaucoma that is stable and controlled on medication? Would you do minimally invasive glaucoma surgery (MIGS)?

Dr Desai: If a patient is on only 1 glaucoma medication, I think there is a good chance the medication could be eliminated after MIGS. Cataract surgery alone could also be a reasonable option because it can reduce IOP.[32]

Dr Donnenfeld: For patients who need cataract surgery, combining the procedure with MIGS may be the best approach to resolving the OSD because it can reduce the medication burden without any real downside.

Dr Gupta: If the patient had cataract surgery without a glaucoma procedure and still needed to use medication to control IOP, then selective laser trabeculoplasty could be done to try to eliminate medication use. Otherwise, I would try to switch the patient to a medication that is preservative free or that does not contain BAK as its preservative. The patient's prescription insurance plan may, however, determine access to that type of medication.

CASE 3: ALIGNING AND REALIGNING TORIC INTRAOCULAR LENSES

Presented by Mitchell A. Jackson, MD
(From the Files of Denise Visco, MD, MBA)

A 69-year-old man underwent cataract surgery with implantation of a toric IOL and a target of plano spherical equivalent. Preoperative manifest refraction was -3.25 +4.50 × 050 20/80.

The patient did not adhere to instructions to avoid eye rubbing after surgery. At the postoperative day 1 visit, he had 2 D of residual astigmatism, and the IOL had rotated 10° off axis **(Figure 6)**.

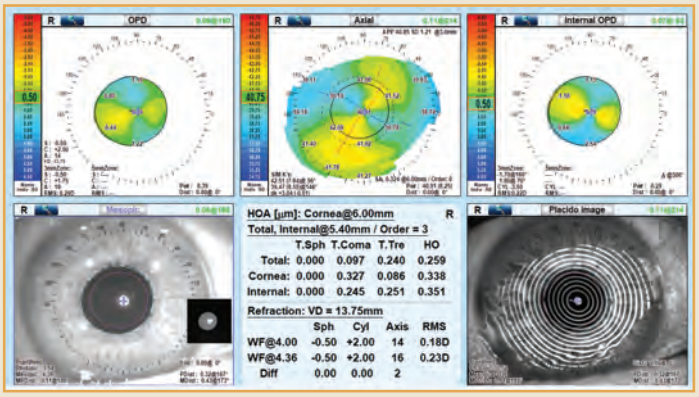

Figure 6. Imaging (OPD-Scan III Wavefront Aberrometer) of the patient presented in Case 3 on day 1 after toric intraocular lens surgery shows the implant was misaligned by at least 10° and the patient had 2 D of residual cylinder. The steep corneal axis of astigmatism (top, middle panel) is at 56°. The intraocular lens toric axis (top, right panel) should be exactly 90° opposite at 146°, but it is at 160°—a 14° difference. (The patient's postoperative refraction result suggests a 10° rotation.)

The patient was taken back to the operating room. A capsular tension ring (CTR) was placed, and the IOL was repositioned. Final manifest refraction was plano +0.25 × 155, BCVA was 20/20, and UCVA was 20/25 +2.

Toric Intraocular Lens Alignment

Dr Jackson: Precise alignment is critical to achieve good outcomes with toric IOLs, considering that every 1° of misalignment translates into a 3.3% loss of astigmatic correction.[11] I believe that concern about both the ability to achieve accurate positioning and the possibility of having to go back to the operating room to adjust a misaligned or rotated lens may explain, in part, why toric IOLs are not being used more often to treat astigmatism in patients undergoing cataract surgery. According to data from Warren Hill, MD, 1,386,254.5 D of astigmatism was left uncorrected in 2018.

An ongoing evolution of techniques is addressing the challenge of precise toric IOL alignment. We now have some very good devices for marking at the slit lamp. There are also advanced tools for marking intraoperatively, eliminating cyclorotation error; among them, the Robomarker creates marks that are visible under the femtosecond laser. Another intraoperative technique that I described several years ago uses the vertical

rectus muscle as a landmark, although it cannot be used in anyone with prior strabismus surgery.

In addition, there are intraoperative digital guidance systems (Callisto eye and Verion) that use readings from preoperative diagnostics. This approach is subject to parallax errors, adds time to the surgery, and may require use of a specific preoperative diagnostic device.

There are several ways to try to achieve a precise alignment. I perform a lot of FLACS procedures and have the LENSAR laser available in my practice. It is my current preference to mark the capsulotomy rim at the steep axis **(Figure 7)**. Some surgeons will also place marks preoperatively or intraoperatively for additional confirmation.

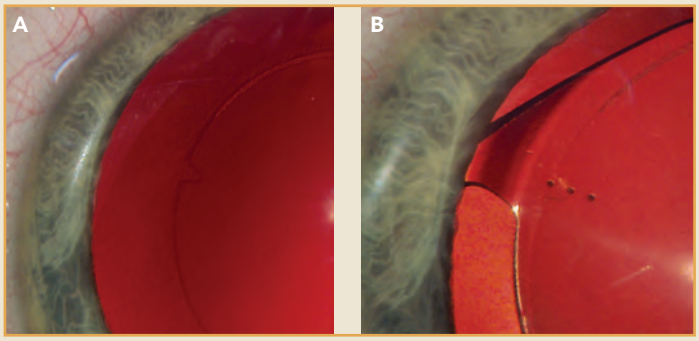

Figure 7. Anterior capsular nubs without an intraocular lens in place (A) and with a toric intraocular lens in place (B). Arrow indicates the capsular marks.

The laser placement is guided by iris registration and can be done using images obtained with any of the 4 different diagnostic devices. The iris registration compensates for cyclorotation; because the markings are on the capsule and not in or on the cornea, the technique eliminates parallax errors. Regarding safety, results from a laboratory study showed that the laser marks do not compromise capsulotomy rim strength or extensibility.[33] In addition, the marks are permanent and can therefore be used to guide lens rotation if a realignment procedure is needed. Even though they may not accurately identify the steep axis once there is capsular bag phimosis and contraction, this has minor clinical relevance because most toric IOL rotation occurs within the first hour after surgery.[34]

Toric Intraocular Lens Stability and Realignment

Dr Jackson: Modern toric IOLs have excellent rotational stability, but a retrospective review of more than 8000 cases on https://www.astigmatismfix.com found that the percentage of cases misaligned by ≥ 5° was significantly less with both the Trulign and Staar toric IOLs (0.29% and 0.28%, respectively) compared with the AcrySof and TECNIS toric IOLs (0.75% and 1.86%, respectively).[35] It could not be determined if the misalignments were orientation errors or due to postoperative rotation. Amid other factors, differences in lens haptic design may explain postoperative rotation differences among lenses. The Trulign IOL has a 4-point haptic fixation that is thought to enhance stability by providing increased haptic-to-haptic compression. The Staar IOL has a plate haptic design with two 1.5-mm fenestration holes to encourage capsular fibrosis and long-term rotational stability.

Dr Gupta: Do you find rotation occurs more often in patients who are high myopes, perhaps because the capsular bag is bigger?

Dr Jackson: I am not aware of any data showing that relationship. At the time of the primary surgery, however, I typically put a CTR in any eye that has an axial length > 27 mm regardless of the toric IOL type because I expect there is a higher risk of IOL rotation. Although studies investigating the benefit of a CTR placed primarily to prevent rotation have reported conflicting data,[36,37] it is plausible, considering that a number of factors that would cause predisposition to lens instability are more likely in longer eyes.[34,35,38] I also routinely place a CTR when doing a realignment, although I am not aware of any data showing that it reduces the risk of rerotation.

Dr Donnenfeld: There is also a higher risk of rotation in eyes that have with-the-rule astigmatism than in those that have against-the-rule astigmatism.[37]

Dr Gupta: How the eye is left at the end of the procedure matters as well. If the anterior chamber is overinflated and the incision is not well sealed, eye rubbing can cause chamber shallowing that can lead to IOL rotation. Patients must be told not to rub the eye in the first few hours after surgery.

Dr Jackson: That is a great point. Anticipating that patients may rub the eye, I tend to leave the eye on the softer side when I seal the incision.

Dr Desai: Rotating the lens a couple of times to make sure that the haptics are well seated in the equator of the bag is important. Acrylic can be particularly tacky and adhere to the posterior capsule so that surgeons may mistakenly think that an acrylic lens is centered, but it can release later and rotate.

CASE 4: CATARACT SURGERY FOR A COMPLEX CASE

From the Files of Neel R. Desai, MD

A 62-year-old former boxer presented with monocular diplopia OS. His BCVA was 20/400, and he had a subluxed crystalline lens with significant phacodonesis and > 180° of zonular dehiscence **(Figure 8)**.

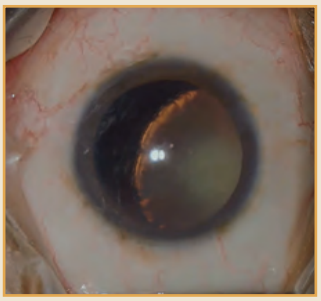

Figure 8. Slit-lamp photograph of the patient presented in Case 4 shows subluxed lens with decentered bag/lens complex

The patient was a poor historian, but reported having a vitrectomy more than 30 years ago for vitreous hemorrhage. A B-scan showed an attached retina but mobile vitreous.

The patient was taken to surgery with a plan to stabilize the capsular bag/lens complex with a CTR or capsular support hooks and to remove his cataract. It was impossible to penetrate the capsule to initiate capsulotomy, and the bag/lens complex was too decentered to consider using a femtosecond laser.

Strategies for Cataract Removal and Intraocular Lens Fixation

Dr Desai: What would you do in this case?

Dr Donnenfeld: I would bring in a retina specialist to do a pars plana vitrectomy, remove the lens through a small incision (< 2.5 mm), and then use either the Yamane flanged intrascleral IOL fixation or a transscleral glued IOL technique.[39,40] Alternatively, the retina specialist can bring the lens up into the anterior chamber for removal by phacoemulsification with an IOL scaffold technique.

Dr Gupta: In my experience, retina specialists do not like to do a scaffold technique if the lens is brunescent, but I think it could be done safely in this case because the lens is dense but not rock hard.

Dr Desai: I like the Yamane technique, but I have seen cases with lens tilt if the sclerostomy tunnels are not exactly the same length or on the same axis. I prefer 4-point fixation with an expanded polytetrafluoroethylene suture.[41] In addition, I like to use a zero SA IOL in these cases because it will have better tolerance to decentration.

Case Continued

Surgery was performed as follows **(for a video of the surgical procedure, visit https://tinyurl.com/BMICSvideo)**. After taking down the conjunctiva, marks for the sclerotomy sites were placed 3 mm posterior to the limbus, exactly 180° off axis and 4.5 mm apart. An anterior chamber maintainer was placed. The subluxed lens was brought anteriorly using posterior-assisted levitation and removed with biaxial microincision cataract surgery (B-MICS). Biaxial vitrectomy was performed through the B-MICS incisions, taking advantage of the fluidics to remove the remaining lens fragments and to perform a better core vitrectomy.

To secure the lens, the sutures were threaded through the eyelets of the lens, passed into the anterior chamber and out through the corresponding sclerotomy using a handshake technique. The IOL was centered by balancing tension on the sutures. After tying and cutting the sutures, the knots were buried in opposite directions to prevent lens rotation. The conjunctival peritomies were sealed with fibrin glue, and acetylcholine chloride was instilled to constrict the pupil. The patient was seen by the retina specialist to rule out a retinal tear and had an excellent outcome.

Biaxial Microincision Surgery

Dr Desai: The B-MICS approach separates irrigation from aspiration and is done through paired 1.2- to 1.6-mm incisions using a sleeveless phacoemulsification/aspiration handpiece and irrigating chopper. I make 1.2- × 1.4-mm trapezoidal incisions that readily self-seal and use 19G instruments. I especially like the Nagahara chopper, which has a blunt tip but a sharp shaft that allows horizontal chopping when necessary.

The B-MICS procedure also requires a phacoemulsification platform that incorporates advanced software to deliver bursts or hyperpulses of cavitation energy with longitudinal phacoemulsification. There are several advantages for using B-MICS that make it a good choice in certain complex cases.[42,43] The paired incisions give 360° of freedom and also flexibility for working around or posteriorly to any astigmatic incisions. The biaxial approach also makes subincisional maneuvers and cortical removal more ergonomic. Relative to surgery done through incisions that are 2.2 mm or larger, B-MICS results in less surgically induced astigmatism and allows for better retention of the ophthalmic viscoelastic device, resulting in better control during capsulorhexis and hydrodissection/delineation.

Separation of irrigation from aspiration with B-MICS allows fluidics control and stability **(Figure 9)**. These features make it particularly desirable in cases involving small pupils—including eyes at risk for intraoperative floppy iris syndrome or those undergoing FLACS—and translate into less turbulence and excellent followability of nuclear fragments. By enabling efficiency for nucleus disassembly and removal, B-MICS reduces phacoemulsification time and therefore results in clearer corneas.[42,43] In addition, conversion to biaxial vitrectomy is easy if vitrectomy is needed.

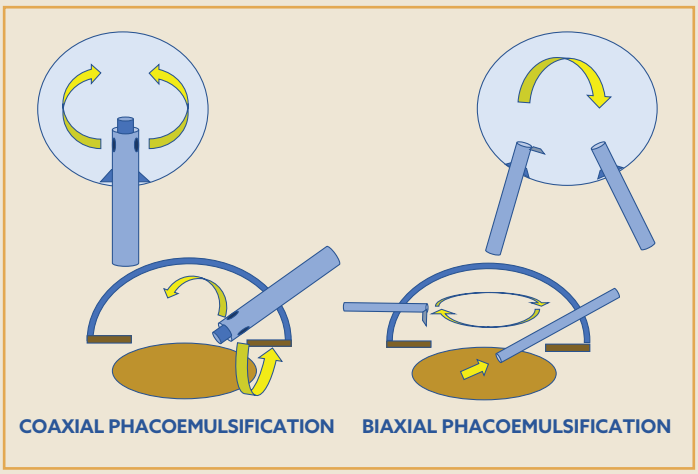

Figure 9. Dynamics of phacoemulsification, irrigation, and aspiration favor greater efficiency and anterior chamber stability during biaxial microincision surgery vs coaxial surgery

Image courtesy of Neel R. Desai, MD

Biaxial surgery has some disadvantages.[42-44] There is a learning curve for the procedure, but I believe that it is shorter than perceived by some surgeons.[42,44] There is also potential for incision burn using a sleeveless phacoemulsification handpiece, but the risk has been minimized because of software advances that modulate energy and careful attention to avoiding occlusion of the phacoemulsification needle or tubing with nuclear material or an ophthalmic viscosurgical device.[43,44] Depending on the IOL used, the B-MICS incision may need to be enlarged for implantation. The Akreos MI60 IOL can easily fit through a 1.8-mm incision, and some surgeons report implantation through smaller incisions using a wound-assisted technique.[45]

Endophthalmitis Prevention

Dr Desai: Endophthalmitis is another pertinent issue in this case because the risk for postoperative infection is increased in the setting of complex, prolonged surgery. Specific risk factors for endophthalmitis after cataract surgery include posterior capsular rupture or other intraoperative complications, clear corneal incisions, surgery without an intracameral cephalosporin, male sex, advanced age, and intracapsular or extracapsular technique.[46]

Use of povidone-iodine for preoperative antisepsis and intracameral cefuroxime are the only 2 strategies for endophthalmitis prophylaxis supported by high-level evidence.[47,48] Topical antibiotics are widely used according to data from retrospective studies and surrogate evidence.[49]

Findings from the ARMOR (Antibiotic Resistance Monitoring in Ocular Microorganisms) surveillance study can inform selection of a topical antibiotic. Data from ARMOR showed that among 182 presumed endophthalmitis isolates, coagulase-negative *Staphylococcus* was the most common pathogen, followed by *Staphylococcus aureus*.[50] Approximately one-half of the coagulase-negative staphylococcal isolates and one-third of the *S aureus* isolates were resistant to methicillin. Among commercially available ophthalmic antibiotics, besifloxacin had the best in vitro activity against these organisms **(Table)**.[50]

Table. ARMOR Surveillance MIC_{90} Values for Presumed Endophthalmitis Isolates[50]

Antibiotic	MIC_{90}, µg/mL			
	MSSA	MRSA	MSCoNS	MRCoNS
Vancomycin	1	1	2	2
Besifloxacin	0.03	2	1	4
Gatifloxacin	0.12	32	16	64
Moxifloxacin	0.06	32	16	64
Ciprofloxacin	0.50	256	64	64
Tobramycin	0.50	> 256	8	4
Azithromycin	512	> 512	> 512	> 512

Abbreviations: ARMOR, Antibiotic Resistance Monitoring in Ocular Microorganisms; MIC_{90}, minimum inhibitory concentration that inhibits the growth of 90% of indicated isolates; MRCoNS, methicillin-resistant coagulase-negative staphylococci; MRSA, methicillin-resistant *Staphyloccocus aureus*; MSCoNS, methicillin-susceptible coagulase-negative staphylococci; MSSA, methicillin-susceptible *Staphylococcus aureus*.

TAKE-HOME POINTS

Intraocular Lens Considerations

A zero SA IOL is preferred in patients with irregular corneas who have a history of hyperopic LASIK.

Advances in biometry devices and IOL formulas are contributing to better refractive outcomes after cataract surgery in eyes with a history of corneal refractive surgery.

Toric IOLs have excellent rotational stability, provide reliably effective correction of astigmatism, and can be used to correct low amounts of astigmatism in eyes with comorbidities that would rule out multifocal IOL implantation.

An evolution in alignment techniques for toric IOLs has enabled accurate positioning.

- Femtosecond laser-assisted capsular marks in FLACS procedures offer an efficient and parallax-error free method for identifying the steep axis

Ocular Surface Disease

Screening for OSD should be done in all cataract surgery patients. Visually significant OSD should be treated prior to surgical planning.

Glaucoma medications containing BAK contribute to OSD.

- Combining cataract surgery with a MIGS procedure might reduce medication need in patients with glaucoma and OSD

Surgical Techniques

Multiple techniques exist for safe removal of a subluxed lens and IOL fixation in the absence of capsular support.

FLACS reduces phacoemulsification time and endothelial cell loss.

B-MICS provides advantages that are related to its paired and smaller incisions and separation of aspiration and irrigation.

Infection and Inflammation

Complex cataract surgery cases are at increased risk for postoperative endophthalmitis.

Optimal endophthalmitis prophylaxis incorporates a multimodal approach.

Among commercially available topical antibiotics, besifloxacin has the most potent in vitro activity against the most common endophthalmitis pathogens.

Combination treatment with a topical nonsteroidal anti-inflammatory drug and a corticosteroid provides the best regimen to control inflammation after cataract surgery.

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1. Which type of IOL would be the most appropriate choice in an eye with a decentered LASIK ablation?
   a. Positive SA
   b. Negative SA
   c. Zero SA
   d. Any of the above

2. Which treatment would you use to rapidly rehabilitate the ocular surface in a patient with DED needing cataract surgery?
   a. Preservative-free artificial tears 6 times a day
   b. Punctal plugs
   c. Topical corticosteroid
   d. Topical cyclosporine

3. According to the ASCRS Corneal Clinical Committee algorithm, which 2 tests should be used to screen for signs of OSD before a patient has refractive surgery?
   a. Meibometry and matrix metalloproteinase-9
   b. Lipid layer analysis and tear breakup time
   c. Tear osmolarity and rose bengal staining
   d. Tear osmolarity and matrix metalloproteinase-9

4. According to results of the prospective, randomized European Society of Cataract & Refractive Surgeons–sponsored study, the best regimen for controlling inflammation after cataract surgery is:
   a. Topical nonsteroidal anti-inflammatory drug with a topical corticosteroid
   b. Topical nonsteroidal anti-inflammatory drug alone
   c. Intracameral dexamethasone
   d. Intracanalicular dexamethasone

5. A toric IOL will have no astigmatic-correcting effect if it is misaligned by ___.
   a. 10°
   b. 20°
   c. 30°
   d. 50°

6. Femtosecond laser-assisted marking of the steep axis on the capsular rim:
   a. Increases the risk of anterior capsular tears
   b. Eliminates parallax error but does not compensate for cyclorotation
   c. Eliminates parallax error and compensates for cyclorotation
   d. Can only be done using preoperative diagnostic images from a single manufacturer

7. Compared with cataract surgery performed using conventional manual techniques, cataract surgery using the femtosecond laser has been proven to:
   a. Improve surgical workflow
   b. Minimize intraoperative miosis risk
   c. Reduce ultrasound energy use
   d. Avoid IOP increase

8. A B-MICS procedure is associated with all the following, EXCEPT:
   a. Increased access to subincisional cortex
   b. Increased anterior chamber stability
   c. Increased efficiency of nucleus disassembly and removal
   d. Increased risk of endophthalmitis because the incision needs to be enlarged for IOL implantation

9. Which is the most common cause of endophthalmitis after cataract surgery?
   a. Coagulase-negative staphylococci
   b. *Staphylococcus aureus*
   c. *Pseudomonas aeruginosa*
   d. *Streptococcus pneumoniae*

10. According to data from the ARMOR surveillance study, which fluoroquinolone had the greatest in vitro activity against methicillin-resistant coagulase-negative staphylococci and methicillin-resistant *Staphylococcus aureus*?
    a. Besifloxacin
    b. Ciprofloxacin
    c. Gatifloxacin
    d. Moxifloxacin