In association with

March 2008

Cataract & Refractive Surgery TODAY

# Premium Cataract Surgery

## *(Not just for premium IOLs.)*

A continuing medical educational activity based on a symposium held in New Orleans in November 2007.



SUPPORTED BY AN UNRESTRICTED EDUCATIONAL GRANT FROM ALLERGAN, INC.

This continuing medical education activity is jointly sponsored by

THE DULANEY FOUNDATION

BMCGROUP MEDICAL EDUCATION
BRYN MAWR COMMUNICATIONS GROUP LLC

Cataract & Refractive Surgery TODAY

# Premium Cataract Surgery
# *(Not just for premium IOLs.)*

Jointly sponsored by the Dulaney Foundation, Brayn Mawr Communications Group, and *Cataract & Refractive Surgery Today*.

Release date: March 2008; Expiration date: March 2009

This continuing medical education activity is supported by an unrestricted educational grant from Allergan, Inc.

## STATEMENT OF NEED

The growing availability of and interest in presbyopia-correcting IOLs has renewed surgeons' determination to raise the bar with respect to cataract surgical techniques. The Dulaney Foundation, Bryn Mawr Communications Group LLC, and *Cataract & Refractive Surgery Today* have compiled this educational activity of peer-reviewed research regarding best practices in cataract surgery.

Presented are surgeon-authored articles describing best practices for implanting premium IOLs, using antibiotics, the prophylaxis of cystoid macular edema, and for managing the capsulorhexis.

## TARGET AUDIENCE

This activity is designed for anterior segment ophthalmic surgeons and other ophthalmologists.

## LEARNING OBJECTIVES

Upon successfully completing this learning program, participants should be able to:

- demonstrate strategies for successful outcomes in lenticular surgery
- employ techniques for managing capsulorhexis complications
- practice prophylaxis for cystoid macular edema
- take measures in the prophylaxis of endophthalmitis

## METHOD OF INSTRUCTION

Participants should read the learning objectives and continuing medical education (CME) program in their entirety. After reviewing the material, they must complete the self-assessment test, which consists of a series of multiple-choice questions. To answer these questions online and receive real-time results, please visit www.dulaneyfoundation.org and click "Online Courses."

If you are experiencing problems with the online test, please e-mail us at support@dulaneyfoundation.org and explain the details of any problems you encounter with the Web site. Alternatively, you can fax your exam to us at (610) 771-4443. Please note, in order to receive your certificate and credit when faxing your test, you must include your full name as well as an e-mail address, as certificates will be issued electronically.

Upon completing the activity and achieving a passing score of over 70% on the self-assessment test, you may print out a CME credit letter awarding 1 *AMA PRA Category 1 Credit.*™ The estimated time to complete this activity is 1 hour.

## ACCREDITATION

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of The Dulaney Foundation, Bryn Mawr Communications Group LLC, and *Cataract & Refractive Surgery Today*. The Dulaney Foundation is accredited by the Accreditation Council for Continuing Medical Education to sponsor continuing education for physicians. The Dulaney Foundation designates this educational activity for a maximum of 1 *AMA PRA Category 1 Credit*™. Physicians should only claim credit commensurate with the extent of their participation in the activity.

## DISCLOSURE

In accordance with the disclosure policies of The Dulaney Foundation and to conform with ACCME and FDA guidelines, all program faculty are required to disclose to the activity participants: (1) the existence of any financial interest or other relationships with the manufacturers of any commercial products/devices, or providers of commercial services; and (2) identification of a commercial product/device that is unlabeled for use or an investigational use of a product/device not yet approved.

## FACULTY CREDENTIALS

David F. Chang, MD, is Clinical Professor at the University of California, San Francisco, and is in private practice in Los Altos, California. Dr. Chang may be reached at (650) 948-9123; dceye@earthlink.net.

Steven J. Dell, MD, is Director of Refractive and Corneal Surgery for Texan Eye Care in Austin. Dr. Dell may be reached at (512) 327-7000; sdell@austin.rr.com.

Eric D. Donnenfeld, MD, is a trustee of Dartmouth Medical School in Hanover, New Hampshire, and is Partner in Ophthalmic Consultants of Long Island in Rockville Centre, New York. Dr. Donnenfeld may be reached at (516) 766-2519; eddoph@aol.com.

John R. Wittpenn, Jr, MD, is a partner in Ophthalmic Consultants of Long Island and is Associate Clinical Professor at the State University of New York in Stony Brook. Dr. Wittpenn may be reached at (631) 941-3363; jrwittpenn@aol.com.

## FACULTY DISCLOSURE DECLARATIONS

David F. Chang, MD, states that he is a consultant to Advanced Medical Optics, Inc., Alcon Laboratories, Inc., and Visiogen, Inc.

Steven J. Dell, MD, states that he is a consultant for Advanced Medical Optics, Inc., Eyeonics, Inc., and Bausch & Lomb.

Eric D. Donnenfeld, MD, states that he is a consultant to Advanced Medical Optics, Inc., Alcon Laboratories, Inc., Allergan, Inc., Bausch & Lomb, Inspire Pharmaceuticals, Inc., and Eyemaginations, Inc.

John R. Wittpenn, Jr, MD, states that he is on the speakers bureau for and is a consultant to Allergan, Inc.

All those involved in the planning and editing of this educational activity have indicated that they have no financial relationships to disclose.

# Premium Refractive IOLs: Best Practices

Strategies to help surgeons take advantage of refractive surgery's anticipated upswing.

**BY STEVEN J. DELL, MD**

Ophthalmologists are concerned right now that the US LASIK market is either declining or growing at a very low single-digit rate. Rest assured, some of these patients have not abandoned refractive surgery, they are just moving into a new treatment category. Baby boomers have gotten older and have moved out of the laser vision correction market. When LASIK debuted in 1996, the average age of baby-boomer candidates was 41 years. The average baby boomer is now 52 years old and might be a better candidate for refractive lens exchange with a premium refractive IOL. Meanwhile, boomers' children are entering laser vision correction candidacy. This population is sometimes referred to as the "echo-boom" generation or Generation Y, and it is larger than the baby boomer population. As these two enormous groups move into the sweet spots of their respective treatment categories, they are creating huge markets for laser refractive surgery and lenticular surgery that will endure for the next 20 years.

Preliminary experience indicates that approximately 10% to 30% of Medicare patients want premium refractive IOLs, and about 50% of the commercial group of younger patients with cataracts express interest in this technology. Shareef Mahdavi from Pleasanton, California, who provides marketing counsel to medical manufacturers, points out that if 20% of the cataract market adopts premium refractive IOLs, refractive lens exchange will be the number-two elective medical procedure among all medical specialties, second to LASIK. Certainly, that would be an enviable position for our surgical specialty (oral communication, 2007).

In light of this anticipated demand, following are a few key strategies for ensuring success with the new paradigm of premium refractive IOLs.

## NEW TECHNOLOGY: APPROPRIATE USE AND EDUCATION

In refractive surgery, new technology often debuts with overly broad applications before it retreats to more specific and logical guidelines. Historical examples include radial keratotomy for -12.00 D, small-optical-zone PRK for -10.00 D, LASIK for -19.00 to +6.00 D, and multifocal lenses for everyone. My point is that an ample supply of addressable patients gives us the luxury of being appropriately conservative with current and future new technologies. In my practice, the process of introducing patients to a new modality involves several steps. With presbyopia-correcting IOLs, for example, my staff and I first show patients a video to present the concept and establish a common vocabulary. Next, we provide them with a handout that describes the choices of IOLs and my personal experience with each one. We then give patients a questionnaire (available at http://www.crstoday.com/Pages/Dellindex.doc) to determine what range of vision they want postoperatively and also to set their expectations (usually, the questionnaire helps patients realize that they can't have everything). Finally, we conduct a preoperative examination and consultation and then schedule the patient if appropriate.

## OPTIMIZING THE CORNEAL SURFACE

In 2002, the *Journal of the American Medical Association* published a watershed cardiology study that dramatically affected ophthalmologists' practices. The Antihypertensive Lipid-Lowering Treatment to Prevent Heart Attack Trial (ALLHAT) followed 33,000 patients with hypertension and

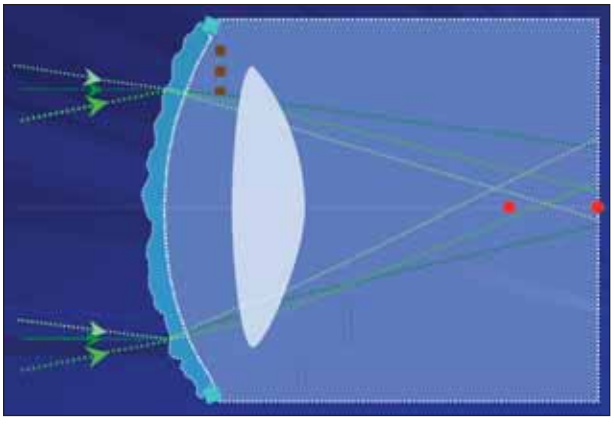

**Figure 1. Disruption of the ocular surface induces distortion that is magnified by a multifocal IOL.**

elevated lipid levels and found that clinical outcomes were worse with calcium-channel blockers and ACE inhibitors.[1] The study concluded that thiazide diuretics yielded better results, and thus the use of these drugs has risen substantially in the last 5 years. Unfortunately for ophthalmic patients, thiazide diuretics substantially impair corneal tear film and significantly alter the quality of the corneal surface. Patients with these corneas may have distorted preoperative keratometry readings, which are the basis for IOL measurements, and they also suffer from fluctuations in postoperative visual acuity. Although optimizing the corneal surface pre- and postoperatively in a healthy eye is merely important, it is critical for patients taking these medications, and hypercritical if they have chosen a multifocal IOL, because those types of lenses will magnify any disruption of the ocular surface (Figure 1).

Optimizing the tear film has become a major component of my premium IOL surgery. Treatments include artificial tears, omega-3 fatty acids taken orally, punctal occlusion (as long as there is no inflammatory blepharitis), topical cyclosporine, and topical steroids. I often use topical steroids to help patients acclimate to topical cyclosporine.

Topical cyclosporine is the only FDA-approved therapeutic agent for the treatment of dry eye, and it works by improving all three layers of the tear film.[2] It improves visual outcomes in LASIK patients.[3] Eric D. Donnenfeld, MD, and Calvin Roberts, MD, studied cyclosporine in multifocal patients who received the ReZoom lens (Advanced Medical Optics, Inc., Santa Ana, CA). Compared with the control group, the patients who received cyclosporine had less corneal staining, better visual acuity, and greater contrast under mesopic and photopic conditions.[4]

## MANAGING ASTIGMATISM

More than 70% of premium refractive IOL patients have over 0.50 D of astigmatism, which must be corrected for these lenses to work optimally. The primary question for a patient's candidacy is whether his preexisting astigmatism is treatable. Conditions such as pellucid marginal degeneration, for example, are contraindications for any kind of incisional keratorefractive surgery such as limbal relaxing incisions or LASIK. In corneas suffering from severe dry eye syndrome, it should be noted that limbal relaxing incisions will render a good portion of the cornea significantly neurotrophic, possibly aggravating the situation.

A study that my colleagues and I conducted using different brands of premium refractive lenses confirmed the importance of astigmatic correction to patients' satisfaction. The study involved the Crystalens accommodating IOL (Eyeonics, Inc., Aliso Viejo, CA), the AcrySof Restor IOL (Alcon Laboratories, Inc., Fort Worth, TX), and the ReZoom multifocal IOL, and various combinations of the three. No matter the combination of lenses used, we were able to achieve consistently high rates of success and satisfaction rates when we kept the final refraction to within 0.25 D of astigmatism.[5] In another study, Michael Knorz, MD, of Mannheim, Germany, tested a two-step process to achieve excellent acuity with premium IOLs. He performed cataract surgery in a highly ametropic population and achieved about 1.00 D of postoperative sphere and cylinder. He then used laser vision correction to refine the result to within 0.25 D of emmetropia.[6]

## MAKING ACCURATE IOL CALCULATIONS

One other reason that accurate IOL measurements are critical with presbyopia-correcting IOLs is that their acceptable target zone of correction is narrower than the acceptable target zone for laser vision correction. For example, if surgery gives a 25-year-old 0.75 D hyperopic vision, he will see 20/12 and be happy, but the same result in a pseudophakic patient will make him dissatisfied.

The predominant source of error in IOL calculations used to be determining the axial length. With the advent of measurement tools such as noncontact partial coherence interferometry and immersion A-scan ultrasound, the weakest links are now the outdated IOL formulae and keratometric errors. My staff and I go to great lengths to ensure that our keratometric calculations are precise and accurate, and we use a modern IOL formula like the Holladay 2 (Holladay Consulting, Inc., Bellaire, TX). These steps have helped improve our results measurably.

## EXCITING CHALLENGES

The premium IOL options have made our job both more interesting and complex. In this paradigm in which patients pay out of pocket, the stakes are substantially amplified and the criteria for success are elevated. The two keys for success are to accurately identify what type of visual performance the patient wants after surgery and then set his expectations appropriately. Then, strategies such as optimizing the tear film and correcting astigmatism will further assist you in achieving the best outcomes for your patients. ■

1. ALLHAT Officers and Coordinators for the ALLHAT Collaborative Research Group. The Antihypertensive and Lipid-Lowering Treatment to Prevent Heart Attack Trial. (ALLHAT-LLT). *J Am Med Assoc.* 2002;288:23:2998-3007.
2. Sall K, Stevenson OD, Mundorf TK, et al. Two multicenter, randomized studies of the efficacy and safety of of cyclosporine ophthalmic emulsion in moderate to severe dry eye disease. *Ophthalmology.* 2000;107:4:831-839.
3. Salib GM, McDonald MB, Smolek M. Safety and efficacy of cyclosporine 0.05% drops versus unpreserved artificial tears in dry-eye patients having laser in situ keratomileusis. *J Cataract Refract Surg.* 2006;32:5:772-778.
4. Donnenfeld ED, Roberts C. Efficacy of topical cyclosporine versus tears for improving visual outcomes following multifocal IOL implantation. Poster presented at: The ARVO Annual Meeting; May 6, 2007; Fort Lauderdale, FL.
5. Dell S. Matching patient needs with the appropriate IOL in cataract and refractive lens exchange surgery. Paper presented at the ASCRS Symposium on Cataract, IOL and Refractive Surgery; May 1, 2007; San Diego, CA.
6. Jendritza BB, Knorz MC. Wavefront-guided excimer laser vision correction after multifocal IOL implantation. *J Refract Surg.* 2008;24 (in print).

# Best Practices for Cystoid Macular Edema Prophylaxis

The use of NSAIDs is key in treating cataract patients.

**BY JOHN R. WITTPENN, JR, MD**

All surgeons recognize the risk factors for cystoid macular edema (CME) and will respond appropriately. Doctors have often told me, "When I have a high-risk patient, I often treat him with an NSAID to prevent CME." The question is, what about patients who you do not identify as high risk? What are the chances of those patients with no risk factors developing clinically significant or even subclinical CME that would affect their visual function? Is it important that we use prophylaxis in all cases?

I believe that all surgeons should prescribe a nonsteroidal anti-inflammatory drug (NSAID) for all cataract patients, not just high-risk ones. As the data discussed herein show, using at least ketorolac with a steroid produces a statistically significant improvement in visual outcomes.

## DIFFERENT MECHANISMS OF ACTION

Some surgeons feel that NSAIDs are not necessary if they prescribe a steroid, because both of these agents block prostaglandin synthesis. The two work differently, however. Although steroids block the arachidonic acid cascade, the binding is not an irreversible blockage, but rather a reversible bond (ie, only a partial blockage). NSAIDs block cyclooxygenase COX-1 and COX-2 inhibitors in a nonreversible bond. In other words, once a COX-1 or COX-2 enzyme is blocked, it is out of the system. Therefore, prescribing steroids and NSAIDs together produces synergistic effects, as recent studies show.

## TREATING NON–HIGH-RISK PATIENTS

### Criteria

My colleagues and I conducted a large, multicenter, randomized, masked trial that examined the importance of adding ketorolac to steroids in 546 patients undergoing cataract surgery.[1] We specifically identified patients who had no risk factors for CME. The study criteria included (1) zero risk factors for CME, (2) complication-free surgery, and (3) an expected amount of inflammation on the first day after surgery. If patients experienced an unexpected amount of inflammation (eg, toxic anterior segment syndrome), they were eliminated from the study. Our goal was to study the patients who were most likely not to have CME and find out if there was still an advantage to adding ketorolac to their medication regimen. We found that there was, in fact, a benefit.

### Outcomes

The patients' outcomes were evaluated by a masked retinal analyst who compared preoperative and 4-week postoperative optical coherence tomography (OCT). We found that the CME rate was statistically significant between the two treatment groups (Figure 1). The group that received only steroids had a 2.4% rate of definite or probable CME and a loss of visual acuity ranging from 20/30 to 20/100. The group of patients who received ketorolac plus steroid had no cases of definite or probable CME. Furthermore, when all patients of both groups were compared for retinal thickening, more than half of the steroid-only patients had macular thickening of greater than 10 µm, whereas only 25% of the

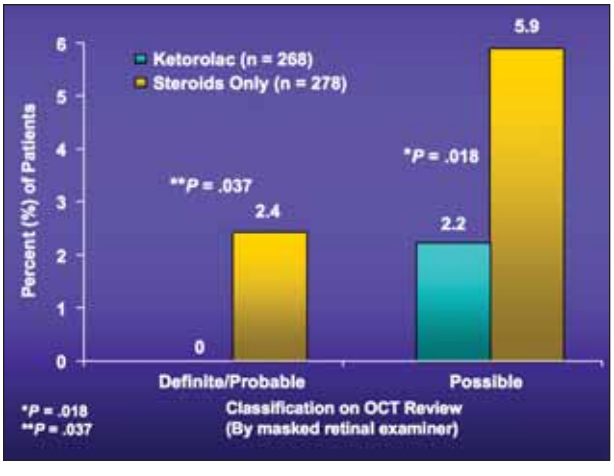


**Figure 1. Incidence of CME on examination with ocular coherence tomography.**

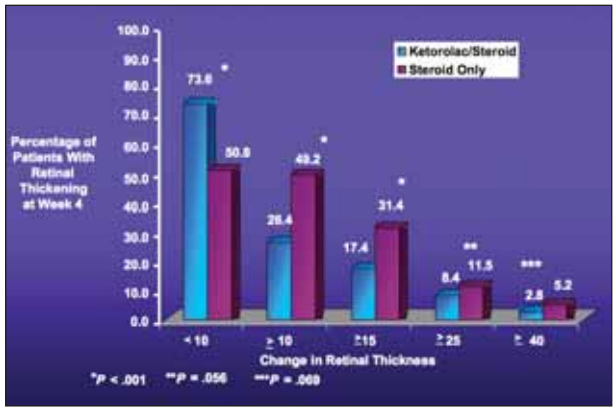


**Figure 2. Incidence of retinal thickening between the two treatment groups.**

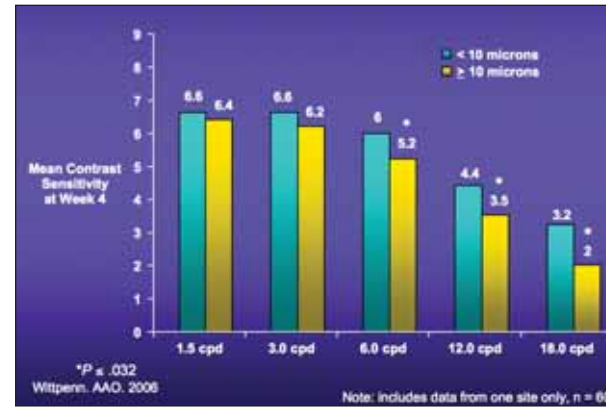


**Figure 3. Limiting retinal thickening improves contrast sensitivity.**

ketorolac group had this degree of thickening, which was also statistically significant (Figure 2). Patients with less than 10 µm of thickening exhibited statistically significant better contrast sensitivity (Figure 3).

### CME and Contrast Sensitivity

Unfortunately, one of my patients in the steroid-only group developed CME. At 4 weeks postoperatively, her BCVA was 20/40, and I treated her with the combination therapy. Two months later, her condition had improved to 20/20 BCVA. She has a cataract in her other eye, which is about 20/30- BCVA. To this day, she will not let me remove the cataract, because she insists this eye is her better eye. The reason is that the eye with CME has abnormal contrast sensitivity. Although she can read the letters on an eye chart easily and we consider her to be a cured patient, her final visual function is so poor that she still considers this eye her worse eye.

### NSAID Dose Response Curve

In a smaller study of 100 patients reported by Eric Donnenfeld, MD, patients were grouped to receive ketorolac starting 3 days, 1 day, 1 hour, or not at all before cataract surgery. All patients except the last group received ketorolac and a steroid following cataract surgery. In comparing the four groups at 15 days, the group receiving ketorolac for 1 or 3 days preoperatively had less pain during and after surgery, faster surgery, and no cases of CME. The study highlighted the importance of beginning ketorolac at least 1 day before surgery.[2]

## NSAIDS AND MULTIFOCAL IOLS

These studies emphasize the importance of using NSAIDs and steroids in combination for all cataract patients. Furthermore, to paraphrase Steven Dell, MD, this regimen is hypercritical when working with multifocal IOLs. Another study by Dr. Donnenfeld and Kerry Solomon, MD, presented at the ASCRS last year compared ketorolac plus steroid to steroid alone in multifocal IOL patients. They enrolled 26 patients undergoing bilateral multifocal IOL cataract surgery into the study. One eye of each patient was treated with steroids plus ketorolac, and the other eye with steroids only. They reported that the eyes receiving both ketorolac and steroid had better BCVA and statistically significant better contrast sensitivity. Subjectively, more patients preferred the ketorolac-plus-steroid eye when questioned.

## DOSING RECOMMENDATIONS

Macular thickening is an issue for all cataract patients. They demand and we strive to give them the absolute best vision. CME or any degree of macular thickening is an unacceptable problem. As a result of these studies on ketorolac, I believe that the gold standard of care for all cataract surgery patients should include preoperative ketorolac for 1 to 3 days followed by a combination of a steroid and ketorolac postoperatively for 4 to 5 weeks. If the patient has high risk factors for CME, I initiate treatment for 1 week preoperatively and plan to continue the treatment for 8 to 12 weeks. Since the newer NSAIDs have been shown in studies to reduce inflammation following cataract surgery, many assume these agents will provide similar results with regard to macular thickening, although we still need to see studies confirming these assumptions. Finally, surgeons should note that these are off-label indications for all NSAIDs. ■

1. Wittpenn J Jr, Silverstein SM, Hunkeler JD, et al. A masked comparison of acular LS plus steroid vs. steroid alone for the prevention of macular leakage in cataract patients. Poster presented at: The AAO/APOA Annual Joint Meeting; November 12, 2006; Las Vegas, NV.
2. Donnenfeld ED, Perry HD, Wittpenn J Jr, et al. Preoperative ketorolac tromethamine 0.4% in phacoemulsification outcomes: pharmacokinetic-response curve. *J Cataract Refract Surg.* 2006;32:9:1474-1482.

# MRSA in Cataract and Refractive Surgery

An outline of the problem, its implications, and preventive strategies.

**BY ERIC D. DONNENFELD, MD**

I am passionate about educating ophthalmic providers about the implications of methicillin-resistant *Staphylococcus aureus* (MRSA) and *Staphylococcus epidermidis* (MRSE) for ocular surgery. Here, I share my experience with these organisms to illustrate the consequences of these difficult-to-treat bacterial infections and to highlight their growing threat to public health. Methicillin-resistant staphylococci are currently the most common cause of infection following LASIK, PRK, and cataract surgery.

## CASE PRESENTATION

I recently performed PRK to correct moderate myopia on the right eye of a municipal employee who was in his 40s. I decided to treat him with PRK instead of LASIK because corneal topography with the Orbscan (Bausch & Lomb, Rochester, NY) showed an inferiorly decentered apex, inferior steepening, and corneal thinning that could have increased his risk of developing postoperative ectasia.

Immediately after surgery, I instilled prednisolone acetate 1%, gatifloxacin 0.3%, and ketorolac tromethamine 0.4% (all manufactured by Allergan, Inc., Irvine, CA), into the patient's right eye, and I fitted him with a bandage contact lens. The next day, the patient's endothelium appeared to have healed sufficiently, so I told him to discontinue his NSAID. On day 2, his eye had some pain; by accident, he had stopped using the antibiotic instead of the NSAID. He had a minor corneal infiltrate on his eye, but I saw no evidence of hypopyon or ulceration. I cultured the infiltrate and increased the fluoroquinolone dosing to every 2 hours. We arranged for him to be seen 16 hours later.

On postoperative day 3, I noted that the infiltrate had significantly enlarged, there was iritis, and we were clearly dealing with an infection. I started the patient on vancomycin every half hour and oral doxycycline to prevent collagenase release. I also continued him on gatifloxacin and discontinued the prednisolone acetate. The culture came back 2 days later and revealed MRSA. However, the patient's eye did not improve. He returned on the seventh day with a dense central corneal infiltrate, and I knew he would likely need a corneal transplant. At this point, I thought his condition could not worsen, but I was wrong. When he came back the next day, his cornea had perforated (Figure 1), and I applied cyanoacrylate glue.

A couple months later, I performed a corneal transplant, to which the eye responded very well. One year after the PRK surgery, I removed the transplant sutures, and the eye was -5.00 D with only 0.25 D of cylinder on refraction and 0.10 D of cylinder on aberrometry. The patient's left eye was plano. He was miserable due to the anisometropia and his inability to wear contact lenses.

I chose to perform thin-flap LASIK with a femtosecond laser (Advanced Medical Optics, Inc., Santa Ana, CA) on his right eye to minimize the risk of infection (LASIK's risk of infection is five to eight times less than PRK's[1]). Also, in healthy eyes, the risk of infection is far greater than the risk of ectasia after PRK.[2] The patient's eye did very well after the LASIK surgery; the anisometropia resolved, and his UCVA reached 20/25 (Figure 2).

## A PROBLEM GAINING ATTENTION

Unfortunately, the problem posed by MRSA is worse

**Figure 1. The perforated and MRSA-infected cornea of a PRK patient after he mistakenly discontinued his antibiotic.**

than the public realizes. I maintain that MRSA is the number-one health problem in the US today, and, as a study my colleagues and I published in the *American Journal of Ophthalmology* showed,[3] it may be particularly worrisome for ophthalmology. Of the 14 cases of MRSA we described in our study, 12 occurred in healthcare workers and four in physicians. Physicians and other healthcare workers are colonized by MRSA at an increased rate that puts us at a very high risk of developing infection. More than 50% of all infections in the ICU setting are due to MRSA.[4]

The incidence of MRSA infections is also increasing exponentially in the general population, and this trend is likely to continue, according to the literature.[5] Surgical candidates must understand this risk, as illustrated by a study of endophthalmitis among cataract patients at the University of Pittsburgh. From 1993 to 2004, the university's physicians found that 30% of postoperative infections were caused by MRSA. MRSE accounted for an additional 48% of cases of endophthalmitis. By 2006, MRSA appeared in 60% of their surgical cases, and MRSE—the greatest cause of endophthalmitis—was responsible for three quarters of the endophthalmitis outbreaks.[6] Additionally, the ASCRS Clinical Committee Refractive Surgery Survey[7] cited MRSA as the number-one cause of infection following LASIK and PRK. A study presented at the 2006 ARVO meeting showed that 55% of patients who have endophthalmitis are resistant to generic gatifloxacin and moxifloxacin molecules.[8] Thus, half of the cases of endophthalmitis are not going to respond effectively to the primary antibiotics in use today. With odds like these, our best strategy is to prevent infections before they occur.

## CLINICAL IMPLICATIONS

Many clinicians wonder if clinical evidence favors one antibiotic over another for preventing postoperative infections. A study published by Moshirfar et al in *Ophthalmology* in 2007[9] gave the first clinical evidence that cataract patients' incidence of endophthalmitis was approximately 50% lower for those who received gatifloxacin 0.3% compared with moxifloxacin ophthalmic solution 0.5% (Alcon Laboratories, Inc., Fort Worth, TX). This study included 14 cases of endophthalmitis (an overall rate of 0.07%). Importantly, endophthalmitis' average time to presentation is 9.3 days, and the participants in this study were instructed to stop their antibiotics after 7 days. Six cases of endophthalmitis occurred after the drops were stopped and the eyes were left unprotected. When the investigators eliminated these cases, there was a fourfold increase of endophthalmitis with moxifloxacin versus gatifloxacin. Until I see a human endophthalmitis study with different results, I will consider this one the best guide for choosing an antibiotic.

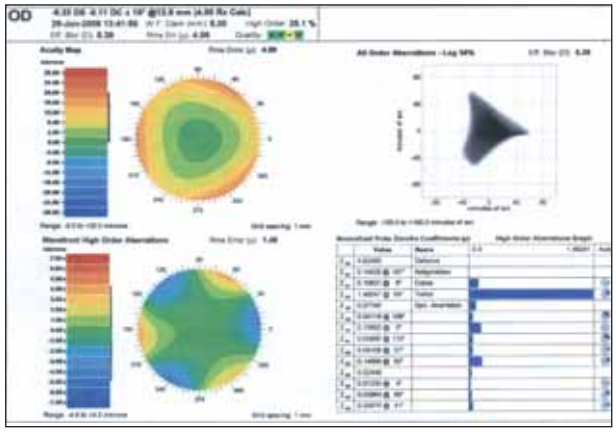


**Figure 2. Topography of the patient's eye after undergoing thin-flap LASIK 1 year after a corneal transplant.**

## STRATEGIES FOR PREVENTION

Endophthalmitis prevention occurs mainly on the ocular surface. Well-constructed wounds and the use of a suture when necessary are critical for preventing late inoculation of organisms into the eye following surgery, because again, most cases present later than 3 days.

Fortunately, MRSA and MRSE respond brilliantly to the benzalkonium chloride (BAK), a preservative that is added to many ophthalmic medications. A study by Blondeau et al[10] showed that BAK greatly increased an antibiotic's killing effect and reduces the minimal inhibitory concentrations (MICs) to manageable rates versus the generic moxifloxacin and gatifloxacin molecules that lack it. A European study showed a 78% reduction of endophthalmitis with intracameral cefuroxime.[11] Although the study had some flaws, the idea of using antibiotics intracamerally is valid and warrants more research. If you use an antibiotic intracamerally, mix and match: use a broad-spectrum fluoroquinolone on the ocular surface, and use an antibiotic that is specifically effective against MRSA inside the eye.

Also, disinfect the lid well with one of the advanced products available today. The TheraTears SteriLid eyelid cleanser (Advanced Vision Research, Inc., Woburn, MA) is very effective against MRSA. Additionally, the prescription nasal gel mupirocin (Bactroban; GlaxoSmithKline, Research Triangle Park, NC) is a super bacitracin with an FDA-approved indication of effectiveness against MRSA. I apply this to the lid margins of patients known to carry MRSA preoperatively.

## CONCLUSION

In summary, we surgeons must do a better job of disinfecting the operative field against infectious organisms.

*(Continued on page 11)*

# Strategies for Managing the Difficult Capsulorhexis

Understanding the problem is the key to avoiding complications.

**BY DAVID F. CHANG, MD**

There are four general conditions that increase the risk of a radial capsulorhexis tear: poor visibility, eye movement, chamber shallowing, and increased capsular elasticity. These situations may arise either because of the ocular anatomy or due to poor surgical technique.

## POOR VISIBILITY

A good red reflex and visibility are important in order to manipulate the flap and monitor the direction of the tear as it develops. A surgeon's delayed recognition of a peripherally escaping tear may preclude any chance to redirect it in time.

Ocular causes of a poor red reflex include tear film debris, decreased corneal clarity, small pupils, anterior cortical opacity (anterior spokes or white cataract), nuclear opacity (brunescence), and vitreous opacities such as asteroid hyalosis or hemorrhage. Errors in surgical technique may also compromise visibility. Excessive drying can cloud the corneal epithelium. Poor irrigation fluid runoff may submerge the cornea. Clumsy instrument maneuvers might create corneal striae or displace the globe out of optimal microscope alignment. Finally, excessive downward pressure from the capsulotomy needle's tip will penetrate and stir up the epinucleus. This can cause focal loss of the red reflex right at the area where the flap inserts.

With challenging cases, surgeons must pay greater attention than usual to sharp focus, a clear corneal tear film, and positioning the eye so as to optimize the red reflex. The surgeon should increase the microscope zoom if necessary. Furthermore, a surgeon should consider trypan blue dye whenever he anticipates difficulty with visualizing the anterior capsule. He can apply dye even after he initiates the capsulotomy, because trypan blue preferentially stains the capsule but not the cortex.

## EYE MOVEMENT

The potential for eye movement is characteristic of topical anesthesia or an unintentional consequence of a poor regional block. A sudden unanticipated head or eye movement may cause a peripheral radial tear. Patients must be cooperative enough to have surgery under topical anesthesia, and using appropriate levels of sedation and communication should enhance their cooperation. Fixation is improved by avoiding excessive microscope light intensity, which can induce squeezing. During the capsulotomy, the cornea should be moistened in a way so as to avoid startling the patient or surgeon. One way to eliminate the need for an assistant to manually wet the cornea during surgery is to lubricate it in the following manner. The surgeon first smears a few streaks of a dispersive ophthalmic viscosurgical device (OVD) such as Viscoat (Alcon Laboratories, Inc., Fort Worth, TX), Amvisc Plus (Bausch & Lomb, Rochester, NY), or Occucoat (Bausch & Lomb) onto the corneal surface. Adding several drops of balanced salt solution will create an even, but viscous wetting layer that will resist evaporation and provide superb clarity.

## ANTERIOR CHAMBER SHALLOWING

The natural anterior convexity of the equatorial lens tends to steer any capsular tear toward the periphery. The shallower the chamber is, the more convex the anterior

**Figure 1. Soft-shell technique. After first injecting the dispersive OVD (Viscoat), the cohesive OVD (Provisc), is injected over the convex anterior capsule. This step pushes the dispersive OVD into the cornea and against the inner incision wall.**

capsule becomes, and the more the tear tends to run radially "downhill." The direction of the tear is most easily controlled if the anterior capsular surface is flattened.

A shallow anterior chamber may be the natural result of a small globe, narrow angles, or an intumescent lens. Severe zonular laxity may result in an unexpectedly shallow chamber despite a normal axial length. A common cause of anterior capsular convexity is intraoperative shallowing of the anterior chamber due to escape of fluid or OVD through the wound. Excessive instrument pressure on the posterior incision lip will "burp" the chamber through a momentary wound gape, and the surgeon should interrupt the capsulotomy step to inject more OVD.

Because it creates more of a mass effect, a maximally cohesive OVD is better able to flatten the anterior capsular convexity when compared with a dispersive OVD. The latter better resists being burped out through the incision however. The soft-shell technique originated by Steve A. Arshinoff, MD, FRCSC, from the University of Toronto combines the complementary advantages of each OVD by placing the cohesive agent directly over the anterior capsule and blocking the incision with the dispersive OVD[1] (Figure 1). Healon 5 (Advanced Medical Optics, Inc., Santa Ana, CA) is a maximally cohesive and viscoadaptive OVD that combines both of these desirable characteristics in a single agent.[2]

## CAPSULAR ELASTICITY AND PSEUDOELASTICITY

The more elastic a material is, the more difficult it is to control how it tears. As an example, latex is more difficult to tear accurately than paper. As one attempts to tear an elastic material, it first stretches before abruptly splitting. Because of the rebound energy, the resulting tear is overly rapid and tends to slingshot away from, rather than toward, the grasping instrument. Because pediatric anterior capsules are very thin and elastic, the flap tends to spiral outward and is very difficult to control.[3] Similarly, the adult posterior capsule has less tensile strength, and it is thinner and more elastic than the anterior capsule. It behaves more like the pediatric anterior capsule, and accomplishing a posterior capsulorhexis is more challenging for this reason.

Lacking sufficient circumferential tension, a capsule that is not taut will also exhibit elastic behavior. As the surgeon pulls on the anterior capsular flap, the peripheral capsule should be immobile if he is to control the precise direction of the tear. This situation occurs if the zonules are intact, but weak zonules give rise to a condition that I call *capsular pseudoelasticity*,[4,5] where the anterior capsule is of normal adult thickness but behaves as though it is more lax and pliant due to insufficient zonular traction. Because the peripheral capsule will move along with, and in the same direction as the flap is being pulled, the tear is difficult to control and will tend to slingshot radially. Poor surgical technique whereby the capsular flap is allowed to become too long can also create pseudoelasticity. The farther the grasping point of the capsular forceps is from the tearing point, the more pliant the flap becomes, and the more difficult it is to direct the tear. If the tear tends to spiral radially outward, the surgeon must regrasp the flap closer to the leading edge of the tear.

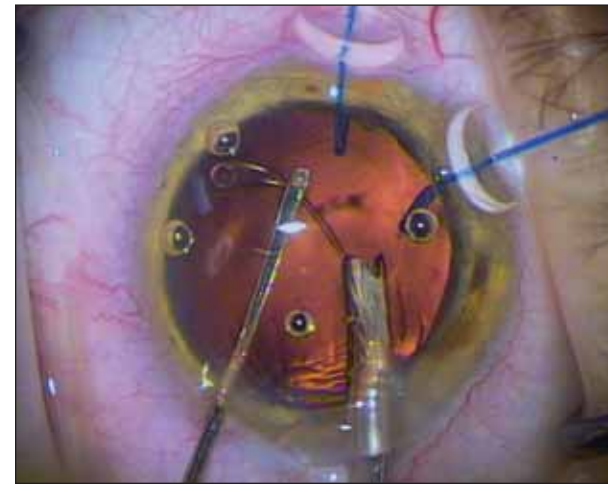

**Figure 2. Mackool capsular retractors (Impex Surgical, Staten Island, NY) are long enough to be able to hook the capsulorhexis edge and yet support the equatorial capsule.**

In higher-risk cases, I consider the capsulorhexis to be a "zonular stress test," because the first indication of how weak the zonules are becomes evident during this step. If the anterior capsule is very lax, the capsulotomy needle's tip will tend to dimple and indent it, rather than immediately puncture it. Next, as the surgeon tugs the capsular flap, the peripheral lens capsule is likely to stretch and move along with the flap toward the forceps. With extreme zonular weakness, the entire lens may start to move with the capsular forceps. The surgeon needs to take great care to avoid outward spiraling of the tear. In addition to using capsular forceps to regrasp the flap more frequently, employing the tear recovery technique originated by Brian Little, MD, from the Royal Free Hospital NHS Trust, in London, United Kingdom, is invaluable in these situations.

If pseudoelasticity is severe, the surgeon can use iris hooks or specially designed capsular retractors to help anchor the bag during the capsulorhexis step.[6] Richard Mackool, MD, Director of The Mackool Eye Institute and

Laser Center in Astoria, New York, has designed self-retaining retractors that are elongated enough to hook a small-diameter capsulorhexis from the limbus[7] (Figure 2). After completing several clock hours of the capsulorhexis, one or more capsular retractors can be placed. These retractors stabilize the bag and provide helpful countertraction against the tugging flap. Care must be taken to avoid placing too much tension on the capsular edge with the retractors, as this force alone can extend the tear uncontrollably. A surgeon can use the capsular tension segments created by Ike Ahmed MD, FRCSC, from the University of Toronto and the University of Utah in Salt Lake City, in a similar manner. A surgeon should never insert a capsular tension ring before completing the capsulorhexis, however, because the expansive force of the ring will extend the tear. If the pupil is of borderline size, enlarge its diameter with iris retractors. Optimal visualization of the peripheral capsular region is of far greater importance here than with a routine case.

Opinions differ regarding the target diameter of the capsulorhexis in eyes with loose zonules. A larger-diameter capsulorhexis will make nuclear and cortical removal much easier, but it is much harder to complete in eyes with capsular pseudoelasticity. With weakened zonules, the more peripherally the tear advances, the more it wants to veer radially outward, and the more difficult it is to rescue the flap. In comparison, a smaller-diameter capsulorhexis is easier to control. It increases the margin for error by allowing more time to recognize and rescue a peripherally escaping tear. Although a small-diameter capsulotomy may somewhat hinder the subsequent surgical steps, it is far preferable to having a torn capsular edge, particularly when other risk factors are present.

For this reason, I believe that one should always aim for a smaller-diameter capsulorhexis in the presence of significant zonular laxity. Successful completion of a continuous circumlinear edge is more important than attaining the optimal size. The surgeon must mentally visualize its diameter during nuclear emulsification, however, so as not to tear it with the chopper shaft or phaco tip. Bimanual instrumentation is superior for cortical cleanup in loose capsular bags and greatly improves subincisional access through a small capsulorhexis. Modern injectors facilitate implantation of foldable IOLs through a small capsular opening. Finally, the surgeon should secondarily enlarge the capsulorhexis after the IOL and capsular tension ring are safely implanted.

## CONCLUSION

In summary, achieving an intact capsulorhexis is crucial to the safety of the cataract procedure. To maximize the odds of success, the surgeon needs to make the diameter smaller when he encounters difficulty. Given the long-term importance of having a properly sized capsular opening, the surgeon should secondarily enlarge a small capsulorhexis following IOL insertion when the surgical conditions are more favorable. ■

1. Arshinoff SA. Dispersive-cohesive viscoelastic soft shell technique. *J Cataract Refract Surg.* 1999;25:167-173.
2. Arshinoff SA. Using BSS with viscoadaptives in the ultimate soft-shell technique. *J Cataract Refract Surg.* 2002;28:1509-1514.
3. Saini JS, Jain AK, Sukhija F, et al. Anterior and posterior capsulorhexis in pediatric cataract surgery with or without trypan blue dye. Randomized prospective clinical study. *J Cataract Refract Surg.* 2003;29:1733-1737.
4. Chang DF. Phacoemulsification in high-risk cases. In: Wallace RB, ed. *Multifocal IOLs and Refractive Cataract Surgery.* Chapter 11. Thorofare, NJ: Slack; 2001.
5. Chang DF. Strategies for the difficult capsulorrhexis. In: Chang DF, ed. *Phaco Chop.* Chapter 12. Thorofare, NJ: Slack; 2004.
6. Lee V, Bloom P. Microhook capsule stabilization for phacoemulsification in eyes with pseudoexfoliation-syndrome-induced lens instability. *J Cataract Refract Surg.* 1999; 25:1567-1570.
7. Mackool RJ. Capsule stabilization for phacoemulsification (letter). *J Cataract Refract Surg* 2000;26:629.

*(Continued from page 8)*

BAK destabilizes cell membranes and enhances the speed of microbial kill. Also, reducing the size of our wounds will greatly minimize the risk of endophthalmitis. Finally, I suggest prescribing antibiotics postoperatively for 10 to 14 days instead of 7, as supported by the Moshirfar study.

MRSA is here to stay as a major health concern. Be aware of it, and remember that prevention is the key. ■

1. Donnenfeld ED, Solomon, Holland EJ, et al. Changing trends in infectious keratitis following refractive surgery. Paper presented at: The ASCRS Symposium on Cataract, IOL and Refractive Surgery; April 16, 2005; Washington, DC.
2. Randleman JB, Woodward M, Lynn MJ, Stulting RD. Risk assessment for ectasia after corneal refractive surgery. *Ophthalmology.* 2008;115:1:37-50.
3. Solomon R, Donnenfeld ED, Perry HD, et al. Methicillin-resistant Staphylococcus aureus infectious keratitis following refractive surgery. *Am J Ophthalmol.* 2007;143:4:629-634. Epub 2007 Feb 23.
4. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 to June 2002, issued August 2002. *Am J Infect Control.* 2002;30:8:458-475.
5. Kowalski TJ, Berbari EF, Osmon DR. Epidemiology, treatment, and prevention of community-acquired methicillin-resistant Staphylococcus aureus infections. *Mayo Clin Proc.* 2005;80:9:1201-1207.
6. Lab Diagnostic Testing: Bacteria. The Charles T. Campbell Eye Microbiology Lab. Available at: http://eyemicrobiology.upmc.com/Bacteria.htm. Accessed February 1, 2008.
7. Donnenfeld. ED. Cornea clinical committee treatment of infectious keratitis. Paper presented at: The ASCRS Symposium on Cataract, IOL and Refractive Surgery; April 16, 2005; Washington, DC.
8. Major JC, Jr, Flynn Hw, Jr, Miller D, et al. Antibiotic sensitivities and visual acuity outcomes in endophthalmitis caused by methicillin-sensitive (MSSA) versus methicillin-resistant (MRSA) Staphylococcus aureus. Paper presented at: The 2006 ARVO meeting; May 4, 2006; Ft. Lauderdale, FL.
9. Moshirfar M, Feiz V, Vitale AT, et al. Endophthalmitis after uncomplicated cataract surgery with the use of fourth-generation fluoroquinolones: a retrospective observational case series. *Ophthalmology.* 2007;114:4:686-689.
10. Blondeau JM, Borsos S, Hesje CK. Antimicrobial efficacy of gatifloxacin and moxifloxacin with and without benzalkonium chloride compared with ciprofloxacin and levofloxacin against methicillin-resistant *Staphylococcus aureus. J Chemother.* 2007;19:2:146-151.
11. Barry P, Seal DV, Gettinby G, Lees F. ESCRS study of prophylaxis of postoperative endophthalmitis after cataract surgery: preliminary report of principal results from a European multicenter study. *J Cataract Refract Surg.* 2006;32:3:407-410.

## CME QUESTIONS

**CME credit is available electronically via www.dulaneyfoundation.org.**

To answer these questions online and receive real-time results, please visit **www.dulaneyfoundation.org** and click "Online Courses." If you are experiencing problems with the online test, please e-mail us at **support@dulaneyfoundation.org** and explain the details of any problems you encounter with the Web site. Alternatively, you can fax your exam to us at (610) 771-4443. Please note, in order to receive your certificate and credit when faxing your test, you must include your full name as well as an e-mail address, as certificates will be issued electronically. If you do not have an e-mail address, please include a fax number or a physical mailing address and indicate how you would like to receive your certificate (ie, fax, e-mail, physical mail). Please print clearly.

**1. Thiazide diuretics compromise what ocular component?**
a. The iris
b. The zonules
c. The tear film
d. The sclera

**2. Which of the following was not listed as a strategy for optimizing tear film?**
a. Artificial tears
b. Oral omega-3 fatty acids
c. Punctual occlusion
d. Topical NSAIDs

**3. Topical cyclosporine works by improving all three layers of the tear film.**
a. True
b. False

**4. Which statement about the mechanism of action of steroids and NSAIDs is correct?**
a. Steroids have a reversible bond, and NSAIDs have a nonreversible bond
b. Steroids have a nonreversible bond, and NSAIDs have a reversible bond
c. Both steroids and NSAIDs have a nonreversible bond
d. Both steroids and NSAIDs have a reversible bond

**5. What preoperative dosing regimen does Dr. Wittpenn recommend for NSAIDs in routine cataract surgery?**
a. 3 days
b. 1 to 2 days
c. 1 to 3 days
d. 1 week

**6. A study presented at the 2006 ARVO meeting showed that what percentage of refractive surgery patients who have endophthalmitis are resistant to the generic moxifloxacin and gatifloxacin?**
a. 25%
b. 35%
c. 45%
d. 55%

**7. According to the Moshirfar study, what is the average time to presentation of endophthalmitis?**
a. 3.5 days
b. 6.2 days
c. 9.3 days
d. 10.2 days

**8. What did Dr. Chang state were the four general conditions that increase the risk of a radial capsulorhexis tear?**
a. Poor visibility, eye movement, chamber shallowing, and weak zonules
b. Poor visibility, eye movement, chamber shallowing, and increased capsular elasticity
c. Ocular instability, chamber shallowing, increased capsular elasticity, and small pupils
d. Poor corneal tear film, poor visibility, increased capsular elasticity, and wound gaping

**9. Which type of ophthalmic viscosurgical device (OVD) is better for flattening anterior capsular convexity?**
a. A dispersive OVD
b. A cohesive OVD

**10. Pseudoelasticity is primarily a result of insufficient zonular traction.**
a. True
b. False