Ophthalmology MANAGEMENT
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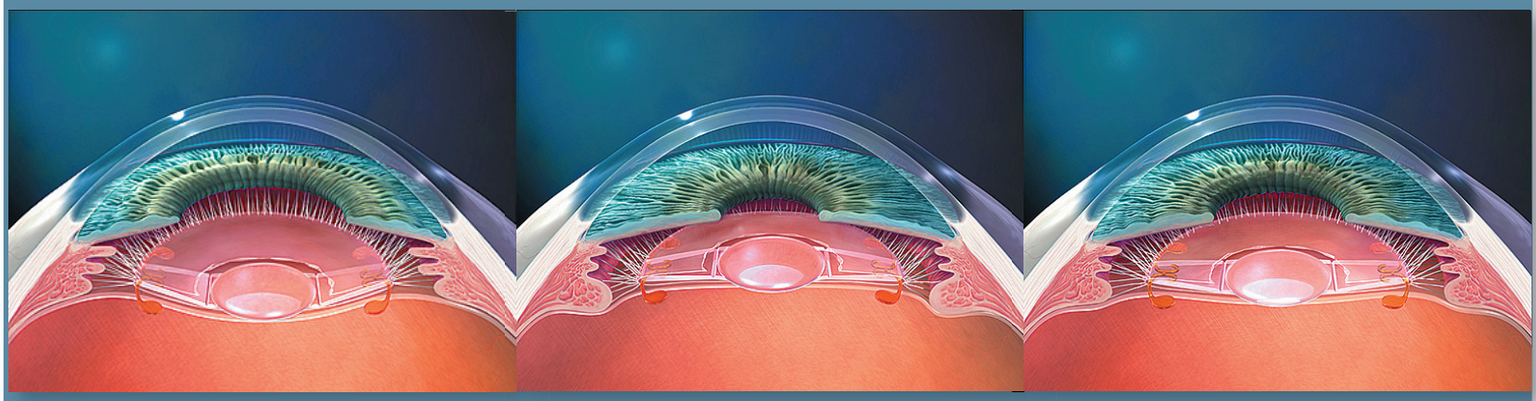
INCORPORATING THE

Crystalens HD into Practice

Learn about the benefits of this accommodating IOL and how top surgeons are maximizing visual outcomes in refractive cataract patients.



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By Jay S. Pepose, MD, PhD

Learn the Keys to Success With Crystalens HD

The Crystalens gives patients increased depth of field without compromising visual quality.

If you want to minimize patient complaints associated with presbyopia-correcting IOLs and maximize patient satisfaction, you must produce high retinal image quality. While patients with residual refractive error after cataract surgery have difficulty reading the lower lines of the eye chart, those who have reduced retinal image quality and decreased contrast sensitivity report that even the larger optotypes on the eye chart appear waxy or ghosty. The most common cause of decreased contrast sensitivity is cataract, partly due to forward scatter of light, but decreased contrast sensitivity also has been reported in some patients following multifocal IOL implantation.

Just as every passenger who steps onto an airplane assumes the pilot knows how to safely fly and land, patients with lenticular dysfunction expect high-quality, uncorrected distance vision when choosing a premium channel IOL. In contrast to refractive or diffractive multifocal IOLs, the Crystalens doesn't simultaneously divide light into multiple focal points or sacrifice a portion of light energy to unfocused higher diffractive orders (**Figure 1**).

By definition, multifocal IOLs project more than one image onto the retina simultaneously, which may result in decreased contrast sensitivity that isn't obviated by the addition of an aspheric optical design (**Figure 2**). Decreased contrast sensitivity associated with multifocal IOLs, compared with monofocal or accommodating lenses (particularly at lower spatial frequencies), can cause decreased reaction time during night driving, impaired perception of facial expressions, difficulty in judging the edge of a curb and carrying out other daily tasks. That's why FDA labeling for multifocal IOLs states that "a reduction in contrast sensitivity as compared to a monofocal lOL may be experienced by some patients and may be more prevalent in low-lighting conditions. Therefore, multifocal IOL patients should exercise caution when driving at night or in poor visibility conditions." No comparable warning exists for the Crystalens accommodating IOL.

In this article, I'll discuss the unique features of the Crystalens HD and how it compares with multifocal IOLs. I'll also explain how the Crystalens can restore full range of vision for patients and how to choose the best candidates for this accommodating IOL.

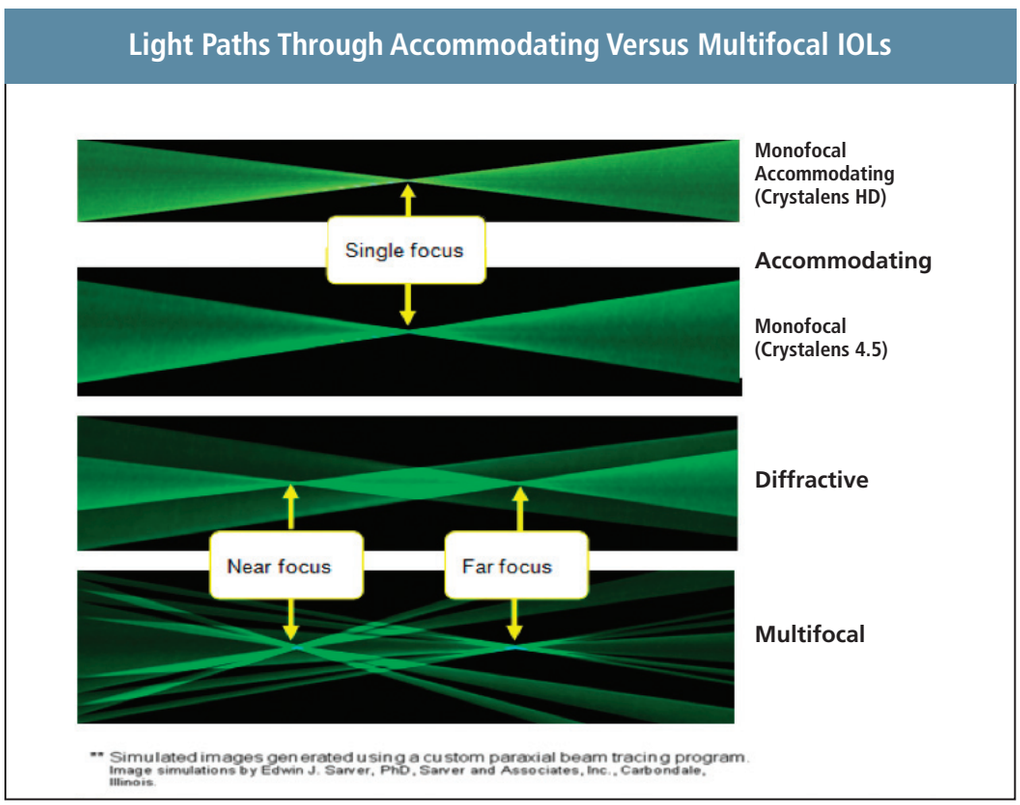

Figure 1. Simulated images generated by a customized paraxial beam tracing program demonstrate a single point of focus with Crystalens IOLs, in contrast to diffractive and refractive multifocal technologies.

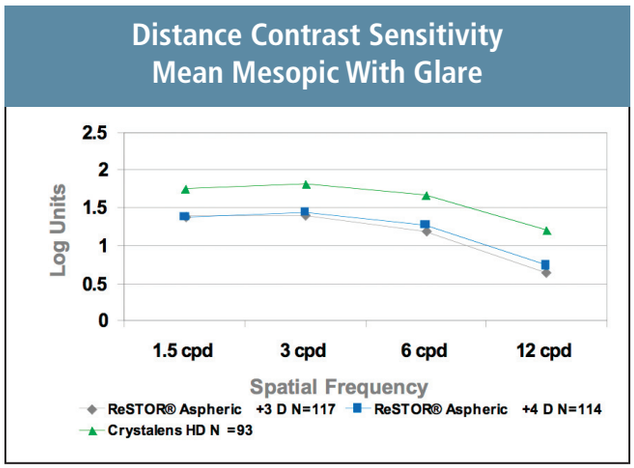

Figure 2. Multifocal IOLs project more than one image onto the retina simultaneously, which may result in decreased contrast sensitivity, and can't be resolved with the addition of an aspheric optical design.

Crystalens Difference

Crystalens IOLs are a modified plate haptic design made from silicone of high refractive index with an ultraviolet filter. The lens is hinged adjacent to the optic and has T-shaped polyamide loops on the plate haptics. Since the introduction of the first-generation Crystalens in 2003, a number of modifications have been made to improve its stability and predictability. The first revision created Crystalens AT-45SE, which, with its square-edged optic, showed a reduced incidence of asymmetric capsular fibrosis and therefore capsular contractions and IOL tilt. For the Crystalens Five-0, the third-generation Crystalens, the lens diameter was enlarged from 4.5 mm to 5.0 mm. The shape of the haptic plates became square to optimize capsular support, and the haptic arc was increased to create greater stability. The Crystalens HD, the fourth-generation Crystalens, has been enhanced further to ensure excellent vision at all distances without any loss of contrast sensitivity. It has a reduced radius of curvature in the central 1.5-mm zone of the optic.

This bispheric modification adds approximately another 1D of add to the lens and improves its near (**Figure 3**) and intermediate vision compared with its predecessors, without reducing contrast sensitivity or distance vision. The increased depth of focus compared with its 4.5-mm predecessor is clearly seen on optical bench testing (**Figure 4**). Crystalens is designed to undergo a shape confirmation during ciliary muscle contraction, known as accommodative arching, demonstrated on finite element analysis (**Figure 5**).

Proper targeting is essential to maximize the performance of the Crystalens HD. The recommendation for the Crystalens Five-0 was to target between plano and -0.25D for the dominant eye and -0.50D for the nondominant eye. But this recommendation has changed for the Crystalens HD, because of the effect of negative spherical aberration and its interaction with defocus. The image quality is higher when the dominant eye is targeted slightly plus, and the effect of wound healing averages approximately a -.21D myopic shift over 3 months. This is another reason why it may be prudent to wait 90 days for a laser vision enhancement. The nondominant eye can be targeted a bit minus, according to the patient's response in the dominant eye at distance and near.

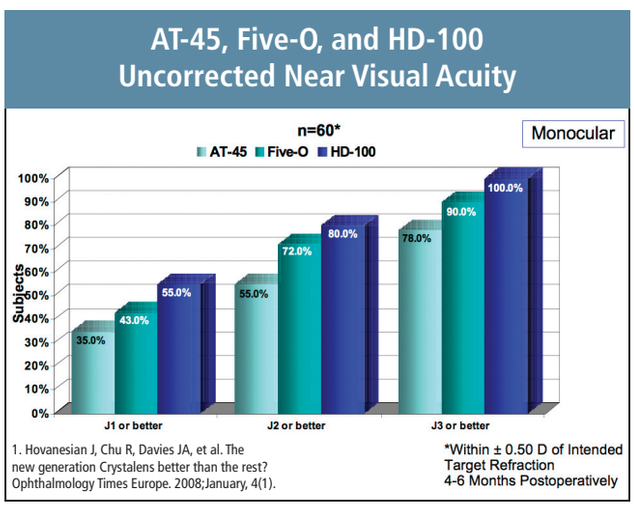

Figure 3. Based on a cross-study comparison, eyes implanted with the Crystalens HD had the best monocular uncorrected visual acuity compared with eyes implanted with the Crystalens AT-45 and Crystalens Five-O.

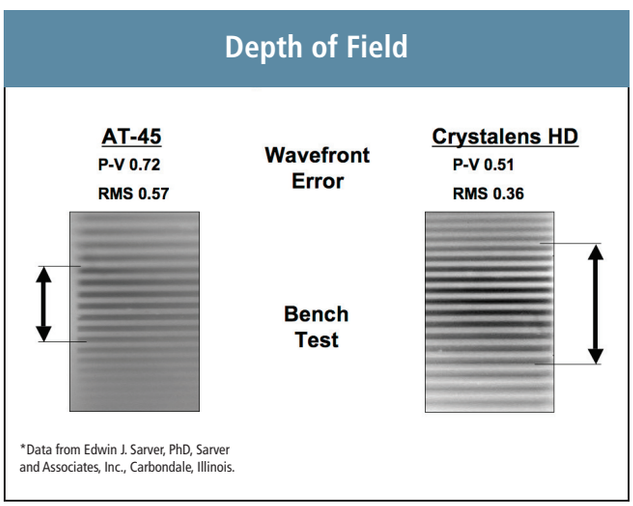

Figure 4. The Crystalens HD provides increased depth of focus compared with the AT-45, as shown on optical bench testing. The peak-to-valley value and the RMS wavefront error values are lower with the Crystalens HD.

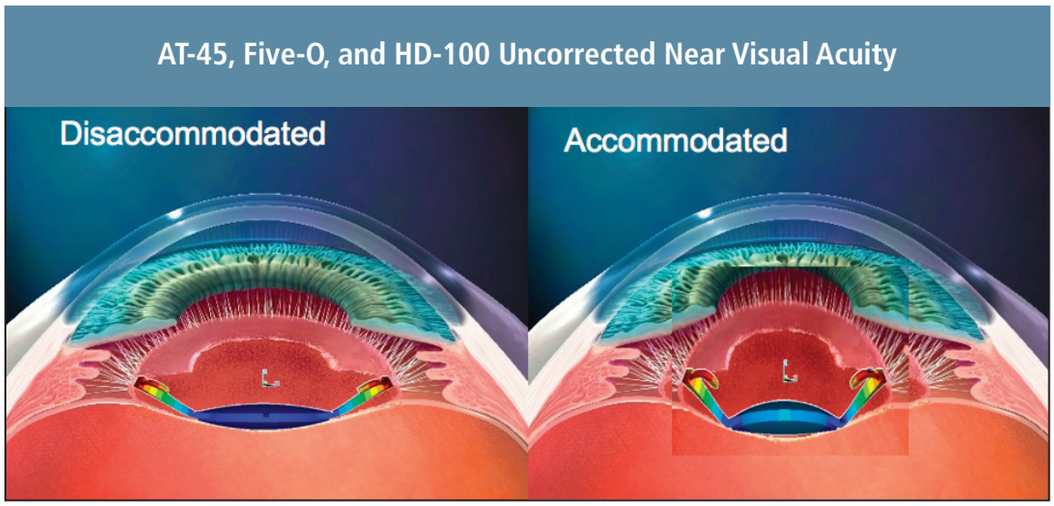

Figure 5. The Crystalens HD is designed to undergo a shape confirmation during ciliary muscle contraction, known as accommodative arching, demonstrated on finite element analysis.

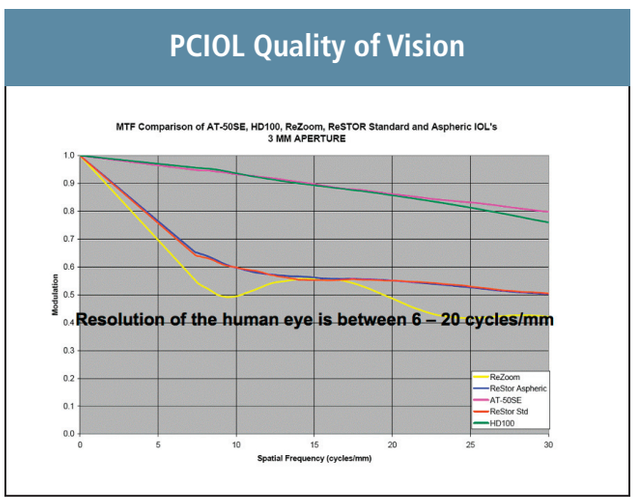

Figure 6. This slide compares the modulation transfer function of a 3-mm pupil plotted over a wide range of spatial frequencies for the Crystalens HD and Crystalens Five-O compared with the aspheric and standard ReStor and ReZoom IOLs.

Comparison With Multifocal IOLs

The modulation transfer function (MTF) is a ratio of relative image contrast to relative object contrast. **Figure 6** compares the MTF of a 3-mm pupil plotted over a wide range of spatial frequencies for the Crystalens HD and Crystalens Five-0 compared with the aspheric and standard ReSTOR and ReZoom IOLs. The higher MTF for the accommodating lenses reflects superior image contrast.

The increasing longevity of our patients creates additional concerns about the use of multifocal IOLs to improve near vision at the expense of contrast sensitivity. Contrast sensitivity decreases with each decade of life, so the way a multifocal IOL functions today in a particular patient may not be the case in the same patient 10 or 15 years from now. Also, it's not possible to determine which patients may go on to develop age-related macular degeneration, glaucoma or other comorbidities that may further reduce contrast sensitivity in the future. Finally, pupil size, shape and dynamics often are affected by age, so some multifocal IOLs that have pupil-dependent distribution of light energy between various foci may function differently as the patient ages. With all lenses, image quality and tolerance to defocus is pupil-dependent. For example, **Figures 7 and 8** show through-focus images of United States Air Force (USAF) 1951 resolution targets, using monochromatic light at varying vergence for ReSTOR spherical (top row), aspheric ReSTOR (middle row) and Crystalens HD (bottom row). As shown, the USAF 1951 targets demonstrate better image quality with the Crystalens HD. Aspheric optics have only small beneficial effects on image quality until the pupil exceeds 4 mm, but maximum pupil dilation lessens with age.

Choosing the Best Candidates

Most patients with lenticular dysfunction are candidates for the Crystalens HD if their goal is to reduce their dependence on eyeglasses postoperatively. However, when first starting out, it may be best to begin with patients who are the easiest to satisfy — those who have significant cataracts, 1D or less of astigmatism, easy-going personalities, positive attitudes and reasonable expectations. In general, hyperopes often have lower preconceived expectations compared to low-to-moderate myopes with regard to near vision postoperatively, since the latter are used to reading without eyeglasses. Patients with map-dot-fingerprint dystrophy, severe dry eye, irregular corneal astigmatism, macular pathology or advanced glaucoma aren't ideal candidates. Post-LASIK patients generally are good candidates for the Crystalens, but they need to understand that the accuracy of

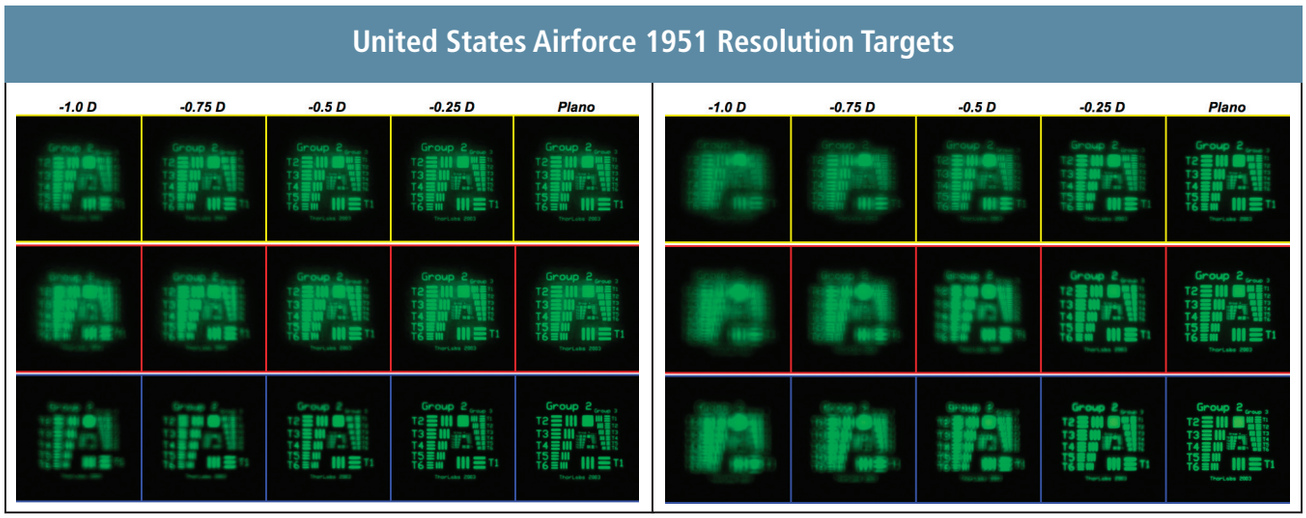

Figure 7 (2-mm pupil [left]) and Figure 8 (4-mm pupil [right]). These slides illustrate through-focus images of United States Airforce 1951 resolution targets, using monochromatic light at varying vergence for ReSTOR spherical (top rows), aspheric ReSTOR (middle rows) and the Crystalens HD (bottom rows). These resolution targets demonstrate better image quality with the Crystalens HD.

IOL power calculations isn't fully predictable in their case and that they may require a laser vision enhancement. I often use the Crystalens Five-0 for post-hyperopic LASIK patients, because they tend to have higher negative spherical aberration, although I rely on the Crystalens HD for all of my other cases. Similarly, patients with very high levels of corneal astigmatism preoperatively must be made aware of the greater likelihood of requiring laser vision enhancement after surgery.

The key to success is establishing achievable, realistic expectations. You must explain to patients that reading the stock page or a menu in a dimly lit restaurant likely will require reading eyeglasses, and that there's no guarantee with any lens implant that they'll be completely free of eyeglasses all of the time. I emphasize that these new lenses are superior to the monofocal IOLs of the past, but they still won't have the depth of focus of the natural crystalline lens in a 20-year-old. I explain that a reasonable expectation would be like having the near vision of someone around age 40, not age 20. I've found that the best approach is to underpromise and then overdeliver. Most patients readily comprehend that there's no prosthetic device that can compare to that of a 20-year-old. I use terms such as "walk around vision" to establish realistic expectations. I tell patients that it's possible to drive to the supermarket, look down the aisle and read what's on the front of a soup can without eyeglasses, but they'll probably need eyeglasses to read the smallest ingredients on the back of the can.

Finally, you'll need to inform patients before surgery that they may require additional procedures, such as Nd:YAG laser capsulotomy or laser vision correction, to achieve their desired visual acuity, and that this process from start to finish can span up to 3 months. The assessment for laser vision correction (ie, corneal topography, regional pachymetry, dry eye status) is integrated into the initial cataract evaluation for the Crystalens patient. Comorbid conditions that can negatively impact outcomes, such as dry eye syndromes, must be treated preoperatively. It's important to monitor patients for the development of posterior capsular fibrosis, capsular contraction and cystoid macular edema. Keeping patients on a lengthy postoperative tapering regimen of NSAIDs and corticosteroid drops may minimize these complications. **OM**

By Jay S. Pepose, MD, PhD

Communicating Unreimbursed Fees Associated With the Crystalens HD

Discussing the costs and benefits of premium IOLs with staff and patients is imperative for success.

In 2005, the Center for Medicare and Medicaid Services (CMS) issued a ruling, stating that the presbyopia-correcting functionality of an IOL doesn't fall into the benefits category, and therefore isn't covered, along with provider or physician services required to insert a presbyopia-correcting IOL or monitor a patient receiving a presbyopia-correcting IOL.

With this mandate, for the first time in ophthalmology, the physician can bill for the difference in cost of a premium IOL over a standard monofocal IOL and the additional services associated with implantation and postoperative management. This change created a true paradigm shift for patients, physicians and staff. While patients anticipated incurring out-of-pocket expenses when going to the dentist for a crown or bridge, they were accustomed to nearly carte blanche coverage when their physician wasn't performing cosmetic surgery. Because of this fairly recent change in policy, it's not unusual to encounter patients who express dismay when they learn that Medicare won't fully cover the costs of services and products associated with premium lens implantation.

However, thanks to the availability of long-term, no-interest financing, patients can better afford the cost of the Crystalens HD and fit it into their monthly budgets. In my practice, we offer the services of Care Credit. Patients can quickly determine their eligibility online in a matter of minutes.

This article will review the importance of educating staff and patients about the out-of-pocket costs associated with premium IOLs, the inherent benefits of IOLs and strategies to communicate the surgical process to patients.

Communication Challenge

Whether or not patients are eligible for long-term financing, ophthalmologists are presented with the challenge of effectively educating patients and staff about the value of the additional services and benefits associated with premium-IOL implantation. For example, a cataract evaluation for presbyopia-correcting IOLs requires additional tests to determine a patient's candidacy for laser vision correction, since this may be required postoperatively to achieve the desired visual outcome. The surgeon needs to assess corneal topography (not just keratometry), regional pachymetry, dry eye status, risks for developing ectasia, in addition to the standard cataract evaluation. Biometric testing may be more extensive.

Physicians must make patients aware of these additional services and benefits associated with their out-of-pocket expenses. It's best to discuss these issues and put them in writing. Sometimes the staff isn't fully aware of these additional services, the amount of chair time involved or the details of postoperative coverage.

Since postoperative enhancements are generally delayed 90 days or longer to allow for possible refractive effects of healing, the length of time allotted for covered post-op services is longer than the customary 90-day window Medicare provides. Physicians must make patients aware of these additional services and benefits associated with their out-of-pocket expenses. It's best to discuss these issues and put them in writing. Sometimes the staff isn't fully aware of these additional services, the amount of chair time involved or the details of postoperative coverage. If staff members don't appreciate the added value and cost of providing these services, they could subliminally convey their uneasiness to patients and inadvertently undermine a refractive

It's important to explain to patients that the Crystalens HD provides better enhanced near vision and depth of field than monofocal IOLs and isn't associated with increased photic phenomenon or decreased contrast sensitivity seen in some patients who have multifocal IOLs. However, because it's a man-made lens, it doesn't compare with the form and function of the natural crystalline lens we had when we were 20-years-old.

IOL practice. So staff education is as important as patient education.

Benefits of Premium IOLs

Quality of life and quality of vision surveys attest to the benefits of the Crystalens.[1,2] There's a delicate balance between conveying the improvement in depth of field associated with the Crystalens HD without creating unreasonable or unachievable expectations. It's important to explain to patients that the Crystalens HD provides better enhanced near vision and depth of field than monofocal IOLs and isn't associated with increased photic phenomenon or decreased contrast sensitivity seen in some patients who have multifocal IOLs. However, because it's a man-made lens, it doesn't compare with the form and function of the natural crystalline lens we had when we were 20-years-old. More appropriately, physicians should compare the Crystalens HD to alternative, existing IOL technology, not the natural lens in youth. My staff emphasizes that choosing a particular IOL is a once-in-a-lifetime opportunity, and in these times of economic uncertainty, what better investment is there than in yourself? As Shareef Mahdavi, MD, once asked, "What other purchase can you make, which you'll use 16 hours a day, every day for the rest of your life?"

Avoiding Unwanted Surprises

Patients implanted with the Crystalens, like any other premium IOL, may require Nd:YAG laser capsulotomy or postoperative laser vision enhancement. It's important to discuss these possibilities before cataract surgery, so patients don't view the development of posterior capsular fibrosis as a failure of the IOL procedure. Some surgeons roll the cost of potential laser vision enhancement into their global fee, while others charge an additional surgical fee or limit it to a facility fee. I recommend physicians discuss any potential additional costs preoperatively and have patients sign a written document outlining all potential fees. Ask your staff to make a copy of the document to give to the patient and keep a copy in the office medical records, so there's no miscommunication.

Change is the Only Constant

I often tell my staff that the only thing one should count on is change. Yet, change can be quite painful — for patients who have become accustomed to Medicare benefits that have been established for many years and for nonrefractive surgery practices that aren't used to asking patients for out-of-pocket expenses for unreimbursed products and services. I anticipate that the premium IOL model of patients paying for upgraded services could become more prevalent in other aspects of ophthalmology and the medical profession in general. We need to embrace this change in our practices and facilitate it with effective communication. **OM**

References

1. Pepose JS, Qazi MA, Davies J, et al. Visual performance of patients with bilateral vs combination Crystalens, ReZoom, and ReSTOR intraocular lens implants. *Am J Ophthalmol.* 2007;144:347–357.
2. Cumming JS, Colvard DM, Dell SJ, et al. Clinical evaluation of the Crystalens AT-45 accommodating intraocular lens: results of the U.S. Food and Drug Administration clinical trial. *J Cataract Refract Surg.* 2006;32:812–825.

By John F. Doane, MD, FACS

Maximizing the Use of the Crystalens HD In a Variety of Cases

Understand how this top surgeon managed patients preoperatively and postoperatively for optimal outcomes.

The introduction of the Crystalens HD has had a tremendous impact on my refractive and cataract surgery practice. This accommodating IOL provides distance, intermediate and near visual acuity in a single eye. In a bilateral implantation, the synergistic effects are greater than the individual parts, giving credence to the adage "two eyes are better than one."

Simply implanting the Crystalens HD in and of itself is a new process, because it's a flexible haptic-plate-optic platform. Aside from implanting the lens, the more important task involves understanding what patients want and expect from their surgery and managing key issues postoperatively.

With 10 years of experience implanting the Crystalens, I've learned many things about patient management. For example, a physician has to have the wherewithal to know he may have to employ a different surgical technique in each eye. Specifically, limbal relaxing incisions (LRIs) may be required in 30% of cases, and small laser vision correction adjustments of 0.50D of spherical equivalent may be needed in 20% to 25% of eyes to achieve patient satisfaction. With perseverance, surgeons can achieve this.

The following case studies demonstrate the diverse applications for the Crystalens HD in a 21st Century cataract and refractive surgery practice.

With 10 years of experience implanting the Crystalens, I've learned many things about patient management. For example, a physician has to have the wherewithal to know he may have to employ a different surgical technique in each eye. Specifically, limbal relaxing incisions (LRIs) may be required in 30% of cases, and small laser vision correction adjustments of 0.50D of spherical equivalent may be needed in 20% to 25% of eyes to achieve patient satisfaction.

Case 1

A 72-year-old man presented with a 3-year history of decreasing distance and night vision. He had an approximate 10-year history of type 2 diabetes and was being treated for arthritis and hypertension. He had previously corrected to 20/15 in each eye separately but we tested him with best-spectacle correction at 20/25 minus in each eye.

His preoperative manifest refraction was -2.25 +0.5 x 045 OD and -3.0 +0.5 x 050 OS. Manual keratometry was OD 44.25 x 000 / 44.75 x 090, and OS 44.12 x 177 / 45.25 x 087. Pachymetry was 550 microns OD and 561 microns OS. IOL Master axial lengths were 25.73 OD and 26.15 OS. His scotopic pupil size was 6.1 mm OD and 6.3 mm OS.

Meeting Expectations

The patient led an active lifestyle. He wanted spectacle independence but no induced scotopic symptoms, so we implanted the Crystalens HD bilaterally during cataract surgery. Because I usually induce about 0.50D of corneal astigmatism 90° from my temporal incision, I decided to place a 5-mm LRI with a 600-micron blade setting at 270° OD and a 5-mm LRI with a 600-micron blade setting at 087° and 267°.

The target for the first eye (left) was -0.75D. The patient had a relatively long eye, normal K values but low myopia. The longer end-to-end length HD-520 lens was available, but I selected a 12.5D Crystalens HD-520 IOL, because the unadulterated Holladay 2 formula within the Holladay IOL Consultant predicted a -0.65 refraction. At 4 days post-op, his un-

Simply implanting the Crystalens HD in and of itself is a new process, because it's a flexible haptic-plate-optic platform. Aside from implanting the lens, the more important task involves understanding what patients want and expect from their surgery and managing key issues postoperatively.

corrected distance vision was 20/20-1 and J-6 at near. The right eye underwent surgery 4 days after the left eye. I targeted -0.50D and selected a Crystalens HD-520 13.5D lens that predicted a -0.57 refraction with an unadulterated Holladay 2 formula.

Post-op Care

After surgery, I routinely prescribe prednisolone acetate (Pred Forte, Allergan Inc.) q.i.d. and taper it by day 28. I prescribe ketorolac (Acular, Allergan Inc.) q.i.d. for 28 days as well as gatifloxacin (Zymar, Allergan Inc.) q.i.d. for one week. At 5 months post-op, the patient's uncorrected distance vision is 20/25+2 OD, 20/25 OS and 20/20 OU. His uncorrected near vision at 14 inches is J-3 OD, J-3 OS and J-1 OU. His manifest refraction was -0.75 + 0.5 x 118 for 20/20 OD and -0.25 sphere for 20/20 OS and 20/20 OU. At 4 months post-op, he reported difficulty reading. I suggested he put a lamp by his favorite chair in which he reads, and this resolved the issue. Now, he's reading comfortably with no correction.

Case 2

I evaluated a 51-year-old sales executive who complained about being "burned out" when it came to wearing contact lenses and eyeglasses. His refraction was -2.25 +1.5 x 170 for 20/20 OD and -3.0 +0.5 x 005 for 20/20+ OS. His uncorrected near vision without distance correction was J-2 OD and J-3 OS. His distance corrected near vision without add was J-10 and J-5. His spectacle-corrected distance vision OS was undercorrected by -0.75D so he could function without a bifocal, which was his preference. He didn't want full monovision, and wasn't sure he wanted a target of -1.5 sphere in his nondominant eye. Because of the patient's expectations, the only solution I could offer was a presbyopia-correcting IOL.

Before surgery, I explained that he'd lose the excellent near vision he had with his contact lenses and eyeglasses if I targeted him for plano at distance. He understood this, but his priority was to improve his uncorrected distance vision. His manual keratometry was 41.5 sphere OD and 42.00 x 000 / 41.50 x 095 OS. His pachymetry was 520 OD and 530 OS. His axial lengths were 25.57 mm OD and 25.63 mm OS. His scotopic pupil size was 6.5 mm OD and 6.8 mm OS. Interestingly, he had flatter than average K readings and longer than average axial lengths. The patient was approximately 6 feet, 5 inches tall, so these measurements gave him an advantage for reading because of his long arms, as you'll see below.

IOL Selection

I selected a 17.0D HD-500 lens for the patient's left eye. I targeted -0.5 sphere in the left eye and predicted a -0.03 refraction with the unadulterated Holladay 2 formula within the Holladay IOL Consultant. At 1 week, the refraction was -1.0 +0.5 x 128 for 20/20+2, and his uncorrected near vision was J-5 at 24 inches. For the right eye, I selected a 17.0D HD-500 lens that predicted +0.33D postoperatively. At 1 week post-op, the patient's uncorrected distance vision was 20/20 OD; the uncorrected near vision was J-1 at 24 inches and the refraction was -0.25 +0.5 x 013 for 20/15-1 acuity. At 4 months post-op, the patient reported he was doing well. His uncorrected distance vision was 20/20-2 OD, 20/25-1 OS and 20/20 OU. His uncorrected near vision was J-3 in each eye and J-1 OU. He reported his near, intermediate and distance vision was good. The length of his arms allows him to read 20 inches out for near vision, but he requires no correction.

Case 3

A 49-year-old woman who was employed as a claims adjuster complained of decreased distance and near vision. Her ocular history included 16-cut RK OD and 12-cut RK OS in 1993. Her fogged manifest refraction was +1.75 +1.0 x 170 OD for 20/20-1 and +3.75 +0.5 x 130 for 20/25 OS. As with all RK cases, I perform an early morning (8 am), midday (noon) and late afternoon (after 4 pm) refraction to determine diurnal variation. The patient had no significant refractive change (> 0.75D spherical equivalent between most minus and most plus refractions). Two options were presented to her: a multifocal rigid contact lens or bilateral accommodative IOLs in a refrac-

tive lens replacement procedure. Her manual K readings were 37.12 x 005 / 39.00 x 095 OD and 36.75 x 042 / 36.37 x 132 OS. Her central pachymetries were 632 OD and 631 OS. The patient had normal bilateral endothelium. Her axial lengths were 24.55 mm OD and 24.62 mm OS. Her scotopic pupil sizes were 6.1 mm OD and 6.2 mm OS.

Calculating IOL Power

Based on the average central 2-mm optical zone K reading from the Humphrey Atlas topographer, I selected a K-true value. I subtract 1.0D from this value and insert this as the K-true reading for the IOL calculation. In this patient's case, the value for the left eye was 34.0D; the value for the right eye was 35.8D. The adjusted K- true value was 33.0D OS and 34.8D OD. For the left eye, I selected a 30.0D HD-500 lens. The unadulterated Holladay 2 formula predicted a -0.75 refractive error. Important note: If eight or more incisions are required, generally I'll choose a scleral tunnel wound construction to avoid rupturing the radial incisions. For six or fewer incisions, I'll choose a clear cornea technique.

Post-op Results

At 1 week post-op, the refraction was +1.5 sphere for 20/25+1 acuity OS. This was an excellent 1-week refractive end point. At 1 week, the cornea was artificially flat due to corneal edema. As the edema decreases, the cornea assumes its presurgical corneal value. At 1 to 2 months post-op, the eye stabilizes and presents the end refraction.

Keep in mind that if the patient is plano or minus at 1 day and 1 week post-op, you can expect progressively more minus to occur at 1 month and possibly 2 months after surgery. In a longer eye, my experience with the HD-500 is that I'll possibly get more minus than predicted by the unadulterated Holladay 2 IOL formula. In cases such as this, I'd prefer to be plano or slightly 1.0D to 2.0D hyperopic postoperatively, because these cases are much easier to get to plano with a hyperopic corneal laser vision correction than a flattening or myopic procedure. These corneas already are significantly flat and may not get any flatter with a myopic excimer laser ablation procedure.

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For the patient's right eye, I selected a 29.0D HD-500 lens that predicted a -1.09 refractive error based on the unadulterated Holladay 2 formula. At 1 day post-op, the refraction OD was +1.50 +0.5 x 047 for 20/30+2. The uncorrected visual acuity was 20/30-2 OD, 20/30 OS and 20/25 OU. The uncorrected near was J-2+ OD, J-3+ OS and J-1 OU. The manifest refraction was -0.5 +0.75 x 043 for 20/25 OD and -0.5 +1.25 x 005 for 20/25 OS.

Interestingly, the near visual acuity with best distance correction was J-1 OD, J-2 OS and J-1 OU. The patient's average 2-mm optical zone average K value had returned to its pre-op reading, so I'm fairly certain there will be no significant change in the end result. It's possible the patient has completed treatment. In my experience, a patient who had previous radial keratotomy will require additional laser vision correction about 35% to 40% of the time to reach a refractive end point that allows spectacle independence. **OM**

By John F. Doane, MD, FACS

Gleaning the Bottom-line Benefits of Premium IOLs

Learn how far premium IOLs have come and how valuable they can be in an ophthalmology practice.

Premium IOLs provide many benefits to patients, surgeons and ophthalmology practices. I couldn't imagine not having the capability of implanting presbyopia-correcting IOLs. In 1995, as a fellowship-trained refractive surgeon, I believed the fundamental surgical technique would be LASIK. At that time, the median age of the baby boomer population was 40 years old, which coincidentally was the average age of patients seeking laser vision correction. From 1995 to 2004, we saw tremendous growth and then a decline in the number of laser vision correction candidates. I believe demand will pick up again, but probably not for a few years.

In this article, I'll discuss the limitations we once had as cataract and refractive surgeons more than 10 years ago and explain what we can do now with accommodative IOLs to ensure the best outcomes in our patients.

Earlier Unmet Expectations

Around 1997, I realized that corneal refractive surgery couldn't provide everything patients wanted. Essentially, they desired binocular distance, intermediate and near vision without correction. One difficult group of patients were those needing hyperopic corneal procedures greater than 3D. Hyperopes generally don't inquire about laser vision correction until age 50. Usually, the need for correction in this population isn't just for distance but primarily for better near vision. To that end, these patients would need an additional 1.5D to 2D of hyperopic correction. But this is simply too much surgery for the cornea to effectively create an optic for long-term patient satisfaction. The ultimate kicker is that these patients tend to have drier eyes. And the way physicians perform the ablation in the mid-periphery tends to exacerbate dry eye symptoms.

We also have a slight dilemma with the typical emmetropic presbyope and myopic presbyope. For laser vision correction to work, the patient must be willing to have a physician create monovision. Approximately 40% of these patients can't tolerate monovision; 30% enjoy it, and the remainder tolerate it. Those who simply tolerate it may have to wear eyeglasses for night driving and some reading tasks because of the rivalry between the two eyes. In 1997 and 1998, the only way you could combat presbyopia surgically was to induce some aspect of monovision with corneal-based procedures or IOLs. So, in 2000 researchers initiated the first FDA study for accommodative IOLs with the Crystalens (Cumming JS, et al. *J Cataract Refract Surg*. 2006;32:812-825).

Debut of Accommodative Lenses

The study demonstrated that accommodative IOLs could be the solution to resolving presbyopia. We can't promise 99% of patients spectacle independence, minimal-to-no unwanted scotopic symptoms and equal binocular vision at distance, intermediate and near. However, with bilateral implantation of accommodative IOLs, we can promise excellent quality of vision, minimal-to-no binocular imbalance and no induced scotopic symptoms.

What are the shortcomings? In my practice, I've learned you must reduce refractive astigmatism to 0.50D or less, 20% of eyes will undergo laser vision correction, and a certain amount of surgeon-patient hand-holding is required. You must be available, compassionate, cognizant of patients' time and understanding, because you're serving a group whose expectations are above the traditional monofocal cataract patient who already expects to wear eyeglasses for the rest of his life.

Premium IOLs Are a Must

Fundamentally, offering premium IOLs makes all the sense in the world. Patients want exceptional vision. Performing the surgery and providing the highest quality of vision enables the entire practice to be involved in something that only a few years ago was just a dream for a few innovators in the ophthalmic field.

Because of this, it's important for surgeons and staff to communicate to patients what they can and can't provide. If the surgeon can over-deliver on what the patient is expecting, he can obtain a visual outcome with the glass more than half full. **OM**

By Uday Devgan, MD, FACS

Optimizing the Crystalens HD in Refractive Cataract Surgery

Learn how this surgeon maximizes visual outcomes preoperatively, intraoperatively and postoperatively.

The ideal intraocular lens implant would be similar to the young, natural crystalline lens. It would provide sharp vision over a wide range of distances with great image quality and no dysphotopsias. Currently, there are no man-made body parts, whether IOLs, heart valves or artificial hips, that perform as well as the natural body part of a young, healthy patient. Nevertheless, we're getting closer to achieving such perfection every year, at least when it comes to IOLs.

The Crystalens HD is the only FDA-approved accommodating IOL that provides a substantial improvement in range of vision compared with traditional monofocal IOLs. Simply inserting an accommodating IOL at the time of cataract surgery isn't enough. To maximize visual results for patients, we need to achieve refractive accuracy, optimize the ocular surface and retina, and exceed patient expectations.

In this article, I'll discuss how to achieve the most accurate postoperative refractive results and use limbal relaxing incisions to reduce astigmatism. I'll also review IOL positioning and how to optimize the ocular surface and retina to obtain the best visual outcomes.

Increasing Refractive Accuracy

The difference between cataract surgery and refractive cataract surgery is having the ability to accurately control the postoperative refractive result, eliminating defocus and astigmatism. Delivering a desired post-op refractive result, usually plano, is important for the optimum performance of the Crystalens HD and for patient satisfaction.

The single most important modification you can make in practice to achieve accurate IOL calculations is to move away from applanation A-scan and incorporate immersion A-scan or, if possible, the IOL Master (Carl Zeiss Meditec, Dublin, Calif.). The IOL Master is a noncontact optical coherence biometric device that more accurately measures axial lengths through light. Although it's significantly more accurate than ultrasound A-scan, it doesn't work as well in eyes with severe cataracts, particularly posterior subcapsular and dense cataracts, which limit the view into the eye.

In my practice, I use the IOL Master for nearly all cataract patients, reserving A-scan ultrasound only for those in whom optical measurements aren't feasible, or in situations where I want to double-check the IOL Master's calculations. With these techniques, the percentage of patients achieving an accurate post-op refractive status (goal +/- 0.50D) has increased, but this is only for the spherical equivalent. To maximize the patient's visual results, you need to address corneal astigmatism to ensure it's approximately 0.50D or less in most cases.

When calculating the power of an IOL, it's critical to use a newer-generation theoretical formula (ie, Hoffer Q, SRK-T, Holladay 1 and 2, Haigis) and not a regression formula.[1] It's also important to track your results and then personalize the A-constant you use for your lens calculations. For patients who've undergone previous corneal refractive surgery, lens calculations are far more difficult to establish and require more detailed methods.

Address Astigmatism

Every incision made in the cornea has the potential to affect astigmatism. What's the effect of your incision in routine cataract surgery? For most surgeons, cutting a 2.5-mm to 3.0-mm self-sealing, corneal incision creates a flattening effect of approximately 0.25D to 0.50D at the axis of the incision.[2] If the patient has a small amount of preexisting corneal astigmatism at the site of your planned incision, your incision may be enough to reduce or eliminate the astigmatism. However, a considerable percentage of patients will have significant corneal astigmatism that requires specific treatment.[3]

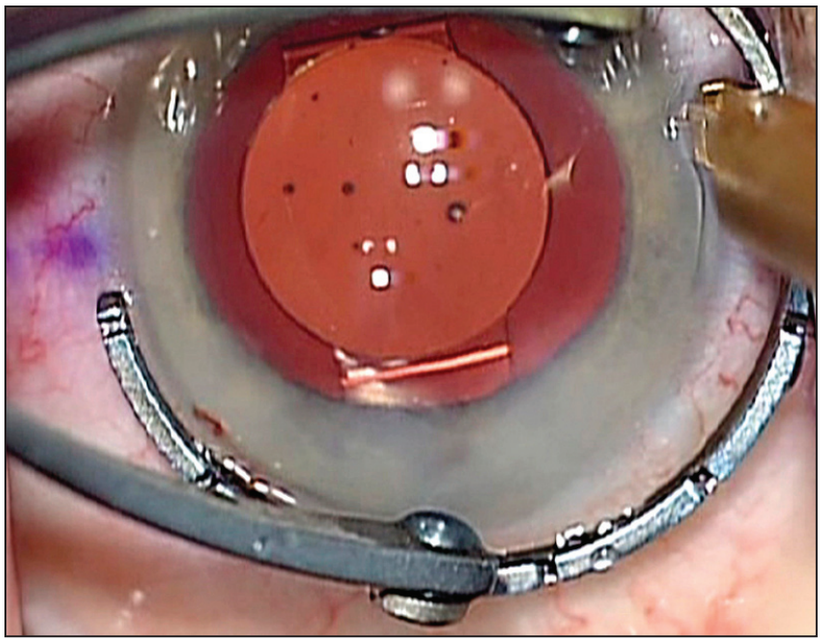

Figure 1. To optimize the performance of the Crystalens HD, the eye must be left in focus with the astigmatism reduced to 0.50D or less. In this case, a limbal relaxing incision in the peripheral cornea neutralized with-the-rule astigmatism.

Learning to use LRIs at the time of cataract surgery is an effective way to reduce preexisting corneal astigmatism and achieve post-op emmetropia. Topography is the most effective way to properly understand the extent of the corneal astigmatism, and it will make your LRI planning more accurate. Excellent nomograms and instructions are available from some of the pioneers of LRIs, such as Louis D. "Skip" Nichamin, MD,[3] Doug D. Koch, MD,[4] and Jim P. Gills, MD,[5] among others. Practicing the technique of LRIs as well as honing your own nomogram will help you deliver consistent results (**Figure 1**).

For more significant degrees of astigmatism (0.75D or higher), it's recommended you use LRIs. A key consideration when making the LRI is the additive effect of your clear corneal incision. If the patient has 1.00D of corneal astigmatism at 90° and you make a clear corneal incision at 180°, which causes 0.50D of flattening, the patient may need 1.50D of LRIs at the 90° meridian.

It's not always possible to deliver post-op emmetropia due to variations in lens calculations, labeling and positioning, and patient healing. In these patients, it's helpful to employ methods to address post-op refractive surprises. For small, spherical residual refractive errors, implanting a piggyback IOL into the ciliary sulcus is an easy option for most cataract surgeons.

Corneal refractive surgery can be a very accurate way to correct residual refractive errors. PRK and LASIK are very accurate methods for those who have access to an excimer laser. Modern methods of surface ablation provide excellent results for patients, and they're well within the scope of care of any general ophthalmologist. Surgeons without an excimer laser should consider teaming up with a local refractive surgeon who has one.

Positioning the IOL

Intraoperatively, clinicians should position the IOL so it's vaulted posteriorly to achieve an accurate IOL calculation, which is largely determined by an effective lens position. If the Crystalens HD is properly positioned, the post-op result will be more accurate than if it were shifted anteriorly, which could induce a myopic shift. It's believed that the best visual results and accommodative amplitude are achieved with this lens positioning. Note that if the anterior chamber deflates at the end of the case, simply reinflating it with balanced salt solution isn't enough. You must reposition the IOL to ensure the haptic footplates are at the capsular bag equator and the optic is vaulted posteriorly. To keep the IOL in this position, your incisions must be completely watertight at the end of the surgery.

Now that you've achieved your post-op goal of plano with minimal corneal astigmatism, the patient will recover sharp vision as long as his ocular surface and retina are healthy.

Optimize the Ocular Surface and Retina

The first refracting surface of the eye is the tear film, so it's important to optimize the ocular surface. This entails treating preoperative conditions, such as blepharitis, dry eye, tear film dysfunction and corneal irregularities. Dry eye is particularly common in cataract patients, so make sure you screen them carefully during the preoperative examination.

Lissamine green or rose bengal staining are vital and may be more effective in detecting dry eye than simply examining the tear lake and tear film break-

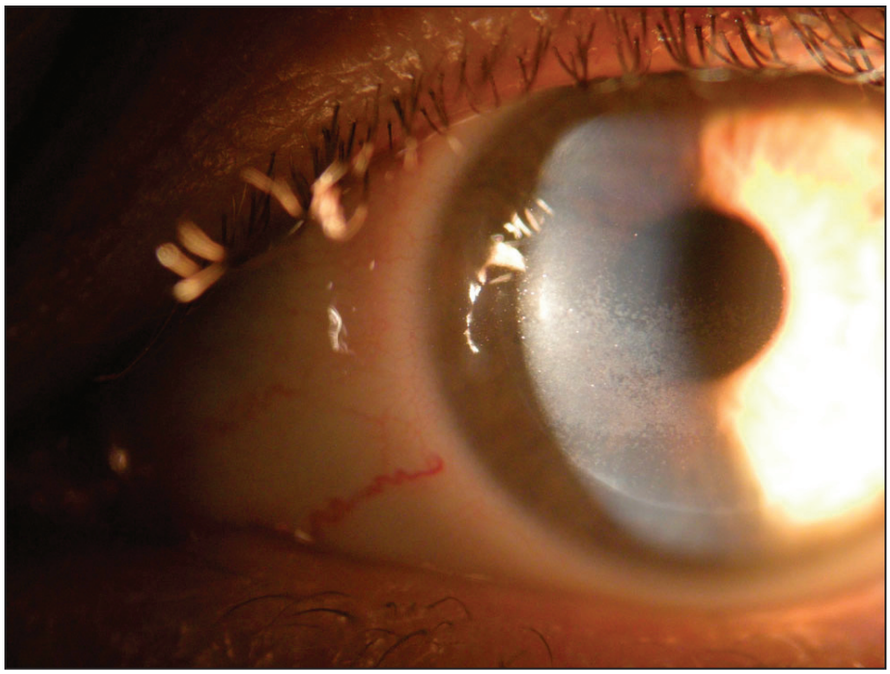

Figure 2. This patient has dry eye syndrome that was further exacerbated by cataract surgery and subsequent LASIK surgery for the treatment of residual refractive error. While this patient is plano with no astigmatism, her vision is suboptimal due to a compromised ocular surface. A strict treatment regimen restored her vision.

up time. If the patient has any degree of dry eye syndrome, it's important to tell him about this before surgery, since surgical procedures can further exacerbate dry eye (**Figure 2**).

With a healthy ocular surface and accurate refractive results, light can sharply focus on the retina. Any irregularities of the macula, particularly cystoid macular edema (CME), also can lead to suboptimal vision after surgery. Preoperative screening using optical coherence tomography may be beneficial to weed out patients with macular pathology who wouldn't fully reap the benefits of an IOL like the Crystalens HD.

Eyes with epiretinal membranes are more prone to post-op CME, but even normal retinas are at risk, because of the inflammation created during routine cataract surgery. Research shows that the perioperative use of topical NSAIDs is important for the prevention and treatment of CME.[6] For this reason, I recommend using a topical NSAID for all cataract patients. Dosing begins 3 days before surgery and then continues for 6 weeks following surgery. The NSAIDs not only help resolve inflammation, they're also effective at reducing pain and irritation, which increases patient comfort.

Exceed Patient Expectations

The goal for any refractive surgeon is to meet or exceed the expectations of patients. Making sure patients have a realistic expectation of the limits of refractive IOL surgery is important, because no surgery or lens implant is perfect. The Crystalens HD can provide the wide range of vision found in patients who are in their 40s but not the amazing level of accommodation seen in teenagers.

A 65-year-old patient doesn't expect a plastic surgeon to make her look 25 years old again; rather, she expects to look better. Similarly, we need to help our 65-year-old patients understand they won't be able to see as well as they did when they were 25, but we certainly can help them see better.

With anatomic and refractive accuracy, patients can recover a wide range of sharp vision without eyeglasses. I anticipate that in the years to come, our technology will progress further, and while we may never find the fountain of youth, we'll certainly be able to restore a larger degree of accommodation. **OM**

References

1. Hoffer KJ. The Hoffer Q formula: a comparison of theoretic and regression formulas. *J Cataract Refract Surg.* 1993;19:700–712.
2. Borasio E, Mehta JS, Maurino V. Torque and flattening effects of clear corneal temporal and on-axis incisions for phacoemulsification. *J Cataract Refract Surg.* 2006;32:2030–2038.
3. Nichamin LD. Nomogram for limbal relaxing incisions. *J Cataract Refract Surg.* 2006;32:1408; author reply.
4. Wang L, Misra M, Koch DD. Peripheral corneal relaxing incisions combined with cataract surgery. *J Cataract Refract Surg.* 2003;29:712–722.
5. Gills JP. Treating astigmatism at the time of cataract surgery. *Curr Opin Ophthalmol.* 2002;13:2–6.
6. O'Brien TP. Emerging guidelines for use of NSAID therapy to optimize cataract surgery patient care. *Curr Med Res Opin.* 2005;21:1131–1137.

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