Over the past several years, the Crystalens has become an integral part of my clinical practice. I prefer the Crystalens for presbyopia correction over multifocal options for one very fundamental reason—visual quality. The Crystalens’ greatest strength is that it offers patients an improved range of visual function without a reduction in visual quality. Neuroadaptation is not required, dependence on spectacles is reduced, and there is nothing difficult for the Crystalens patient to get used to.

Success with the Crystalens, however, requires attention to detail. Intraocular lens (IOL) surgery for presbyopia correction is intrinsically a refractive procedure. The implantation of the Crystalens requires the same appreciation for detail that we afford our keratorefractive patients. Good patient selection, careful counseling, sound surgical technique, and optimization of refractive outcomes are all necessary to achieve the highest level of patient satisfaction.

Choosing Patients: Who Is a Candidate for the Crystalens?

The ideal initial Crystalens candidate is the hyperope, 55 years or older, with a visually significant cataract, who requires surgery in order to maintain an acceptable quality of life. The Crystalens affords approximately 1.5 to 2.0 diopters (D) of accommodation for most patients. The average age of cataract patients in my practice is 72 years of age. The chances are very good that a hyperopic patient of this age, who has been without useful accommodation for years, will be thrilled with the accommodative boost provided by the Crystalens. As the surgeon’s experience with the Crystalens grows, the refractive range of candidates can be expanded. Emmetropes and high myopes over the age of 55 are also very likely to be happy with the vision afforded by the Crystalens, if the desired refractive target is achieved.

Poor candidates for the Crystalens are myopes who like to read without their glasses, successful monovision contact lens wearers, and younger patients who still have useful accommodation. Patients with pseudoexfoliation are not good candidates for the Crystalens because of potential problems with capsular support and anterior capsular phimosis. Also, patients who dilate poorly and patients with a history of Flomax use should be approached with great caution, because of potential problems with creation of the anterior capsulotomy and probable difficulties with visualization of the anterior capsular margins during implantation. Clearly, patients who do not have the potential for good uncorrected vision (eg, those with significant maculopathy) are poor candidates for the Crystalens, because they will not be able to appreciate the benefits of the technology.

Preoperative Evaluation and Planning: What to Look for and What to Think About

In addition to all the standard aspects of preoperative evaluation, careful attention should be paid to ocular dominance, mesopic pupil size before and after mydriasis, and manual keratometry.

Ocular dominance is important to establish for 2 reasons. First, a little “mini-monovision with the Crystalens” helps to enhance reading vision and is very well tolerated. In most cases, the ideal refractive outcome is plano to −.25 sphere in the dominant eye and −.50 to −.75 sphere in the nondominant eye. Second, it is helpful, but not essential, to perform surgery on the nondominant eye first. The refractive outcome of the nondominant eye is sometimes useful in refining the uncorrected distance vision of the dominant eye.

Mesopic pupil testing before mydriasis helps identify patients who may be at greater risk to experience postoperative glare and halo. The Crystalens has an optic size of 5 mm. In my experience this is seldom an issue in older patients who generally have smaller pupils in mesopic conditions. Younger
patients, however, who have larger pupils in low levels of illumination, are more likely to experience glare and halos with the smaller optic.

Pupil measurement after mydriasis helps to identify patients who may present intraoperative challenges with the creation of the anterior capsulotomy or with implantation of the Crystalens.

Manual keratometry helps define the corneal component of astigmatic error. Corneal astigmatism of .75 D or less can be managed effectively by simply placing the incision on the steep axis. Astigmatic errors up to 2.00 D generally can be managed with limbal relaxing incisions. Corneal topography is very helpful in directing the placement of these incisions. Patients with corneal astigmatism of greater than 2.00 D are much more difficult to correct with limbal relaxing incisions, especially if the cornea is steep horizontally. Patients with these higher levels of astigmatism are less likely to achieve the desired uncorrected refractive outcome, and generally are not ideal candidates for the Crystalens unless keratorefractive surgery is also part of the preoperative plan.

The importance of accurate biometry cannot be overemphasized. The benefits of the Crystalens simply cannot be realized unless the patient achieves a desirable refractive outcome. Immersion ultrasound or IOLMaster measurements provide the most reliable biometric data, and up-to-date lens calculation formulae help us to select the best possible IOL power. In our facility we use the IOLMaster whenever the "noise to sign ratio" is low and immersion ultrasound when the ratio is high (as with denser lenses). We use the Hoffer Q formula for axial lengths of less than 22mm, the Holladay 1 for lengths between 22 and 25mm, and the SRK/T for eyes with lengths greater than 25mm.

How to Counsel Crystalens Patients

Careful preoperative counseling is a critical element to success with the Crystalens. Setting realistic expectations may be the most important thing a surgeon can do to insure patient satisfaction. The good news is that it is easy to tell a Crystalens what to expect. Here is a step-by-step approach to patient counseling that I have found very useful.

1. Explain That Cataract Surgery Is Actually a Lens Exchange Procedure

I begin the discussion by explaining that the eye works very much like a camera. Sitting next to the patient, holding a model of the eye, I discuss in simple terms how the eye works and how a cataract affects vision. Even very intelligent, well-informed patients need to hear that the cataract is not just a cloudy film over the eye. Patients must understand that a cataract is cloudiness in the focusing lens of the eye and the only way to improve their vision is to remove the cloudy lens and replace it with "a new clear lens." This 2-minute discussion helps the patient understand why an IOL is necessary and is a natural segway into a discussion of the differences between a "standard monofocal IOL" and "the new Crystalens."

2. Discuss the Differences Between the Standard Monofocal Lenses and the Crystalens

If a patient is a good candidate for the Crystalens, I then explain that we are fortunate today because "we have 2 excellent types of intraocular lenses to replace the cloudy cataract lens—the standard lenses and the newer Crystalens. Our standard lens is one that we have used successfully for over 20 years. This standard lens is called a monofocal lens because it provides a single focal point of best vision. This lens usually provides good distance vision without glasses, but glasses are generally needed in order to see the computer screen clearly or to read most printed material."

"The new Crystalens gives vision at distance that is comparable to the standard monofocal lens, but it also offers an improved range of vision. The Crystalens provides better intermediate vision—computer vision—and helps with the reading as well." I explain that "the new Crystalens is a soft, flexible lens that uses the eye's natural focusing muscles to provide a better and more youthful range of vision." I carefully emphasize that "the Crystalens will not allow you to read like you did when you were 29. Most Crystalens patients are able to do the majority of their routine daily activities without glasses but many still use a little pair of over-the-counter reading glasses to see very small print, to read for prolonged periods, or to read in poor lighting." This is a clear, understated message that I am comfortable with, and most of my cataract patients find both reasonable and very appealing.

3. Explain That Presbyopia Correction With the Crystalens Is an Elective Upgrade and That It Is Expensive

Next, I discuss the additional cost of presbyopia correction with the Crystalens. I want patients to know about the expense of the new technology before, not after, they have decided that they want it. "The big problem with this new lens," I point out, "is that it costs a lot more."

I explain that "Medicare and other insurers have recognized that this new lens provides significant benefits, but they view it as an elective upgrade and they will not pay for it." "If you chose to upgrade to the new Crystalens lens," I explain, "you will have to pay the extra costs out of pocket. If, on the other hand, you chose the standard monofocal lens, there is no additional charge."

I finish by saying, "So that's the way it is. Both lenses are excellent, and I think that you will notice a big improvement in your vision with either one of them. The Crystalens certainly offers advantages, but it costs a lot more. Just give it some thought, and we'll go with whatever you decide."

4. Reemphasize Realistic Expectations Before You Proceed

The approximately 50% of our cataract patients who are presented with this option decide immediately that they would like to have the new lens. At this time I want to be sure that the patient's expectations are realistic and that the patient is choosing the new lens based on the
How Do I Get Started With the Crystalens?

I reiterate that glasses will still be needed for small print, prolonged reading, or reading in poor illumination. I explain that “since the Crystalens depends on the natural focusing muscles of the eye, improvement in reading vision with the Crystalens takes some time to develop.” I point out that “the focusing muscles in the eye haven’t done much for quite a few years, so it’ll take some time for these muscles to get strong again.” I also explain that “the reading muscles will get stronger the more they are used after surgery and that data from clinical studies show that reading vision without glasses often continues to improve over time.”

I emphasize that “although most Crystalens patients have very good quality of vision postoperatively, it is possible to experience glare and halos after surgery and sometimes a second procedure is necessary to fine tune the distance vision after the initial operation.” This point is particularly stressed with post–laser in situ keratomileusis (LASIK) or radial keratotomy (RK) patients and with high hyperopes, but all patients are made to understand that it is a possibility.

Aside from the basic consent information regarding the general risks of cataract surgery, I say very little else. I feel very positive about the Crystalens technology. Patients sense this, but also realize that I have their best interest at heart. I believe that a key element to success with any surgery, and the Crystalens in particular, is not to sell it. An honest, straightforward description of the benefits of the Crystalens will allow patients to make a decision that is best for them.

Implantation of the Crystalens

MANAGEMENT OF ASTIGMATISM

The optimization of refractive outcomes requires the careful management of astigmatic errors. This begins with preoperative planning. I find it helpful to make detailed notes and drawings that describe the planned incision location, and the placement and size of limbal relaxing incisions as directed by manual keratometry and corneal topography. For every patient, I review these notes, which I tape to the wall next to my microscope, just before beginning the case.

To insure proper placement of the primary incision and limbal relaxing incisions, it is important to mark the 0- and 180-degree axis, as well as the 90-degree axis, while the patient is in a sitting position (Figure 1). This is easily done on the gurney just before surgery. The axis of the planned incision and that of limbal relaxing incisions, if needed, can then be marked under the microscope using an axis indicator (Figures 2 and 3).

MANAGEMENT OF INCISIONS

It is important that all incisions are absolutely solid and watertight at the end of the case. Any decompression of the anterior chamber in the early postoperative period will lead to forward vaulting of the Crystalens and the induction a myopic shift in the postoperative refraction. This is easy to prevent, but if it occurs, secondly intervention is often necessary to correct the vault.

The primary incision should be sutured, if it is corneal, or a scleral tunnel incision can be made. A well-constructed scleral tunnel incision usually does not require a suture (Figures 4 and 5). Side port incision(s) should be small, beveled, and well hydrated at the end of the case. All incisions should be checked rigorously before completing the case to insure that they cannot be made to leak.
The capsulorrhexis should be central, circular, and between 4 to 6 mm in diameter. If the capsulotomy is too small, it is difficult to insert the proximal haptic in the capsular bag. If the capsulotomy is very large or eccentric, it is possible for the lens to dislocate.

**Figure 3.** Marking of the steep axis insures more accurate placement of the primary incision and limbal relaxing incisions.

**Figure 4.** All incisions in a Crystalens procedure must be absolutely watertight. A scleral tunnel incision helps to insure competency of the primary incision.

**CAPSULORRHEXIS**

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**CRYSTALENS INSERTION AND POSITIONING**

The Crystalens is implanted through a 2.7- to 3.0-mm incision with an injector, using a cohesive sodium hyaluronate viscoelastic material to fill the capsular bag. Care must be taken not to place the Crystalens upside down in the capsular bag. This can happen if the lens is loaded incorrectly in the injector or if the lens rotates in the injector during insertion. Implantation of an upside down lens can be avoided easily by inspecting the flat circular knobs at the ends of the polyamide haptic of the lens during insertion. The lens is designed so that, with the proper side up, the knob to the right is rounded (round on right) and the knob to the left is oval. During insertion it is advisable to pause for a moment, just as the distal haptics unfurl in the anterior chamber (Figures 6 and 7). If the right knob is oval, and not rounded as it should be, the injector should be rotated 180 degrees, so that the IOL anterior-posterior orientation is corrected.

Once the IOL is placed in the capsular bag, I like to lift the optic forward slightly using lens hooks. I then rotate the lens to a 12-to-6 position, with the lens lifted slightly so that the polyamide haptics do not engage the capsule during this maneuver. The cohesive viscoelastic material is then removed completely. This should allow the Crystalens to settle into perfect position with both haptics symmetrically placed in the

**Figure 5.** The length of internal flap of the incision should be as long as the width of the external incision in order to insure maximum stability.

**Figure 6.** The polyamide haptics of the Crystalens are designed to help the surgeon to identify the “right side up” of the lens. The rounded knob of the lead haptic should always be on the right.
equator of the capsular bag and the optic vaulted in a slightly posterior position (Figure 8). If the IOL does not seem to position itself perfectly, viscoelastic should be used to refill the bag and anterior chamber, and these positioning maneuvers should be repeated.

**POSTOPERATIVE MANAGEMENT**

In my experience, the postoperative management of the Crystalens patient is far easier than that of the multifocal patient. The multifocal lens patient is faced with the challenge of adapting to an inherently unphysiologic light-splitting optical system. Sometimes this goes well, but often, it does not. A patient who finds it difficult to adjust to vagaries of multifocality requires a lot of encouragement, a great deal of handholding and frequent postoperative visits. The management of the Crystalens lens patient is generally far less problematic. Complaints of reduced visual quality are rare, patients do not tend to balk at having their second eye done, and small residual refractive errors, especially small astigmatic errors, are far better tolerated with the Crystalens than with multifocal lenses.

Still the level of patient satisfaction is highly dependent on the success in achieving a desired refractive outcome.

When a Crystalens patient presents postoperatively with a refractive outcome that is less than optimal, a cycloplegic refraction should be performed. The magnitude of hyperopic errors, especially, can be underappreciated in the Crystalens patient because of the accommodative action of the lens. Lower levels of residual hyperopia may lead to underperformance of uncorrected near vision and yet be masked by good uncorrected distance vision. This is a very frequent and often overlooked cause for poor uncorrected near vision with the Crystalens.

**SPECIAL POSTOPERATIVE INSTRUCTIONS**

Patients should be instructed not to read without glasses during the first 2 weeks of the postoperative period. Patients who exercise their accommodation excessively too early in the postoperative period tend to develop a myopic shift in their refraction. This can be avoided by asking patients to use a pair of +2.50 readers for reading during the first 2 weeks after surgery. If a myopic shift occurs and is undesirable, correction is generally not difficult.

**Residual Myopia**

A low level of myopia caused by excessive reading early in the postoperative period can sometimes be corrected by simply placing the patient on a cycloplegic of several days. If the refractive error is not corrected with cycloplegia, rotation and repositioning of the Crystalens is often successful. Residual myopia, caused by forward vaulting of the Crystalens early in the postoperative course, is often the result of suboptimal incision closure. This can be managed before capsular fibrosis has occurred by simply suturing the incision and repositioning the optic more posteriorly.

**Astigmatic and Spherical Errors**

Residual refractive errors not caused by lens malposition are best managed by a keratorefractive procedure, IOL exchange, or a “piggy-back” IOL.

A keratorefractive procedure is the treatment of choice for a patient with significant residual astigmatic error. LASIK is a very good option for younger patients but may not be the ideal for many older patients. Recovery from LASIK in older patients can be slow and associated with severe dry eye symptoms. Photorefractive keratectomy (PRK) paradoxically may be more comfortable and predictable for older patients who require a keratorefractive procedure.

An IOL exchange is an excellent option for correction of spherical errors, but this procedure should be performed before there is an opportunity for the polyamide loops of the Crystalens to become fibrosed within the capsular bag. Healon 5, which is a high-molecular-weight sodium hyaluronate viscoelastic material, is especially useful in expanding and maintaining the capsular bag during lens removal. Special care
must be taken, however, to aspirate all of this material after the replacement IOL is in position. If several months have passed before secondary intervention is taken, a “piggy-back” IOL is a very good option for the correction of spherical errors.

With both IOL exchange and “piggy-back” IOL implantation, preoperative topography is very helpful. Topographic analysis allows the surgeon reduce the likelihood of inducing a new astigmatic error though the secondary intervention.

Conclusion

The Crystalens provides a full range of visual function, utilizing an accommodative optical system that is physiologic, effective, and well accepted by patients. Implantation of this lens is easy, but special attention to detail is essential to insure the highest level of patient satisfaction. Careful patient selection, thoughtful preoperative evaluation, good counseling, and a dedication to achieving the best possible refractive outcome are all necessary components of a successful Crystalens procedure.