Crystalens AO: Surgical Experience

Featuring articles by Guy M. Kezirian, MD; Y. Ralph Chu, MD; Gregg Feinerman, MD; Uday Devgan, MD; and Alan B. Aker, MD. Introduction by Stephen G. Slade, MD.
At a recent gathering of Crystalens users held in Boston during the ASCRS meeting, a poll of approximately 100 surgeons who implant the Crystalens family of IOLs (Bausch + Lomb, Rochester, NY) revealed a few trends in the presbyopic population. First, this segment of the refractive market is not growing as quickly as it could. Of the practitioners polled, only 14% reported that more than 30% of their cataract patients had chosen to receive a premium implant in the first 3 months of 2010. Half the group reported that 10% or fewer of their patients were selecting these lenses (Figure 1).

When asked which range of acuity (near, intermediate, or distance) was most important to target for spectacle freedom with premium refractive IOLs, the majority (70%) responded “distance,” compared with 16% and 13% for intermediate and near, respectively. This is an interesting response, considering that so many daily activities—viewing a dashboard, working at a computer, watching TV, conversing with others—require intermediate performance.

Finally, the Crystalens AO is beginning to surpass the HD in frequency of implantation among surgeons, and 49% of respondents said they would choose the AO for their own eyes over the other Crystalenses as well as multifocal and toric options.

Such a rapid adoption seems to indicate that the Crystalens AO’s zero-asphericity optic is proving an impressive IOL technology. As the following articles describe, the lens is easy to implant, performs reliably, even in the presence of slight decentration, and provides an exceptional quality of vision at all distances with an exceptionally low rate of visual symptoms. This supplement presents several surgeons’ feedback on the Crystalens platform and certain multifocal designs as well as surgical and practice management pearls to help practitioners increase patients’ conversion rates to presbyopia-correcting lenses. Perhaps surgeons have been waiting for a reliable premium refractive IOL like the Crystalens AO that gives their patients great vision with few problems. I anticipate that this lens will gain popularity with its continued use.

Figure 1. What percentage of your eligible patients elected to receive premium IOLs in the past 3 months?
Qualifying Visual Performance
With the Crystalens

A review of Crystalens users’ experience as reported on DataLink.

BY GUY M. KEZIRIAN, MD

The SurgiVision DataLink IOL Edition (http://svc.surgivision.net/home/SVChome.html) (SurgiVision Consultants, Inc., Scottsdale, AZ) is an online IOL Registry project with over 70,000 IOLs reported to date. Bausch + Lomb (Rochester, NY) underwrites the cost of enrollment for Crystalens surgeons, and participants may input data from any IOL. The program allows surgeons to evaluate their outcomes with the Crystalens and also to compare outcomes between IOL platforms.

My company maintains the DataLink IOL Registry (there are DataLink editions for various excimer lasers as well). This article compares outcomes for three Crystalens models—the HD, AO, and the Five-O—taken directly from DataLink.

DESIGN DIFFERENCES OF THE CRYSTALENS IOLs

The Crystalens AO and HD lenses are built on the same platform as the Crystalens Five-O IOL. The Five-O has a nonaspheric optic. The Crystalens HD has a 1.5-mm blended bispheric optical zone in the center of the optic to enhance near vision. The AO is the third lens in the Crystalens series to have a 5-mm, square-edge optic. Its optic has zero asphericity, designed to tolerate small amounts of decentration. This article compares clinical results for all three lenses to evaluate the effects of these design differences on performance.

ONE-MONTH COMPARATIVE DATA

Selection Criteria

This series is based on 1-month, single-procedure outcomes with the Crystalens AO (141 eyes), the Crystalens HD (4,610 eyes), and the Crystalens Five-O (4,893 eyes) IOLs. Eyes with extreme axial lengths, those that had undergone preoperative LASIK, and those that showed any posterior capsular opacification were excluded from the comparison. Each surgeon included in the series contributed data on at least five eyes.

Refractive Predictability

Spheroequivalent refractive predictability was clinically similar for all three lenses (Figures 1 and 2). The standard deviation of the outcomes was statistically better for the AO lens (0.52 versus 0.58 for the Five-O and 0.59 for the HD). The standard deviation is the range in which two thirds of outcomes fall. These results are similar to those found for other presbyopia-correcting and multifocal IOLs, and they reflect the limits of accuracy using current biometry and surgical techniques.

Uncorrected Visual Acuity

Figure 3 plots the average distance, intermediate, and near UCVA outcomes for the three lenses. All eyes are included in these analyses; a subsequent analysis was
performed to evaluate visual performance in eyes with excellent refractive outcomes (discussed next). In Figure 3, the lower the line is on the graph, the better the visual acuity. The AO lens slightly outperforms the other IOLs at all distances, and most importantly, it provides the same excellent intermediate acuity that is characteristic of all the Crystalenses. This is the major difference between the Crystalenses and the multifocal IOL platforms. The multifocal platforms provide better near vision, but do not deliver as good visual performance at intermediate distances. Intermediate distance is crucial for much of our daily activities, such as working at computers, viewing a car’s dashboard, seeing faces at a dinner table, etc., so this is a primary consideration in selecting which IOL to use for patients.

Figure 4A-C shows rates of distance UCVA with the three Crystalens IOLs at distance, intermediate, and near. Again, all the lenses performed similarly at distance. The AO lens performed slightly better than the prior models at intermediate and near.

**OPTICAL PERFORMANCE**

My ongoing goal is to promote the concept of refractive cataract surgery among cataract surgeons. I believe surgeons need to “finish the job”—i.e., leave every eye in focus in order to deliver the full optical performance of these IOLs. Of course, reaching the target refraction can sometimes take more than a single procedure.

Correcting astigmatism is an important part of this effort. Many surgeons believe that small amounts of with-the-rule astigmatism can benefit patients by increasing their depth of focus. Figure 5 (pg. 13) quantifies the deleterious effect of this practice on visual performance. As this figure shows, even small amounts of astigmatism decrease the performance of presbyopia-correcting IOLs.
Optic Design and Function

How to select the appropriate Crystalens to use in practice.

BY Y. RALPH CHU, MD

I have participated in some of the FDA clinical trials for the Crystalens Accommodating IOLs (Bausch + Lomb, Rochester, NY), and I have clinical experience with other accommodative IOL platforms as well. This article will review the basic design concepts of the optics of the Crystalens AO and HD IOLs and discuss how surgeons may use these different platforms clinically.

THE AO PLATFORM

The Crystalens AO IOL is based on the same platform as the Crystalens Five-0 lens. The AO’s optic is designed with zero spherical aberration so as not to induce additional aberrations in the eye. The follow-up data from the Crystalens AT-45’s FDA clinical trial show that distance-corrected near visual acuity with this platform continues to improve and remains stable over a 7-year period. The AO’s optic has a 360º enhanced barrier edge designed to reduce posterior capsular opacification. The Crystalens AO IOL is currently available in powers from 10.00 to 33.00 D in 0.50 D increments and from 18.00 to 22.00 D in 0.25 D increments. The AO is slightly thinner than the Crystalens Five-0, which may give the former slightly greater accommodating arching. The AO lens enters the eye through the same Crystalset injector system (Bausch + Lomb) as the Five-0 IOL; its haptics fold inward as the lens enters the inserter.

OPTICAL PERFORMANCE

Scientists measure optical quality with modulation transfer function (MTF) curves. Figure 1 shows MTF curves for multiple presbyopia-correcting IOLs. These data show that all generations of the Crystalens Accommodating IOL are optically superior to the multifocal lenses, and that the AO lens demonstrates an even better quality of vision than the Crystalens HD.

Another measure of the Crystalens AO’s quality of vision is the amount of visual symptoms patients see with the implant. The Crystalens AO imparts less glare and halo (1.1% and 3.4%, respectively) compared with the ReZoom refractive multifocal IOL (Abbott Medical Optics Inc., Santa Ana, CA) (5.8% for both) and the AcrySof IQ ReSTOR IOL +3.0 D (4.3% and 7.3%, respectively) (Alcon Laboratories, Inc., Fort Worth, TX), although not significantly less than a standard monofocal IOL (data on file with Bausch + Lomb). We have to remember, however, that even some monofocal IOL patients have visual complaints.

FREQUENTLY ASKED QUESTIONS

Following are the four main questions that surgeons who are considering adopting the Crystalens platform ask their colleagues, and the answers that I give.

Why does the Crystalens AO provide better vision than the Crystalens Five-0? The Crystalens AO offers slightly

Figure 1. Modulated transfer function tested with +22.00 D lenses at a 3-mm aperture.

Figure 2. With a 3-mm pupil at plano refraction, the Crystalens AO demonstrates superior distance image quality than the two multifocal IOLs.

Figure 3. Spherical aberration of three presbyopia-correcting IOL styles.
better visual acuity because it induces less spherical aberration. The AO is intended to improve the patient’s quality of vision and range of focus without sacrificing near vision. This lens also tolerates decentration and tilt better than the Five-0 platform, which leads to more consistent outcomes.

If the Crystalens AO reduces spherical aberration, why does it not compromise depth of field? Because the Crystalens AO has zero spherical aberration, it does not counter the +0.27 µm of spherical aberration present in the average cornea. Adding more spherical aberration to the cornea, like standard monofocal IOLs do, does not increase depth of focus, it only degrades the quality of the image.

How will the Crystalens AO’s optics impact its accommodative effect? The Crystalens AO has a thinner optic than the Five-0, which may increase the former’s potential for accommodative arching. DataLink data confirms that the AO lens provides slightly better reading acuity than the Five-0 IOL (see Dr. Kezirian’s data on pg. 4).

Why does the Crystalens HD lack an aspheric optic? Bausch + Lomb’s scientists considered all the options for the HD lens: giving it positive, negative, and neutral spherical aberration. They tested various powers and diameters for the optic’s central zone. Ultimately, they determined the bi-spheric design to be optimal for the Crystalens HD. Figure 2 demonstrates the premium visual quality of three IOLs at an average pupil size; only the Crystalens platform achieves 20/15 UCVA.

SPHERICAL ABERRATION: A REVIEW

We know that spherical aberration causes a zone of blur in the eye. If we can neutralize that zone of blur, we can theoretically sharpen the eye’s focus and improve its quality of vision. With negative spherical aberration optics, the power decreases from the center to the periphery (Figure 3). Again, the Crystalens AO is spherically neutral; its power remains uniform from the center to the edge. Figure 4 graphically illustrates the dioptic power of the various IOLs.

Spherical aberration changes with lens power, so the more spherical a lens is, the higher its dioptic power and the more spherical aberration it induces. Although a small amount of spherical aberration increases depth of field, the greater the amount of spherical aberration, the more the patient experiences a degradation in image quality at the best point of focus. Furthermore, when a lens with spherical aberration is decentered, it induces aberrations, specifically defocus astigmatism and coma.

Figure 5 shows a comparison of the effect of spherical aberration on depth of field with monofocal IOLs. The Crystalens AO IOL does not induce any spherical aberration. Although it has a slightly degraded image quality, it preserves the benefits of the positive spherical aberration inherent in the natural eye. The modern traditional spherical lens provides good depth of focus, but it has the worst quality of vision of the three platforms. In short, we have to balance the amount of spherical aberration in an IOL with the quality of vision patients will receive. Figure 6 illustrates the
balance between image quality and depth of focus between four presbyopia-correcting IOLs. The Crystalens AO provides less than 5% degradation of image quality, but it still offers an excellent depth of field. Again, this platform optimizes the optics to improve quality of vision but maintains a range of focus.

IOL DECENTRATION AND TILT
It is important to remember that the eye is not a well-centered optical system, which sometimes presents problems for multifocal implants. The pupillary axis is not exactly aligned with the visual axis, and the IOL is slightly decentered, typically nasally. According to Rynders,1 the decenteration between the visual axis and the pupil is 0.34 ±0.27 mm, and numerous published studies have concluded that the decenteration between the IOL and the pupil is approximately 0.36 ±0.22 mm.2 So, theoretically, an IOL can have a fairly large amount of decenteration, even with perfect surgery and perfect alignment in the capsular bag. This may explain why some patients with multifocal and other types of lenses experience a decreased quality of vision after a perfect surgery. We can see how lens decenteration combined with the standard deviation may compromise the quality of the image (Figure 7). Again, the spherically neutral AO IOL retains its quality of vision.

Although tilting is not a significant problem for IOLs, more than 5° of tilt begins to degrade the image. Again, the Crystalens AO performs the best with this degree of tilt.

STRATIFYING THE CRISTALENS CLINICALLY
Although I have had great results with the Crystalens Five-0 IOL and still use it, I love the quality of vision my patients get with the Crystalens AO, and I think consumers’ demand for high-quality optics is increasing. Because of this, the Crystalens AO IOL is quickly becoming my dominant lens. Resolution efficiency is another way the FDA evaluates the quality of an IOL. Figure 8 shows the different dioptric powers and quality of vision of the various Crystalens. The resolution efficiency stays the highest with the Crystalens AO versus the Five-0 platform. In MTF curves, the AO lens showed the greatest depth of focus as well as the highest peak function of all the Crystalens platforms.

EXPECTING HIGH ADOPTION
Clinically, I anticipate that the Crystalens AO IOL will become the go-to lens for many practitioners because of its quality of vision and forgiveness. Because I feel that the Crystalens HD offers the best reading vision of the Crystalenses, I may try implanting the AO in the dominant eye and the HD in the nondominant eye for patients who place a premium on reading vision. For most presbyopes, however, I am comfortable implanting the AO bilaterally. I also think the Crystalens AO IOL will be my primary choice for postrefractive eyes because of quality of vision. Some surgeons may try to customize the lens choice based on the amount of preoperative spherical aberration in the patient’s cornea. This is among the questions we will be able to answer as surgeons gain experience with the Crystalens AO.

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Performance of the Crystalens AO

The aspheric optic provides excellent image quality.

BY GREGG FEINERMAN, MD

There are two types of presbyopic IOLs in the United States, accommodating and multifocal. The Crystalens is the only FDA-approved accommodating IOL. Multifocal IOLs include (among others) the refractive ReZoom IOL, the Tecnis diffractive multifocal IOL (both by Abbott Medical Optics Inc., Santa Ana, CA), and the apodized diffractive AcrySof IQ ReSTOR IOL (Alcon Laboratories, Inc., Fort Worth, TX). This article considers recent data that may help surgeons decide which type of lens is the most appropriate for their patients.

BEST OPTICS FOR PATIENTS

Surgeons who are implanting or considering adopting presbyopia-correcting lenses want to know which type gives patients the best image quality. Modulation transfer function (MTF) curves prove that the best image quality comes from accommodative and not multifocal optics. The Crystalens AO IOL is nearest to these ideal optics, followed by the Crystalens HD and Five-0 lenses (see Figure 1 on pg. 5). The multifocal IOLs are a distant fourth and fifth from the ideal. In a quality of vision curve, (Figure 1), the Crystalens AO demonstrates superior visual quality to multifocal IOLs, which is no surprise.

What type of presbyopic lens is best for the majority of patients—one with zero aberration, with negative spherical aberration, or with positive spherical aberration? An aberration-free optic does not affect the small amount of spherical aberration present in the average cornea (approximately +0.27 µm), which is necessary to give patients depth of field. Lenses with negative spherical aberration take away that small amount of aberration and thus diminish depth of field. If this type of lens is off target by as little as ±0.50 D, the patient will see a blurry image. Contrarily, IOLs with positive spherical aberration (most standard implants) add too much spherical aberration to the optical system and induce defocus and coma.

FIELD OBSERVATION DATA

I participated in a field observation evaluation of the Crystalens AO. I selected eyes that had good visual potential, with less than 1.00 D of corneal astigmatism and good ocular health with no history of previous surgery. We targeted plano to -0.25 D in the dominant eye and -0.25 to -0.50 D in the nondominant eye. These are my 1-month results.

I compared my results with data in DataLink and found that for monocular distance UCVA, 100% of my Crystalens AO patients (n = 10) achieved 20/30 or better, compared with 67% with the AcrySof IQ ReSTOR IOL +3.0 D and 75% with the Tecnis multifocal lens. Half of my Crystalens AO patients could see 20/20 or better at near at 1 month, compared with 20% of the AcrySof ReSTOR and 25% of the Tecnis patients. The Crystalens AO excels at intermediate vision (Figure 2): 100% of my AO patients could read 20/25 or better at the computer, compared with 44% of the AcrySof ReSTOR patients and 48% of the Tecnis patients.

For near UCVA, at 1 month, 70% of my Crystalens recipients could read J2 or better, as opposed to approximately 81% of patients in the other two groups (Figure 3). Although the multifocal lenses performed better than the Crystalens AO at J1, they also sacrifice image quality. Many ophthalmic practitioners have heard multifocal patients complain about their image quality, and trying

Figure 1. Quality of vision with a 3-mm pupil.
to improve this issue can be more troublesome than simply telling patients they may periodically need to use reading glasses.

**SURGICAL COURSE**

**Preoperative Workup**

The key to optimizing outcomes with refractive cataract patients is taking precise measurements. Our standard cataract workup includes an Orbscan II topography (Bausch + Lomb), in case we want to perform LASIK postoperatively for residual astigmatism. We perform keratometry, both automatically with the IOLMaster (Carl Zeiss Meditec, Inc., Dublin, CA) and manually with the OPD scan (Nidek, Inc., Fremont, CA). We also conduct noncontact biometry with the IOLMaster, which improves our surgical accuracy by eliminating errors from compression of the capsular bag. A 1-mm biometric error leads to approximately 3.00 D of refractive error. Noncontact biometry also minimizes errors of axial alignment in high myopes.

To implant the lens, I use a 2.75-mm keratome to make a standard temporal clear corneal incision. If there is any wound leakage at the end of the case, then I will suture the incision to prevent vaulting of the lens. I have noticed that wounds made with older diamond knives leak a little more, because the IOL injector may stretch the incision.

**Postoperatively**

At the conclusion of the surgery, I make sure the cornea and anterior chamber are clear. I check the eye’s IOP, confirm that the haptics are in the capsular bag, and ensure the lens is centered and demonstrates good posterior vaulting. I prescribe a postoperative steroid regimen of 8 weeks q.i.d.

My staff and I conduct a standard clinical evaluation at 1 week and 1 month. We especially check the patient’s distance-corrected near vision, because if it is a little hyperopic, he or she will not be able to read as well. If they are happy with their vision, we challenge their near vision and have them return in a month.

At the 3-month visit, we dilate the patient’s eyes to check the posterior capsule. We consider performing a LASIK enhancement if there is any residual refractive error. We treat astigmatism with limbal relaxing incisions at time of the implantation. We will perform an Nd:YAG capsulotomy for any striae or significant fibrosis in the posterior capsule.

**SUMMARY**

The Crystalens AO shows comparable results to previous crystalens models as well as to those of multifocal IOLs. The AO delivers excellent visual quality and quantity, and its aspheric optic is promising for postrefractive use, particularly in terms of night vision compared with multifocal options. I prefer the Crystalens AO to multifocal IOLs, because the former gives patients a high quality of vision with less visual side effects.

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**Figure 2.** Monocular intermediate UCVA (mean postoperative spherical equivalent = -0.37; standard deviation = 0.46).

**Figure 3.** Monocular near UCVA.
Getting Crystalens Patients to Plano

Astigmatism management and other pearls for great outcomes.

BY UDAY DEVGAN, MD

By now, all refractive cataract surgeons know they must correct presbyopic IOL recipients to as close to plano as possible in order to satisfy these patients’ visual demands. Reports from DataLink (SurgiVision, Inc., Scottsdale, AZ) demonstrate that the Crystalens HD Accommodating IOL (Bausch + Lomb, Rochester, NY) performs best with a final refraction of ±0.50 D or less of myopia or hyperopia and minimal cylinder (Figure 1). Figure 2 shows the blurriness a Crystalens HD patient sees with just 1.00 D of astigmatism (cylinder) versus plano with no cylinder at near. Thus, ±0.50 D for both sphere and cylinder is the surgical goal. This article reviews strategies for ensuring this optimal result with the Crystalens Accommodating IOLs.

LENS POSITIONING AND SEALING INCISIONS

The recommended starting A-constants for the Crystalens HD (118.8) and the Crystalens AO (119.1) assume the proper posterior vault of the lenses. Since effective lens position determines the refractive outcome of the surgery, the posterior vault must be achieved in order to improve refractive accuracy. Intraoperatively, there should be a visible gap between the lens and the iris. Postoperatively, the slit lamp’s light reflex should show a space between the iris and the anterior surface of the Crystalens optic. Failure to achieve the correct effective lens position will miss the patient’s refractive target, which may cause anterior displacement of the Crystalens and induce a myopic shift. Also, I recommend that surgeons test their incisions to make sure they are sealed completely, because even a tiny leakage could deflate the anterior chamber and cause anterior displacement of the Crystalens. The way to fix a leaky incision is not with more hydration, but simply with a suture.

ASTIGMATISM

Cylinder

Data from DataLink show that the Crystalens AO is more forgiving of residual cylinder than the HD (see Dr. Kezirian’s data on page 13), something I have also noticed clinically. The HD may have a slightly closer near point than the AO lens, but its sweet spot is also narrower. For measuring cylinder, I recommend any of these devices: the Lenstar LS 900 (Haag-Streit AG, Köniz, Switzerland), the IOLMaster (Carl Zeiss Meditec, Inc., Dublin, CA), topography, and manual keratometry. When calculating astigmatism, the key is to measure the corneal cylinder and not the refractive cylinder as measured by the manifest refraction. Any lenticular cylinder from the cataract will be removed during phacoemulsification, leaving just the corneal cylinder to neutralize. When removing the crystalline lens, only the amount of astigmatism present in the cornea matters, not the total refractive cylinder. I use topography to check the cornea’s symmetry and determine if it would benefit from a limbal relaxing incision (LRI) or perhaps laser vision correction.

Effect of Incisions

It is critical for us surgeons to know the effect of our incisions—how much corneal astigmatism they induce. This can be calculated relatively simply using the data from our last 10 or 20 surgeries. Most clear corneal cataract incisions of approximately 2.8-mm width cause about 0.50 D of corneal flattening. I use LRIs to correct up to 1.50 D of astigmatism and laser vision correction.

Figure 1. This graph shows binocular near, intermediate, and distance acuities with the Crystalens HD if there is minimal cylinder. In these outcomes, the distance eye was corrected from plano to +2.50 D, the near eye was corrected from -2.50 to 0.50 D, and there was no cylinder or PCO.
correction to treat 2.00 D or more. To analyze the effect of the LRI, I map the cornea topographically before and after the astigmatic correction and then compare the maps. We must also keep in mind that although LRIs can be effective with a relatively simple nomogram, older and younger eyes react differently to these incisions (Figure 3).

Here is how I factor my phaco incision into my LRI nomogram. If a patient’s preoperative refraction is 1.00 D steep at 90º, making the phaco incision at 180º would further flatten the corneal curvature and actually increase the cylinder at 90º. Therefore, I would need to create LRIs for 1.50 D (Figure 4). Remember that corneal astigmatism lines up relatively close to the visual axis and the center of the pupil, and not so much with the limbus-to-limbus geometric center of the cornea (Figure 5).

In another example, an eye has 0.50 D of corneal astigmatism steep at 90º, and the preoperative keratometry reads 44.75 X 90 and 44.25 X 180. If I make a phaco incision at 90º, which causes 0.50 D of flattening, then the patient should end up with a perfectly spherical cornea. However, if I make my phaco incision at the usual temporal location, I will flatten the cornea at the 180º meridian and increase the astigmatism to 1.00 D at 90º (Figure 6A-C). So, I will have to create an LRI for this patient to correct the 1.00 D of error at 90º.

To help me perfectly align my LRIs, I designed a fixation ring with Bausch + Lomb Storz (Rochester, NY) that is marked with clock hours. I simply trace the metal footplate of the blade along the fixation ring to achieve perfectly smooth and arced LRIs every time. Finally, remember that LRIs are actually not made at the limbus; rather, they are made in the peripheral clear cornea, about 1 mm central from the limbal vessels.

If the patient’s vision still is not perfect after the LRI procedure, LASIK can fine-tune it, but that procedure can also cause dry eye. Even with a well-formed phaco incision, a beautiful femtosecond flap, and a plano result, corneal dryness can compromise the visual acuity, so make sure to prepare the cornea appropriately with tears.

![Figure 2](image1.png) **Figure 2.** An example of the near vision seen through a Crystalens HD IOL with a plano result (A) and with 1.00 D of astigmatism (B).

![Figure 3](image2.png) **Figure 3.** This simple LRI nomogram, based on the one devised by Kevin Miller, MD, shows the difference in calculations for older and younger patients.

![Figure 4](image3.png) **Figure 4.** How to factor in the phaco incision’s effect on corneal astigmatism.

![Figure 5](image4.png) **Figure 5.** The keratometric (K) values and corneal topography are centered on the visual axis (green crosshairs), not with the geometric center of the cornea (red crosshairs).
and perhaps oral omega-3 fatty acids before proceeding with this option.

Although irregular corneas such as forme fruste keratoconus, corneal dystrophy, or epithelial basement membrane disease can cause some cylinder, these are relatively uncommon conditions. A more common source of residual refraction is an inadequate LRI or capsular contraction that causes the IOL to shift. Figure 7 shows a patient of mine who had a small capsulorhexis. He experienced some phimosis, which caused a hyperopic shift and some induced cylinder. The IOL vaulted slightly posteriorly and asymmetrically. I performed an Nd:YAG anterior capsulotomy to relax the vaulting. I started the capsulotomy at 12 o’clock and then proceeded through 6, 3, and 9 o’clock to maneuver the lens into the perfect position. The result was the eye’s return to a near plano refraction, and the patient was happy.

Figure 8A shows another eye that developed posterior capsular fibrotic bands after implantation with a Crystalens. The fibrotic bands caused a myopic shift and some induced cylinder. I performed a selective Nd:YAG capsulotomy to address the problem and release the tension on these bands, allowing the Crystalens to return to a proper posterior vault. This brought the eye back into focus (Figure 8B). (For further detail on capsulotomy concepts, see
IOL POSITIONING

My final pearl is to make sure the IOL is fully positioned within the capsular bag, including all four footplates. Figure 9 shows an eye that suffered iatrogenic damage to the iris. Because the capsulorhexis was irregular, one arm of the Crystalens was inadvertently placed outside of the capsular bag in the ciliary sulcus. As a result, the IOL tilted and caused a Z-syndrome. The best way to ensure that the lens is in the capsular bag is to spin it—it should rotate completely. If the pupil is small, lift up the iris and directly visualize the four footplates to ensure that they are all fully within the capsular bag.

SUMMARY

We need to go the extra mile to and give our patients the best visual results by achieving a refractive result close to plano, with the final refraction within 0.50 D for both sphere and cylinder. This is the most reliable way to ensure patients’ satisfaction, because it gives them sharp vision. ■

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CONCLUSIONS

In summary, the Crystalens AO IOL is showing incremental improvements over the prior platforms. Good refractive outcomes are essential to the performance of all presbyopia-correcting IOLs. ■

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Premium IOLs are all about precision-driven surgery. These remarkable new lenses are driving other technological development in the field of ophthalmic surgery, such as new applications for femtosecond lasers and intraoperative wavefront aberrometry (ORange; WaveTec Vision Systems, Inc., Aliso Viejo, CA). These new technologies have the potential to dramatically improve our outcomes. I believe that our ability to preserve and grow our practices in the future (especially as reimbursements decline) will depend on our ability and willingness to participate in the premium arena. Currently, surgeons are deciding which premium IOL technology, accommodating or multifocal, will perform best for their patients. This article weighs the options and describes my personal experience.

Walter Mossberg, who writes for the Wall Street Journal and the blog All Things Digital, has stated, “Things work best when they function according to their design.” I have found this statement to ring true for IOL technologies. The eye’s natural design includes a single focal point. Having implanted a lot of multifocal lenses over the years, I have learned that patients prefer a single point of focus over a multifocal option. The Crystalens IOLs (Bausch + Lomb, Rochester, NY) provide a single point of focus that is not dependent on pupil size (Figure 1).

Two particular patients convinced me of the superiority of monofocal versus multifocal optics. The first individual had received an AcrySof ReSTOR IOL +4.0 D (Alcon Laboratories, Inc., Fort Worth, TX) 2.5 years before presenting to me with an open capsule. Despite excellent surgery, she was unable to function because of poor quality of vision relating to multifocality. I explanted the lens and replaced it with a SofPort LI61AO (Bausch + Lomb, Rochester, NY). The second patient was someone in whom I had implanted a ReZoom multifocal lens (Abbott Medical Optics Inc., Santa Ana, CA), and subsequently performed a YAG capsulotomy to alleviate issues with glare. Because of persistent difficulties with night driving, I replaced the ReZoom with a Crystalens Five-0 2.5 years after the initial implant. In both cases, the patients’ complaints and inability to function were relieved once the multifocal IOLs had been replaced with a monofocal lens.

SETTING EXPECTATIONS
Surgical success is built on happy patients, and making patients happy begins with giving them realistic expectations for their outcomes. In order to succeed with premium refractive IOLs, we have to proactively educate our patients about the capability of these lenses and make sure they have heard and understand everything we say. For example, my staff and I use a reading card to repeatedly define and demonstrate binocular functional vision for candidates. I show them the entire reading card, like we do with reading glasses, and indicate the reading ability they can expect with a standard monofocal IOL versus a Crystalens (J5, although I anticipate achieving J3 or J2 in most patients). If the candidate says he or she would like to have the better reading vision, I know I can meet that expectation. I know that the Crystalens (Five-0, HD, or AO) will give my patients 20/30 or better UCVA at distance and 10-pt or better UCVA at near. I also tell patients their intermediate vision will be excellent and that they will be able to perform a range of activities without glasses, although they may need spectacle correction for certain tasks.

The most important part of the preoperative discussion may be about postoperative enhancements. My staff and I carefully explain that some patients need a refractive enhancement after the IOL implantation to give them the best vision possible. With patients who have significant astigmatism or prior refractive surgery, we discuss the need
for them to participate in the cost of these tweaking procedures. In the course of these discussions, I try to get the candidate to ask me for my professional recommendation. I always respond that I would only have the Crystalens in my eye (I would opt for a Crystalens AO in my dominant eye and a Crystalens HD in my nondominant one). I would not want to risk poor-quality vision, dysphotopsias, or the glare and halos my patients with multifocal IOLs have experienced.

PERSONAL VERSUS GLOBAL DATA
I have compared my practice’s outcomes with the Crystalens Five-0, HD, and AO IOLs with the global user data from DataLink (SurgiVision Consultants, Inc., Scottsdale, AZ). Our 20/40 distance UCVA outcomes were slightly better than the global data at all postoperative visits (Figure 2). The difference between good and great outcomes is finishing the job, by which I mean correcting residual refractive error and treating dry eye. We must continually tweak our outcomes in order to uphold our promise to the patient of reduced dependence on glasses. This also means that accuracy in our preoperative measurements is critical to postoperative success.

OPTIMIZING THE QUALITY OF VISION
My staff and I do whatever it takes to make our patients happy, including refractive lens exchanges (within 2 to 3 weeks), limbal relaxing incisions (at 6 to 12 weeks, targeting < 0.50 D of cylinder), LASIK (no sooner than 3 months), piggyback IOLs, and punctal plugs. We also watch the posterior capsule for 4 to 6 months for haze, fibrosis, and striae, which obviously will reduce the quality of vision. Fibrosis and striae respond effectively to an Nd:YAG capsulotomy; I am surprised by the number of patients referred to us from other practices, where the work has not been finished. Some of these patients have residual refractive errors, while others simply need an Nd:YAG capsulotomy.

MANAGING COMPLICATIONS
Malpositioned IOLs and asymmetric vaulting can occur in eyes that have a torn capsule or weak zonules; do not implant premium IOLs in such eyes. Also, be careful not to pull the haptic out of the capsular bag when performing I/A underneath the lens. This is of particular concern when the pupil has come down during the procedure. Before closing the eye, ensure that the lens is properly “seated,” and spin it to make sure it is completely in the capsular bag. Remember, “if it doesn’t spin, it’s not in.”

Asymmetric vaulting (Z syndrome) occurred with the Crystalens AT-45 because we surgeons were making the capsulorhexis too small, the AT-45 was too flexible, and we did not prescribe a long enough course of steroids postoperatively. With the Crystalens Five-0 and HD, we have learned from this experience and have seen no asymmetric vaulting. You can help avert asymmetric vaulting intraoperatively by placing a capsular tension ring to support a floppy capsular bag or loose zonules (it is better to place the ring prior to implanting the IOL, however).

Size the capsulorhexis appropriately (5.5 to 6.0 mm), and always use a tapered 8- to 10-week course of steroids and NSAIDs postoperatively. A white paper I coauthored with Richard Lindstrom, MD (on file with Bausch + Lomb) describes how using a longer course of steroid and NSAID together helps reduce capsule fibrosis postoperatively, prevents decentration of the lens, and reduces the risk of cystoid macular edema and rebound iritis. Patients who are paying out of pocket for a premium IOL do not want to hear weeks later that they have developed cystoid macular edema.

GET IN THE GAME
As you have heard before, growing our practices with premium refractive IOLs means hitting emmetropia and preventing postoperative complications. With reimbursements declining and healthcare reform on the horizon, the medical practice game is changing. If you do not want to participate in the premium IOL market, I recommend comanaging with a surgeon who can implant these lenses to boost your bottom line. ■

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