



Improving Your **ODDS** for Excellent Cataract and Refractive Outcomes

Case Discussions From a Day in the Life of an Ophthalmic Surgeon

Proceedings From a CME Symposium During AAO 2015

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Faculty

Eric D. Donnenfeld, MD (Chair)

John A. Hovanesian, MD, FACS

Tal Raviv, MD, FACS

Robert J. Weinstock, MD

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Faculty

Eric D. Donnenfeld, MD (Chair)
Clinical Professor of Ophthalmology
New York University Langone Medical Center
New York, New York
Founding Partner
Ophthalmic Consultants of Long Island
Rockville Centre, New York

John A. Hovanesian, MD, FACS
Clinical Faculty
Jules Stein Eye Institute
University of California, Los Angeles
Los Angeles, California
Specialist in Refractive Surgery, Cataracts,
Cornea, and External Disease
Harvard Eye Associates
Laguna Hills, California

Tal Raviv, MD, FACS
Associate Clinical Professor of Ophthalmology
Icahn School of Medicine at Mount Sinai
Associate Adjunct Ophthalmologist
New York Eye and Ear Infirmary of Mount Sinai
Founder and Medical Director
Eye Center of New York
New York, New York

Robert J. Weinstock, MD
Associate Clinical Professor
Department of Ophthalmology
University of South Florida
Director of Cataract and Refractive Surgery
The Eye Institute of West Florida
Tampa Bay, Florida

CME Reviewer for New York Eye and Ear Infirmary of Mount Sinai

Joseph F. Panarelli, MD
Assistant Professor of Ophthalmology
Icahn School of Medicine of Mount Sinai
Associate Residency Program Director
New York Eye and Ear Infirmary of Mount Sinai
New York, New York

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Activity Description

Advances in diagnostic systems, surgical technologies, and pharmaceutical products are enabling cataract surgeons to deliver improved outcomes and meet the expectations of today's patient population. This monograph uses case histories as a framework for an expert panel discussion of the role of these developments for patient evaluation, surgical planning, surgical execution, and postoperative care. Topics explored include astigmatism management, ocular surface optimization, inflammation control, and prevention of postoperative endophthalmitis.

Target Audience

This educational activity is intended for ophthalmologists.

Learning Objectives

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

- Manage ocular surface conditions preoperatively in patients undergoing cataract surgery
- Select appropriate medication regimens for preventing inflammation and infection in patients undergoing cataract surgery
- Demonstrate optimal IOL selection
- Review the advantages and disadvantages of femtosecond cataract surgery technology

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Introduction

Advances in diagnostic systems, surgical technologies, and pharmaceutical products are enabling cataract surgeons to deliver improved outcomes and meet the expectations of today's patient population. Using a case-based format, members of an expert panel discuss these developments and offer practical pearls for their successful implementation.

CASE 1: ASTIGMATISM MANAGEMENT

A 64-year-old male presents with a visually significant cataract that is 2+ NS 2+ PSC on examination. His other findings are best corrected visual acuity (BCVA) 20/50 OD, 20/30 OS; refraction +1.00 +2.00 × 180 OD, +1.25 +1.75 × 180 OS; and keratometry 42/43.75 D at 180 OD, 42/43.50 D at 180 OS. The patient expresses a desire for good quality vision after surgery, with a reduced dependence on glasses, at least for distance.

Dr Donnenfeld: Dr Weinstock, what information would you include in your preoperative discussion with this patient?

Dr Weinstock: The patient needs to be told he has 2 problems affecting his vision, cataracts and astigmatism, and about the opportunities to treat both. Considering he has regular astigmatism, which is demonstrated by the symmetric bow-tie pattern on topography, and its magnitude, I think this patient is a great candidate for a toric intraocular lens (IOL).

Dr Raviv: In preoperative counseling, cataract surgeons should explain to patients that they have hyperopia or myopia that will be corrected by the IOL. In addition, patients need to be told if they have presbyopia or astigmatism, and then about the options for treating those conditions.

Dr Donnenfeld: Dr Hovanesian, would you offer limbal relaxing incisions (LRIs) to this patient?

Dr Hovanesian: I consider LRIs for correcting up to approximately 1 D of astigmatism, and then I favor a toric IOL for anything above that cutoff because the results are more predictably accurate in my hands with the implant. This patient is well suited to receive a monofocal toric IOL because he is prioritizing reduced spectacle dependence for distance vision. I think the toric-accommodating IOL is also a good option because it will give him an extended range of good uncorrected vision. I particularly like the

toric-accommodating IOL because it is rotated with equal ease either clockwise or counterclockwise, which makes alignment very easy. In addition, it has excellent rotational stability. In a multicenter study, rotation of a toric-accommodating IOL was $\leq 5^\circ$ in 96% of 123 eyes evaluated at 4 to 6 months after surgery.¹

Dr. Donnenfeld: Dr Raviv, what are your considerations for using LRIs vs a toric IOL?

Dr. Raviv: I generally use LRIs to correct astigmatism < 1.0 D and think about using a toric IOL for higher amounts, although the choice also depends on the axis. We know that because of the contribution of posterior corneal astigmatism, against-the-rule (ATR) astigmatism is typically higher than it seems on anterior keratometry, so I will favor a toric IOL when ATR astigmatism is as low as 0.8 D.

Compared with a toric IOL, the incisional approach is more effective for correcting low-level astigmatism in my hands. LRIs are also less expensive and easily integrated into either manual or femtosecond laser-assisted cataract surgery (FLACS). Although a toric IOL costs more upfront, I find it gives more predictable results than LRIs for correcting astigmatism ≥ 1.0 D. With our modern lenses that have good rotational stability, the long-term outcomes are good as well.

Dr. Donnenfeld: Another downside of LRIs is that they incise corneal nerves. For this reason, they may exacerbate dry eye, which is common in the cataract surgery patient population. The integrity of the corneal nerve plexus is maintained, however, with intrastromal relaxing incisions made with a femtosecond laser. Compared with surface incisions, intrastromal LRIs are also associated with better postoperative comfort and expected to have better stability, although there are yet no longer-term follow-up data in the peer-reviewed literature.²

Decreasing even low levels of astigmatism improves visual performance and reduces spectacle dependence.^{3,4} According to unpublished data from Warren Hill, approximately 50% of patients who present for cataract surgery have at least 0.75 D of astigmatism, and approximately 40% have more than 1.0 D. Considering almost 4 million cataract operations are done in the United States annually, my advice for anyone who wants to be a refractive cataract surgeon is that correction of astigmatism is the way to get started, not multifocal IOL implantation.

Toric IOLs have minimal downsides and fewer exclusions compared with multifocal IOLs. Because multifocal IOLs reduce contrast sensitivity, their use should be avoided in patients with an epiretinal membrane or macular degeneration, and patients with glaucoma should also be given special counseling on this point.⁵ In contrast, individuals with these conditions remain good candidates for a toric IOL.

A toric IOL, however, should not be used in someone with a highly irregular cornea or in a patient who has been wearing rigid gas-permeable (RGP) contact lenses to correct irregular astigmatism because with the cylinder inside the eye, the patient will no longer be able to wear the contact lens.

Patients with a mildly irregular cornea, such as an individual with forme fruste keratoconus whose topography shows a skewed asymmetric cylinder (Figure 1), may be acceptable candidates for a toric IOL. The main challenge surgeons face in this situation is in identifying the steep axis. This is one of the few times when I like to correlate the refractive and topographic axes. When the refractive and topographic axes are similar, I am comfortable with implanting a toric IOL. If there is a lot of discordance, a toric IOL is not a good idea.

Dr. Raviv: Patients wearing RGP lenses will have corneal warpage and need to discontinue lens wear until topography stabilizes. I will then offer a toric IOL to a patient with forme fruste keratoconus if the topography shows regular central astigmatism.

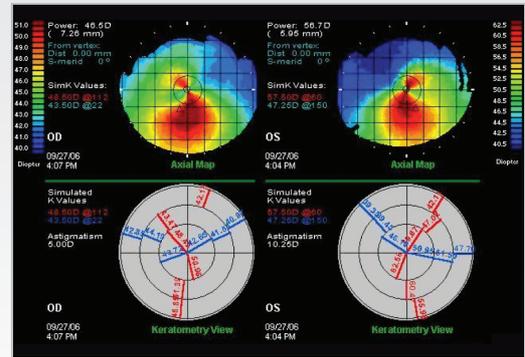


Figure 1. Topography showing a skewed radial axis consistent with keratoconus

Images courtesy of Eric D. Donnenfeld, MD

Dr. Hovanesian: If the astigmatism is regular 1 to 2 mm centrally, then you have a reasonable idea of what to correct. It is important, however, to consider that quality of vision may be suboptimal if there is irregular astigmatism in the overall corneal shape. A patient who has been wearing an RGP to correct irregular astigmatism will probably have a better quality of vision postoperatively with continued RGP use than with a toric IOL. Thorough counseling on the outcomes is necessary in these situations for patients to make an informed decision.

Dr. Donnenfeld: Unlike patients with mildly irregular corneas, those with significant keratoconus or pellucid marginal degeneration (PMD) are often poor candidates for a toric IOL. Keratoconus may be identified on topography by an asymmetric bow tie with a skewed radial axis, and the keratoconus indices will support the diagnosis. A “crab claw” or “lobster claw” pattern on topography that shows inferior steepening is diagnostic for PMD (Figure 2). The astigmatism, however, may appear to be regular if the inferior portion of the image is cut off.

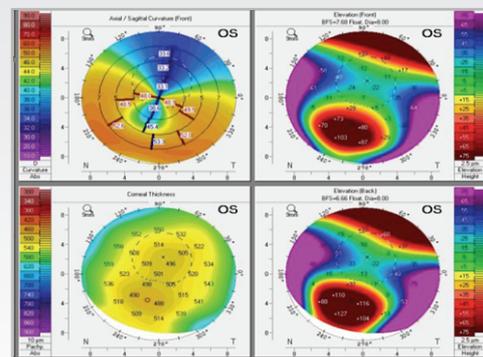


Figure 2. Pellucid marginal degeneration with a “crab claw” deformity

Images courtesy of Eric D. Donnenfeld, MD

I do preoperative topography in all patients with cataracts. Aside from having patients discontinue contact lens wear, what other issues should be considered for getting an accurate map?

Dr. Hovanesian: I have the technician make sure the pupil is centered on the topography map. If it is not, the patient was probably not fixating well, and the imaging should be repeated. An eye with regular astigmatism may show a crab claw pattern with inferior steepening on topography if the patient is in downgaze rather than fixating centrally.

Dr Weinstock: The topography should be done before placing any drops in the eye because they may affect the regularity of the tear film and therefore the cylinder measurement and quality of the test.

Dr Raviv: Speaking as a corneal specialist, I agree that it is important to get topography preoperatively in all refractive cataract surgery patients because occult conditions, such as forme fruste keratoconus, need to be identified. Furthermore, ocular surface disease, which is common in cataract surgery patients, can be characterized on topography and ideally must be treated first.

Dr Donnenfeld: In planning for toric IOL surgery, we identify the astigmatism, determine its magnitude and the steep axis, and then use a toric IOL calculator for power determination. All toric IOL manufacturers have online calculators, but I like to use Graham Barrett's tool (<http://www.ascrs.org/barrett-toric-calculator>).

Is there any particular instrument reading that you rely on most for the astigmatism measurements you use?

Dr Weinstock: I look at all of the data, and if one measurement is an outlier, I might repeat the test. I will not implant a toric IOL unless the measurements from at least 2 different biometry devices agree on the cylinder axis and magnitude. Preoperatively, I obtain measurements with an optical biometer, a manual keratometer, and 2 topographers: the dual Scheimpflug analyzer and a device combining LED (light-emitting diode) imaging with second Purkinje imaging technology. During surgery, I use intraoperative aberrometry and computer-guided 3-dimensional software for checking IOL power and guiding toric IOL alignment.

Dr Raviv: I also look for concordance on anterior keratometry among the K values from autorefraction, optical biometry, and topography. I have been relying on a new topographer that uses LED imaging combined with second Purkinje imaging technology because it measures total cornea astigmatism, which is the sum of anterior and posterior corneal astigmatism, rather than just anterior astigmatism. Intraoperative aberrometry is a critical tool for me as well.

Dr Hovanesian: I think the optical biometry instruments give more reliable readings for astigmatism magnitude than the topography sim K values. The sim K values can be very misleading because they are based on just 2 of 6000 points in the topography.

Dr Donnenfeld: I rely most on the optical biometry measurements, and I think both of the 2 commercially available devices give very accurate information. When in doubt about the axis, I take a straight ruler and put it through the topography to find the steep axis. I recommend against using sim K information from devices that derive topography through keratometric reconstruction.

For accuracy in toric IOL power calculations, it is also essential to account for surgically induced astigmatism (SIA). SIA can be significant, shifting the axis 15° to 20°, and we know that with 10° of misalignment, a toric IOL loses 33% of its cylinder-correcting effect.⁶

Dr Weinstock: I recommend surgeons use Warren Hill's online calculator to determine their SIA (http://www.doctor-hill.com/physicians/sia_calculator.htm). They will need to input astigmatism change data from at least 10 routine cases done without astigmatic correction. The change for each case is calculated using the anterior topography maps from baseline and 3 to 4 weeks after surgery.

Dr Donnenfeld: Dr Raviv already mentioned measurement of posterior corneal astigmatism. Work by Koch and colleagues has shown that failing to account for posterior corneal astigmatism can affect outcomes of toric IOL procedures.^{7,8}

In the future, we will have more technology for measuring posterior corneal astigmatism. For now, surgeons planning toric IOL surgery can try to account for posterior corneal astigmatism and an age-related shift in the

steep anterior corneal meridian by overcorrecting ATR astigmatism and undercorrecting with-the-rule (WTR) astigmatism.⁸ As a general rule, considering that the net effect of posterior corneal astigmatism is ATR in the vast majority of eyes and averages approximately 0.3 D, surgeons can aim to leave patients with 0.25 to 0.5 D WTR astigmatism.^{7,8}

Dr Raviv: The Barrett toric IOL calculator nicely estimates for posterior corneal astigmatism for those who do not have access to posterior corneal measurements.

Now that we recognize the contribution of posterior corneal astigmatism to total corneal astigmatism, I think it is also important to revisit the conventional advice to forget refractive astigmatism when planning astigmatic correction. For example, if I see someone whose glasses have 2.25 D cylinder ATR correction, but the topography shows a 0.8 D cylinder, I am going to suspect the patient has a higher than average ATR contribution from posterior corneal astigmatism. In such a case, I would plan to use a toric IOL with a higher cylinder power than what the topography shows, but I would bring a few toric IOLs with different powers into the operating room and check the aphakic refraction with intraoperative aberrometry.

Dr Hovanesian: Intraoperative aberrometry is useful in a case like that. Otherwise, you have to make a judgment call, and I think there is no pat answer for how much you can fudge the calculation.

Dr Donnenfeld: Toric IOLs should be aligned on the keratometric steep axis, which has historically been identified by marking the eye preoperatively with a gentian violet pen. Intraoperative image guidance systems currently available from several manufacturers allow for much greater precision in IOL alignment and better refractive outcomes.

CASE 2: OPTIMIZING THE OCULAR SURFACE

A retired, 67-year-old physician with a history of atopy presents for further management 6 months after cataract surgery with toric IOL implantation in his right eye. He was formerly a -10 D myope.

Findings on examination are corneal astigmatism 3.25 D at 12, uncorrected visual acuity 20/200 and 20/70 with pinhole, BCVA 20/30, and refraction -1.75 +3.50 × 5.

His topographic map and an image from the slit lamp after fluorescein dye instillation appear in Figure 3. Dilated examination shows no problem with toric IOL rotation.

Dr Donnenfeld: On the basis of assessment of the topography alone, the differential diagnosis for this patient could include dry eye, epithelial basement membrane dystrophy, or Salzmann's nodular corneal degeneration. A detailed slit-lamp examination is needed to understand the cause of the topographic pattern, and ocular surface staining indicates the presence of moderately severe dry eye. With worse dry eye, the

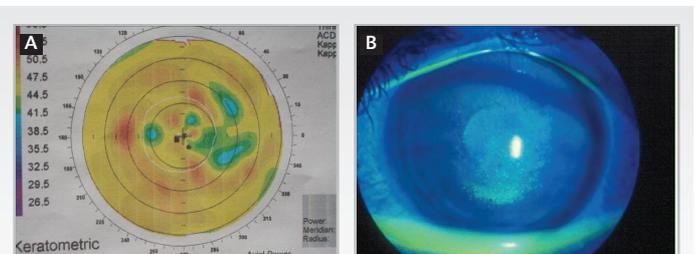


Figure 3. Irregular topography in a patient with dry eye disease (A). Fluorescein shows central corneal staining (B).

Images courtesy of Eric D. Donnenfeld, MD

topography map would also show white areas of dropout where information could not be captured.

Dry eye is common in the cataract surgery population. When present preoperatively, dry eye can affect the reliability of keratometry measurements used for IOL power calculations.⁹ Dry eye after surgery will limit optimal vision. Therefore, it is important to identify and manage dry eye prior to and after cataract surgery.

Keep in mind when evaluating patients for dry eye that ocular allergy is also common, should be controlled prior to cataract surgery, and may coexist with dry eye, but the 2 conditions share overlapping signs and symptoms. A point-of-care test is now available to help ophthalmologists diagnose ocular allergy.¹⁰

Dr Weinstock: This test is a noninvasive skin test. A technician can administer it in 2 minutes, and the results are available in 20 minutes. Each kit includes a regionally specific panel of 60 allergens. The test is usually covered by the patient's insurance.

On the basis of the results, ophthalmologists can establish the diagnosis of ocular allergy, and I find it is useful for determining the best treatment and counseling patients on specific strategies for allergen avoidance. I believe patients feel empowered by knowing what they are allergic to and are glad to have a more definitive understanding of their condition and symptoms.

Dr Donnenfeld: Knowing the etiology of the ocular allergy is very helpful for individualizing the treatment strategy. For example, if I am prescribing a once-daily dual-acting antihistamine/mast cell stabilizer for allergic conjunctivitis, I tell patients to use the medication at bedtime if they are allergic to dust mites and in the morning before they go outside if they have seasonal allergies. The skin test has a positive histamine control. If a patient does not respond to the histamine challenge, the test results are not valid and whatever allergy the patient has will not respond to an antihistamine.

Ophthalmologists should be aggressive about diagnosing dry eye as well. In our practice, we use a modified version of the Ocular Surface Disease Index that patients fill out at their first visit. A technician reviews the questionnaire, and if the responses raise suspicion of dry eye, the patient will have additional testing, including measurement of tear film osmolarity, assay of matrix metalloproteinase-9 (MMP-9), and meibomian gland imaging. Having this information available by the time I see the patient saves time and helps me make an accurate diagnosis and decide on appropriate treatment.

We also evaluate patients for Sjögren syndrome, when indicated, according to the history and clinical findings, such as a younger patient who has severe staining, highly elevated osmolarity, and a positive MMP-9 test. Now we are using a test that measures 3 novel biomarkers in addition to the 4 traditional ones because there is some evidence that it may detect Sjögren syndrome earlier than other screens and with greater accuracy.^{11,12} Patients with Sjögren syndrome should be referred to a rheumatologist. They often need systemic treatment, and early diagnosis can change their prognosis and even be lifesaving.

Dr Hovanesian, what is your approach for diagnosing dry eye?

Dr Hovanesian: Asking questions to get a good history is very important because patients may not spontaneously report symptoms if they are not their chief complaint. We do conventional studies, including a careful slit-lamp examination, and sometimes tear breakup time. In addition, it may be worthwhile to measure tear film osmolarity. Of course, we get topography in all cataract and refractive surgery patients.

Dr Donnenfeld: Treatment for dry eye should take into account the type of disease: aqueous deficiency, evaporative, or mixed. I would use artificial tears and topical cyclosporine in a patient who has aqueous-deficiency disease, and include a short course of a topical corticosteroid as induction

therapy because it will mitigate the burning and stinging that can occur with cyclosporine and hasten improvement of the ocular surface.^{13,14}

I think punctal occlusion is underused for the management of aqueous-deficiency dry eye. Dr Hovanesian, what role does it have in your practice?

Dr Hovanesian: We use it often, although it is important to control inflammation first so that the ocular surface is not exposed to a tear film full of proinflammatory mediators.

Dr Donnenfeld: Most patients with dry eye have some component of meibomian gland dysfunction (MGD), either by itself or combined with aqueous deficiency.¹⁵ Treatment for MGD includes lid hygiene with hot compresses and/or lid scrubs and increased intake of omega-3 fatty acids.^{16,17} Topical azithromycin can also have a role as well as a short course of a topical corticosteroid for inflammation, whereas for more moderate-to-severe MGD, oral doxycycline is useful because it has anti-inflammatory effects and inhibits lipase activity and MMPs.¹⁷

In our practice, we are also treating MGD by relieving meibomian gland obstruction with a device that delivers thermal pulsation therapy.

Dr Raviv: Using meibography, we are identifying meibomian gland dropout in some very young patients — people who are just in their 20s or 30s (Figure 4). The dropout indicates obstructive disease and is something I could not detect with only a clinical examination. I think thermal pulsation therapy has a valuable role in the management of these patients.

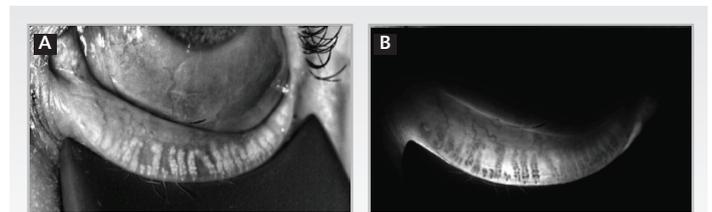


Figure 4. Direct (A) and transilluminated (B) meibography helps visualize truncated and atrophied glands indicative of obstructive MGD

Image courtesy of Tal Raviv, MD, FACS

Dr Weinstock: I agree that meibomian gland imaging is a helpful diagnostic adjunct because it can identify obstructive MGD before a patient becomes symptomatic. In that regard, I think we need to start thinking about dry eye management in the same way we think about glaucoma. Dry eye, like glaucoma, may be asymptomatic early on, but it can be a chronic, progressive disease, leading to severe symptoms and tissue damage. Early treatment initiation is critical because it can arrest that process.

Dr Donnenfeld: Considering that dry eye can affect postoperative vision, surgeons can try to minimize the risk by choosing techniques that limit damage to the corneal nerve plexus.¹⁸ These strategies would include minimizing the size of a clear corneal incision or considering a scleral tunnel incision in patients with more severe dry eye as well as correcting astigmatism with a toric IOL rather than arcuate or limbal relaxing incisions.

Returning to our case, assuming it is determined that the patient's refractive error was explained by significant postoperative rotation of the toric IOL, how would you address this problem?

Dr Hovanesian: The patient needs to be taken back to the operating room for lens rotation, and this is best done as early as possible after the primary procedure. The Toric Results Analyzer developed by David Hardten, MD, and John Berdahl, MD, is a helpful tool for evaluating toric IOL misalignment (<http://www.astigmatismfix.com>).

After the rotation, I recommend sealing the incision with either a suture or hydrogel ocular sealant because incision leakage can lead to anterior chamber instability and movement of the IOL. Suturing the incision or

using a sealant is also something to consider in the primary procedure. In a study investigating the hydrogel ocular sealant, we found by Seidel testing that approximately half of the incisions considered by the surgeons to be intact after stromal hydration would actually leak.¹⁹

Dr Raviv: I like intraoperative aberrometry to guide rotation and verify the refractive result when repositioning a toric IOL.

In my opinion, the capsule tension ring (CTR) designed by Bonnie Henderson, MD, is something surgeons might consider placing when repositioning a toric IOL. I think this device may particularly help limit IOL rotation because it features indentations around its circumference that may enable haptic capture.

Dr Weinstock: In cases in which a CTR is placed during the primary procedure before complete cataract and cortex removal, this particular ring is advantageous in that it does not completely trap the cortex, unlike some earlier-generation rings.²⁰

CASE 3: INFECTION AND INFLAMMATION CONTROL

A 64-year-old man who works as a hospital orderly presents with a cataract in his right eye. BCVA is 20/100, and he is a -7.5 D myope. He lost his left eye because of endophthalmitis. He is currently on tamsulosin.

Dr Donnenfeld: Preventing endophthalmitis is critical in this monocular patient. In the United States, most cataract surgeons are using a topical fluoroquinolone for infection prophylaxis.²¹ A 2015 paper reviewing Medicare beneficiaries with postcataract surgery endophthalmitis found that coagulase-negative *Staphylococcus*, followed by *Staphylococcus aureus*, was the most common pathogen isolated in culture-positive cases.²² Antimicrobial activity against methicillin-resistant species is relevant, considering data from a multicenter study documenting ocular surface/periocular colonization with methicillin-resistant staphylococci in 39.3% of 399 patients presenting for cataract surgery.²³

The most recent data from the ARMOR surveillance study published in 2015 show resistance among methicillin-resistant staphylococci isolates was high for fluoroquinolones, azithromycin, and tobramycin.²⁴ Among the fluoroquinolones, besifloxacin had the lowest minimum inhibitory concentration that inhibits the growth of 90% of indicated isolates (MIC₉₀) values for methicillin-resistant coagulase-negative staphylococci and methicillin-resistant *S aureus* (Table 1).²⁴

Table 1. ARMOR Surveillance MIC₉₀ Values²⁴

Antibiotic	MIC ₉₀ , µg/mL			
	MSSA	MRSA	MSCoNS	MRCoNS
Vancomycin	1	1	2	2
Besifloxacin	0.25	2	0.25	4
Gatifloxacin	2	16	2	32
Moxifloxacin	1	16	1	32
Ciprofloxacin	8	256	8	64
Tobramycin	1	> 256	4	16
Azithromycin	> 512	> 512	> 512	> 512

Abbreviations: MIC₉₀, minimum inhibitory concentration that inhibits the growth of 90% of indicated isolates; MRCoNS, methicillin-resistant coagulase-negative staphylococci; MRSA, methicillin-resistant *Staphylococcus aureus*; MSCoNS, methicillin-susceptible coagulase-negative staphylococci.

Other than choosing a topical antibiotic according to its potency against common endophthalmitis pathogens, surgeons can consider other steps to reduce the risk of this sight-threatening infection (Table 2).

Table 2. Steps to Reduce the Risk of Endophthalmitis

- Prepare the eye with povidone-iodine²⁵**
- Select a topical antibiotic with activity against common pathogens**
- Inject an intracameral antibiotic at the end of the case**
 - Cefuroxime, moxifloxacin, or vancomycin
- Assure incision integrity**
 - Careful construction
 - Place a suture or sealant
- Reduce the risk of vitreous loss**
 - Avoid intraoperative miosis

First, good evidence supports the efficacy of intracameral antibiotics, including cefuroxime, moxifloxacin, and vancomycin.²⁶⁻²⁸ A guideline issued by the European Society of Cataract & Refractive Surgeons (ESCRS) recommended the use of intracameral cefuroxime for endophthalmitis prevention, taking into account results from the ESCRS prospective randomized study and other data.²⁹ The ESCRS guideline panel acknowledged, however, weaker evidence for a benefit of cefuroxime against coagulase-negative staphylococcal endophthalmitis than against streptococcal infection, and cefuroxime is not effective against methicillin-resistant *S aureus*.^{29,30} Currently, an intracameral cefuroxime product is commercially available in Europe. In the United States, no commercially available antibiotics are approved for intracameral use. Although information in the peer-reviewed literature generally supports the safety of using intracameral cephalosporins, vancomycin, and moxifloxacin, there is the potential for dosing errors and compounding risks.³¹ In addition, a possible association between intracameral vancomycin use and the development of retinal vasculitis has been reported.^{32,33}

Dr Weinstock: Some surgeons in the United States are performing “dropless” cataract surgery for endophthalmitis prophylaxis and inflammation control using a preparation supplied by a compounding pharmacy that is injected into the vitreous humor.³⁴ Available formulations contain either moxifloxacin plus triamcinolone or those agents combined with vancomycin.

The peer-reviewed literature has no reports about the dropless approach for endophthalmitis, although an editorial pointed out a number of potential downsides.³⁴ Concerns that would be relevant to this particular approach relate to compounding risks, the unknown duration of antimicrobial coverage, the potential for intravitreal triamcinolone to induce ocular hypertension, and iatrogenic complications, including vitreous hemorrhage and retinal detachment.

I believe there is a learning curve for becoming skilled with the injection technique and a need for evidence on the efficacy and safety of dropless cataract surgery. Nevertheless, I think it is a reasonable option in situations in which there is concern about patient compliance with topical medications after surgery, such as for people residing in assisted-living facilities or patients with severe arthritis.

Dr Donnenfeld: Assuring incision integrity postoperatively is another important step for endophthalmitis prophylaxis, considering that incision leakage is associated with a 44-fold increased risk of this complication.³⁵

I believe that use of a femtosecond laser increases the consistency of constructing a self-sealing surgical incision. Recently, I have been using the laser to make an incision with a tunnel length of 1.2 mm, instead of 1.8 mm, and a 120° side cut angle, which basically creates a tongue and

Femtosecond Laser-Assisted Cataract Surgery

Dr. Donnenfeld: Cataract surgeons who believe there is no need for a femtosecond laser say they can do all of the same steps manually. Intrastromal incisions for reference marks or astigmatism correction, however, are exceptions.

Dr. Weinstock, do you see advantages for FLACS?

Dr. Weinstock: In my opinion, and because I see a lot of dense cataracts in my practice, lens fragmentation is probably where the laser has its greatest benefit for improving efficacy and safety.

Dr. Raviv: I agree that pretreating the lens with the laser makes a difference for facilitating lens removal. I like to use the analogy of trying to cut butter that has been softened in the microwave rather than taken from the freezer. Removing the softened nucleus reduces the need for ultrasound energy.¹

However, cortex removal is a little more challenging in a femtosecond laser-assisted case. To protect the capsule, I always use a disposable silicone-tipped irrigation and aspiration.

Dr. Hovanesian: There are reports that laser capsulotomy is associated with a higher rate of anterior capsule tears relative to conventional surgery.²⁻⁴ However, that was early on, and low anterior capsule tear rates using platforms with newer software and after surgeons overcome the learning curve have been reported.^{5,6}

Dr. Donnenfeld: I had a few anterior capsular tears during my early experience, but I was making capsulotomies that were just 4.5 or 4.6 mm in diameter, and I think having such a small opening created a situation in which there was increased pressure on the anterior capsule during the surgery. I have not had any anterior capsule tears since I have gone to a 5.3-mm capsulotomy. I perform a 4-quadrant cracking technique, and I recommend making a 5.5- or 5.7-mm capsulotomy to surgeons using a flip technique.

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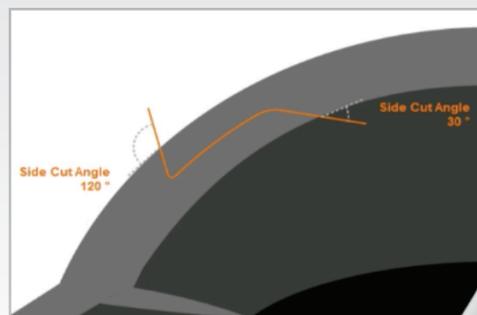


Figure 5. Planning diagram of a reverse side cut incision with the femtosecond laser

Image courtesy of Eric D. Donnenfeld, MD

groove architecture (Figure 5). I find that the incision seals beautifully with hydration. In addition, the configuration of this incision eliminates instrument oarlocking, and its small size makes complete subincisional cortex removal easier.

Five femtosecond laser systems can now be used in cataract surgery for capsulotomy and lens fragmentation and to make the cataract surgery and astigmatic incisions. Whether FLACS has benefits compared with conventional cataract surgery remains a controversial topic (see *Sidebar: Femtosecond Laser-Assisted Cataract Surgery*).

Dr. Hovanesian: The hydrogel incision sealant is another option for achieving incision integrity. It is simple to use, and I think it takes less time than suturing. Furthermore, the US Food and Drug Administration (FDA) study of the hydrogel incision sealant showed it was more effective than a suture for preventing postoperative fluid egress.¹⁹

In addition to reducing the risk of endophthalmitis, ensuring incision integrity may also lead to better refractive results, considering that incision leakage allows for forward vaulting of the IOL. We found a 0.5 D myopic shift in refraction after surgery in eyes with a leaking incision.³⁶

Dr. Donnenfeld: Vitreous loss is another leading risk factor for endophthalmitis, and intraoperative miosis is associated with an increased risk for vitreous loss.^{35,37,38} Preoperative treatment with a nonsteroidal anti-inflammatory drug (NSAID) can help to maintain pupil dilation while also controlling postoperative pain and inflammation.^{39,40}

Because NSAIDs act by blocking prostaglandin synthesis, which is triggered by surgical trauma, it is important to start the treatment before surgery. In a double-masked prospective study including 100 patients randomized to different regimens for initiating ketorolac, 0.4%, we found the mean pupil constriction was significantly less in eyes pretreated with an NSAID for 3 days compared with those that received no pretreatment or started the NSAID 1 hour or 1 day before surgery ($P = .043$) (Figure 6).³⁹ Postoperative patient discomfort was significantly reduced by 1- and 3-day pretreatment with the NSAID. Mean anterior chamber inflammatory scores were also significantly lower in the groups treated with ketorolac for 1 day or 3 days preoperatively vs just 1 hour before ($P < .001$), and a difference favoring the 3-day preoperative regimen vs the 1-day preoperative regimen nearly reached statistical significance ($P = .084$).

The mydriatic effect of NSAIDs is considered a class effect, although flurbiprofen is the only topical NSAID with an indication for preventing intraoperative miosis.⁴⁰ On the basis of the results of 2 pivotal phase 3 placebo-controlled trials, the FDA has approved an NSAID-containing product for intracameral use for preventing intraoperative miosis and reducing postoperative pain.^{41,42} This product is a fixed combination of ketorolac, 0.3%, and phenylephrine, 1%, which is added to the irrigating solution.⁴¹ Analyses of the safety data in the pivotal trials found no clinically significant differences between the ketorolac, 0.3%/phenylephrine, 1%, and placebo groups.⁴² However, systemic exposure to phenylephrine may potentially elevate blood pressure.⁴¹

Dr. Hovanesian: Phenylephrine/ketorolac does not eliminate the need for an NSAID before or after surgery, but I find that it helps reduce postoperative inflammation. Eyes are very quiet the next day.

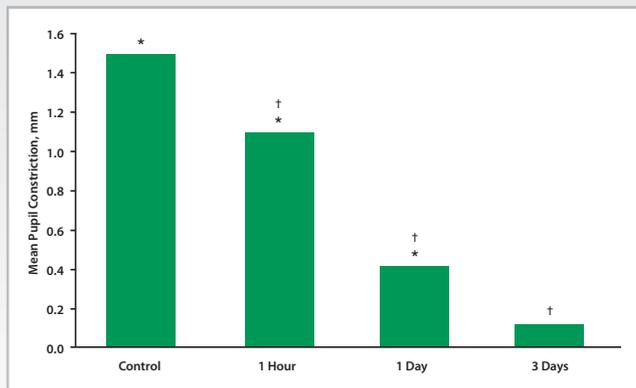


Figure 6. Mean intraoperative pupil constriction was significantly less in all groups receiving preoperative ketorolac, 0.4%, than in the placebo-treated controls ($P \leq .002$) and was significantly less with 3 days of ketorolac pretreatment compared with 1 day, 1 hour, or no pretreatment (controls) ($P = .043$)³⁹

* $P \leq .043$ vs 3 days

† $P \leq .002$ vs control

Dr. Donnenfeld: Corticosteroids are also used for controlling inflammation after cataract surgery. Returning to the patient in our case, he is a 64-year-old with high myopia. According to a published retrospective chart review, high myopia and age ≤ 65 years were risk factors for a postoperative steroid response.⁴³ Among patients with an axial length > 29 mm and aged 40 to 54 years, 35.7% had a significant intraocular pressure (IOP) spike. The study's authors suggested several strategies for controlling inflammation after cataract surgery in patients at high risk for a steroid response, including treating with a topical NSAID alone in the case of uneventful surgery, prescribing a shorter course of a topical corticosteroid, or using loteprednol or fluorometholone because each agent has a reduced potential to raise IOP relative to other corticosteroids.

Summary

Continuing developments in technology and pharmaceuticals are helping cataract surgeons meet or exceed patient expectations for outcomes after cataract surgery. Nevertheless, a comprehensive preoperative evaluation to identify issues that can affect surgical planning and results, thorough patient counseling to set proper expectations, and a meticulous surgical technique are still critical elements for achieving success and satisfying patients. Cataract surgeons should not gamble with their patients' surgical outcomes and can improve the odds for excellent results through a customized approach that takes into account each patient's clinical findings and goals.

▶▶▶ TAKE-HOME POINTS

Residual astigmatism limits optimal visual outcomes after cataract surgery

- New diagnostics are enabling improved assessment of preoperative astigmatism
- Depending on the situation, toric IOLs, LRLs, or femtosecond laser-created intrastromal incisions can be used for intraoperative astigmatic correction

Evaluation and optimization of the tear film and ocular surface is critical prior to cataract surgery

- New objective tests are improving diagnosis of dry eye and ocular allergy and enabling individualized patient care

Endophthalmitis remains the most dreaded complication of cataract surgery

- When choosing a topical antimicrobial agent for prophylaxis, surgeons should consider its activity against the most common pathogens
- Other strategies for reducing endophthalmitis risk include avoiding vitreous loss, using intracameral antibiotics, and avoiding incision leaks through good construction and use of a suture or wound sealant, as needed

Appropriate use of NSAIDs helps to deliver optimal results

- NSAIDs maximize and maintain pupillary dilation, improve postoperative comfort, and hasten visual recovery by reducing inflammation

Corticosteroids can be important for controlling ocular surface inflammation before cataract surgery and for controlling inflammation after cataract surgery

- Selection of a particular regimen should be based on understanding the differences in the potency and safety profiles of available corticosteroids and the patient's risk for a steroid response

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- Which finding makes a patient a poor candidate for a toric IOL?
 - Glaucoma
 - Macular degeneration
 - RGP contact lens wearer
 - All the above
- On what steep axis do you align a toric IOL?
 - Refractive
 - Topographic
 - Keratometric
 - None of the above
- A cataract surgery patient with myopic astigmatism is interested in a toric IOL. On topography, he has a 1.25 D ATR cylinder. His glasses have a 2.25 D ATR cylinder. What would you do?
 - Disregard the refractive astigmatism, knowing his glasses are a few years old
 - Repeat the topography
 - Plan to use a toric IOL with a lower power cylinder than what his topography shows, assuming he has greater than average posterior cornea WTR astigmatism
 - B and C
- A patient presents with complaints of decreased and fluctuating vision. On examination, he has 2+ NS cataracts OU, his topography shows small areas of dropout, and he is found to have moderate MGD. He is anxious to proceed with surgery. What would you do?
 - Plan surgery and recommend he start using artificial tears as needed
 - Recommend surgery with intraoperative aberrometry to check IOL power
 - Treat the MGD and bring the patient back for another preoperative evaluation
 - Place artificial tears in the eyes before repeating topography and schedule surgery
- When would oral doxycycline be considered for treating MGD?
 - In a patient with moderate or worse MGD severity
 - Only if the lid margin disease is associated with acne rosacea
 - Only if the MGD is *Demodex*-related
 - Only if the patient also has inflammation from an autoimmune aqueous-deficient dry eye condition
- In a paper published in 2015, what was the most common pathogen found in postcataract surgery endophthalmitis cases among Medicare beneficiaries?
 - Coagulase-negative *Staphylococcus*
 - Methicillin-resistant *S aureus*
 - Methicillin-sensitive *S aureus*
 - Propionibacterium acnes*
- According to data from the ARMOR surveillance study published in 2015, which fluoroquinolone had the lowest MIC₉₀ value (greatest potency) against methicillin-resistant *S aureus*?
 - Besifloxacin
 - Gatifloxacin
 - Moxifloxacin
 - Ofloxacin
- Why might you consider starting a topical NSAID 3 days prior to cataract surgery rather than waiting until after surgery?
 - If the patient will be using a generic product
 - To reduce intraoperative miosis
 - If the patient has inflammation from ocular surface disease
 - In no case because it is off-label
- A new fixed combination of ketorolac, 0.3%/phenylephrine, 0.1%:
 - Is indicated for preventing intraoperative miosis and reducing postoperative pain
 - Is indicated for preventing intraoperative miosis and reducing postoperative pain and inflammation
 - Is indicated for preventing intraoperative miosis and reducing postoperative pain and cystoid macular edema
 - Should be applied every 15 minutes preoperatively, starting 1 hour before surgery
- Compared with cataract surgery performed using conventional techniques, cataract surgery using the femtosecond laser is associated with:
 - Higher posterior capsule tear rates when the laser is used for lens fragmentation
 - Less intraoperative miosis
 - Less ultrasound energy use
 - Reduced risk of endophthalmitis

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Learner Disclosure: To ensure compliance with the US Centers for Medicare and Medicaid Services regarding gifts to physicians, **New York Eye and Ear Infirmary of Mount Sinai** Institute for CME requires that you disclose whether or not you have any financial, referral, and/or other relationship with our institution. **CME certificates cannot be awarded unless you answer this question.** For additional information, please call NYEE ICME at 212-979-4383. Thank you.

Yes No I and/or my family member have a financial relationship with **New York Eye and Ear Infirmary of Mount Sinai** and/or refer Medicare/Medicaid patients to it.

I certify that I have participated in the entire activity and claim 1.5 *AMA PRA Category 1 Credits™*.

Signature Required _____ Date Completed _____

OUTCOMES MEASUREMENT

Yes No **Did you perceive any commercial bias in any part of this activity? IMPORTANT! If you answered "Yes," we urge you to be specific about where the bias occurred so we can address the perceived bias with the contributor and/or in the subject matter in future activities.**

Circle the number that best reflects your opinion on the degree to which the following learning objectives were met:
5 = Strongly Agree 4 = Agree 3 = Neutral 2 = Disagree 1 = Strongly Disagree

Upon completion of this activity, I am better able to:

• Manage ocular surface conditions preoperatively in patients undergoing cataract surgery	5	4	3	2	1
• Select appropriate medication regimens for preventing inflammation and infection in patients undergoing cataract surgery	5	4	3	2	1
• Demonstrate optimal IOL selection	5	4	3	2	1
• Review the advantages and disadvantages of femtosecond cataract surgery technology	5	4	3	2	1

1. Please list one or more things, if any, you learned from participating in this educational activity that you did not already know. _____

2. As a result of the knowledge gained in this educational activity, how likely are you to implement changes in your practice?
4 = definitely will implement changes 3 = likely will implement changes 2 = likely will not implement any changes 1 = definitely will not make any changes

4 3 2 1

Please describe the change(s) you plan to make: _____

3. Related to what you learned in this activity, what barriers to implementing these changes or achieving better patient outcomes do you face? _____

4. Please check the Core Competencies (as defined by the Accreditation Council for Graduate Medical Education) that were enhanced for you through participation in this activity.

Patient Care Practice-Based Learning and Improvement Professionalism

Medical Knowledge Interpersonal and Communication Skills Systems-Based Practice

5. What other topics would you like to see covered in future CME programs? _____

ADDITIONAL COMMENTS _____

POST TEST ANSWER BOX

1	2	3	4	5	6	7	8	9	10