IOL Debate:
Utilizing New-technology IOLs to Deliver Best Patient Outcomes

With the recent availability of new aspheric and multifocal IOL designs, lens implant surgeons have an expanded menu of options to offer to their cataract and refractive surgery patients. At the American Academy of Ophthalmology 2005 Annual Meeting, CATARACT & REFRACTIVE SURGERY TODAY assembled a blue-ribbon panel of experts for a roundtable discussion on IOL choices in 2006.

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PERSONAL EXPERIENCE

David F. Chang, MD: I thought we would start by having everyone describe their personal experience with presbyopia-correcting IOLs.

Thomas Kohnen, MD: My experience goes back to the diffractive 3M (St. Paul, Minnesota) design when Dick Lindstrom was involved in a study started in Europe. Now most of my experience is with the Acrysof Restor lens (Alcon Laboratories Inc, Fort Worth, Texas) because I was involved in its European trials. I have implanted the Array lens (Advanced Medical Optics Inc [AMO], Santa Ana, California) during the last 10 years, but my use of it is decreasing. I have not used the Rezoom lens (AMO) yet. As for accommodative IOLs, I have only used an experimental design, and I am starting to see a couple of complications.

Louis D. Nichamin, MD: Most of my experience is with the Crystalens (Eyeonics Inc, Aliso Viejo, California), and I am just beginning to implant the Acrysof Restor and Rezoom multifocal IOL. Overall, I am happy with my results. As others have observed, if there is a shortcoming with the Crystalens, it is the lack of near function it achieves. In my experience, patients’ reading ability can vary considerably, but their intermediate vision is better than we would expect with a standard monofocal implant. For my refractive lens exchange population who depend on their computers, I find that the Crystalens represents an excellent option, because it provides an extra 1.50 D of function over that of a standard lens.

Richard L. Lindstrom, MD: In our clinical practice, we use the Crystalens, the Rezoom IOL and the Acrysof Restor lens. We use the Tecnis diffractive IOL (AMO) in clinical trials. In the previous 20 years, I have implanted the 3M diffractive lens, the Nuvue lens (IOLab Inc, Claremont, California), the Acrysof Restor lens, the Storz three-zone lens (Bausch & Lomb, Rochester, NY), and the Array lens, in addition to a large series of monofocal monovision implants.

FROM ARRAY TO REZOOM: IOLs STEP AHEAD

The multifocal lens comprises five concentric, refractive zones.

By H. Burkhard Dick, M D

Advancements and increased expectations in refractive cataract surgery have caused a recent paradigm shift toward diversification and individualized solutions for surgery. In comparing the Array (Advanced Medical Optics Inc, Santa Ana, California) with the Rezoom hydrophobic acrylic multifocal IOL (AMO), there are several advantages to using the Rezoom lens, one being improved functionality and patient outcome.

The Rezoom has a 6-mm optic featuring five zones optimized and proportioned to provide good visual function across a range of distances. I have implanted more than 40 Rezoom IOLs as part of a clinical trial, and I have implanted 30 additional of these. A new biometric evaluation is not needed with this IOL, and smaller incision size and controlled release are distinct advantages compared with the Array.

FEWER PHENOMENA

I conducted a prospective, randomized, masked clinical trial comparing both IOLs. Outcomes with the Rezoom proved superior in several regards over the first-generation Array. Patients who received the Rezoom lens reported that they saw comfortably without glasses at distance (n = 42; 100%), intermediate distance (95%) and near (71%). All Rezoom patients reported great satisfaction with their depth and color perception. Compared with the Array, this multifocal IOL produced fewer photic phenomena including halos and starburts.

Figure 1. The Rezoom IOL has five zones, as illustrated above.
Stephen S. Lane, MD: Most of my experience is with the Acrysof Restor. I have minimal experience with the Rezoom and with the Array. I have very limited experience with the Crystalens.

Frank A. Bucci Jr, MD: Preceding 2005, I made select but steady use of the Array lens for 7 years. In the past 4 to 6 months I have implanted approximately 230 Acrysof Restor lenses and about 20 Rezoom IOLs.

Mark Packer, MD: I have used the Array lens since 1997, the Crystalens since 2000 in clinical trials, the Rezoom lens during the last 6 months and the Tecnis multifocal IOL currently in clinical trials.

Chang: Currently, I am using all three (the Acrysof Restor, Rezoom and Crystalens implants), although I probably implant significantly more multifocal IOLs than Crystalens IOLs.

Kohnen: I use presbyopia-correcting IOLs for refractive lenses exchange more, however, I only use presbyopia-correcting IOLs in clinical trials for my social security patients. For patients whose private insurance will cover the cost of the lenses, I have seen an increase of maybe 30% to 40%.

A DIFFERENT MINDSET

Chang: There was never much patient demand for the Array lens. It was difficult for patients to determine whether they saw well due to cataract surgery or to the multifocal lens implant. In contrast, patients are now requesting a multifocal IOL or the Crystalens. Steve, which lenses are you primarily using, and what are the pros and cons you have observed?

Lane: I mainly use the Acrysof Restor refractive, apodized, multifocal lens. The advantages of this IOL are that it provides excellent near vision in addition to distance vision. The Achilles’ heel of this diffractive IOL will be of benefit to my patients.

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The five concentric refractive zones provide true multifocal vision: zones 1, 3 and 5 are distance dominant; zones 2 and 4 are near dominant; and an aspheric transition between zones provides balanced intermediate vision. The second optical zone provides a sufficiently large near add. It may be argued that the zonal design is a potential drawback compared with the Array, however, the IOls Balanced View Optics Technology provides expanded distance-dominant zones and light distribution for good vision under a wide range of lighting conditions. The Rezoom IOL works satisfactorily at intermediate distance and under dim lighting conditions, an especially important capability for computer work.

I prefer an optic edge design that provides an uninterrupted 360º barrier against lens epithelial cell migration and is designed to minimize edge glare. The Optidege design (AMO), which has been incorporated into the Rezoom IOL, decreases the intensity of reflected images tremendously compared with square-edge designs. The Rezoom provides patients with good distance vision during the day, independent from spectacles for most daily activities. This does not include reading small print or reading for an extended period. Additionally, this IOL allows for a broad transition from near to distant vision.

PERFECTLY CENTERED

The Rezoom is implanted through a 2.7-mm incision, by way of the Unfolder Emerald injector system (AMO). This incision is smaller than is needed for the Array system. I have also found that this IOL centers perfectly. In a rare case of capsular rupture with vitreous loss, the lens may be fixated in the sulcus.

Capsular fibrosis with this hydrophobic acrylic lens material was very low. Moreover, with a low rate of posterior capsular opacification, the near portion of the lens’ optic is not obscured by fibrosis. As a result, patients’ reading capability should last longer compared with the silicone optic of the Array lens. Rezoom patients’ near visual acuity should remain stable for a long time.

When selecting an IOL, surgeons should keep in mind patient motivation. If they are interested in gaining spectacle independence, the Rezoom IOL is a proper choice. Several design improvements and diversifications enable this IOL to match individual functional goals. I do not doubt that the Rezoom lens will be of benefit to my patients.

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is intermediate vision, which, although not as good as distance or near vision with this lens, is more than satisfactory for most intermediate tasks. With any multifocal technology, the problem is that you have to give up something somewhere; it is not an accommodating technology.

It is also important to define what is meant by intermediate vision. What we measure and call an intermediate range might not be the same for every patient. It depends on the person’s activities. You must discuss what a patient wants of the technology. If patients’ main daily tasks are in the intermediate range, then you probably should give them a lens that stresses intermediate vision. If what they really want is something for good near vision, then you probably should choose the optimal lens for that goal. A true accommodating lens that covers all ranges of vision is the Holy Grail. I do not think that we have one at this moment.

**Bucci:** I want to emphasize several points. The transition from a LASIK surgeon to a refractive lensectomy surgeon is different than the transition from a cataract surgeon to a refractive lensectomy surgeon. The expectation of a patient undergoing refractive lensectomy is like that of a LASIK patient and not like a cataract surgery patient. Cataract surgeons who have never performed refractive surgery think they can simply start implanting presbyopia-correcting IOLs. We must manage patients’ expectations preoperatively and develop a relationship with them. It is a whole different culture.

**Nichamin:** I agree strongly with Frank. We can talk as much as we want about the different qualities of these lenses. At the end of the day, however, it is the refractive mindset of the surgeons and their entire practice that is paramount. Surgeons adopting this type of technology have to be versed in bioptics or partner with a surgeon who can perform enhancements such as LASIK and conductive keratoplasty. Implanting presbyopia-correcting IOLs is a big undertaking. I think Steve’s point is excellent: We will need to spend a lot more chair time educating our patients.

**Packer:** I completely agree. It is a different relationship that you have with these patients, whether they are cataract patients or refractive lens exchange patients. You have a real physician/patient relationship. Implanting presbyopia-correcting IOLs is similar to refractive surgery, as Frank said.

We tell refractive surgery patients we want to achieve their goals if possible. Our efforts may include enhancements, astigmatic correction, an investment in biometric technology and topography. They are not part of the skill set of the average cataract surgeon. To me, patients are paying me to do all that I can to help them achieve spectacle independence. Now, if there is something I cannot do, they have to accept that as a limitation of the technology. We can usually fix residual refractive error.

**Bucci:** You have to be prepared to correct astigmatism. I correct astigmatism of 0.75 D or higher. We know that 1.00 D of astigmatism means 20/30 UCVA, and these patients are not going to be happy with that visual acuity.

We know that 1.00 D of astigmatism means 20/30 UCVA and these patients are not going to be happy with that.

— Frank A. Bucci Jr

**Lindstrom:** I said in the past that 20/happy is 20/30 and J3, but, really, it is becoming more like LASIK now. We have to be within 0.50 D of emmetropia and 0.50 D or less for astigmatism, and that is 20/20 and J1 vision. I am aggressive about enhancements in this group of patients.

**Lane:** Dick, you coined the phrase 20/happy. What you want is a happy patient. It really does not matter which plus or minus number you choose. As with any keratorefractive procedure, you want a patient who is both happy and spectacle independent. Usually, you do not get one without the other.

**Bucci:** The added cost of the lens increases the price of the surgery. A cost of $7,000 USD to $10,000 USD for two eyes means patients have a higher expectation. People who can afford this surgery want to be happy. They expect not to use spectacles. You have to be able to solve that problem.

**Lane:** I think the surgery we perform for a patient receiving presbyopia-correcting IOLs must be more meticulous than in the past with monofocal lenses. We must perform thorough cortical cleanup, size the capsulorhexis exactly right and center the lenses well. Posterior capsular cleanup is particularly important because anything on the posterior capsule is going to have a more significant effect on a multifocal than a monofocal lens. We should do as much as we can to prevent posterior capsular opacification (PCO) or any-
thing that would diminish the patient's vision early postoperatively. That includes preventing even mild degrees of cystoid macular edema (CME).

**Chang:** You are saying that it is more than just delivering a premium IOL. It is premium lens removal surgery. You have to have perfect biometry, a perfect capsulorhexis, an intact posterior capsule, good cortical cleanup — essentially flawless surgery.

**Kohnen:** It is not only premium surgery; it is premium diagnostics. We need accurate corneal topography in order to place our incisions correctly to reduce astigmatism.

**Nichamin:** I would point out the corollary to Steve's point. To optimize the result, we have to have a perfectly positioned IOL. If the lens does decenter a little bit, we may find that the patient's vision is significantly worse because of induced higher-order aberrations, particularly with multifocal optics.

**Bucci:** With refractive lensectomy, you cannot tolerate CME. Using nonsteroids with steroids after surgery should be almost standard. The CME may last a few weeks and reduce visual acuity to 20/25 or 20/30. Most of the time this CME resolves, but these patients want to see well fast.

**CONTRASTING IOLS**

**Chang:** Everyone here is routinely using a topical nonsteroidal in cataract patients. Dick, how would you compare and contrast the presbyopia-correcting IOLs?

**Lindstrom:** I have had a chance to examine and talk to patients who have received all of these lenses. One way to think about it is to look at what patients do not like about each lens. They want to have good distance, intermediate and near vision, and they would like to have high-quality vision — including at night — with no dysphotopsia. We do not have such a lens yet. The primary complaint I hear from patients who receive the Crystalens is that their near vision is inadequate. From my perspective, the Crystalens provides the weakest near vision.

With the Acrysof Restor and Tecnis M multifocal lenses, intermediate vision is weaker, and some patients complain about reduced quality of vision and night vision symptoms. With the Acrysof Restor lens, some patients also describe difficulty reading in a dim environment because the near function of the lens depends on pupil-size. They either need more light, or, for instance, they must have someone else read the menu to them in a dark restaurant. Patients who receive the diffractive Tecnis M multifocal IOL do not have that problem.

With the Rezoom lens, my patients' primary complaints have been of night vision symptoms and somewhat weaker near vision. My colleagues and I used the Array lens for years, and like everyone else here, many of our patients were dissatisfied with their near vision. They experienced more night vision symptoms than we wanted. We have found the Rezoom lens to be better at providing near vision and it performs a little better at night. Still, a patient may complain about night vision symptoms and occasionally about weak near vision. So, here I am comparing the lenses according to their shortcomings.

**Packer:** Turning it around, you can look at the relative strengths of the lenses. A patient who has more activities that are distance or intermediate dominant will be happier with the Crystalens, if they do not mind possibly needing a 1.25- or 1.50-D pair of reading glasses. A patient who reads a lot will be happier with a diffractive multifocal IOL (Acrysof Restor or Tecnis M multifocal IOL) that has a +4.00-D add at the IOL plane. Dependence on pupil size is interesting because it is the reverse with the Acrysof Restor and the Rezoom lenses. With the Rezoom IOL, patients need a larger pupil to read because the near does not start until past 2.5 mm. With the Acrysof Restor IOL, a bigger pupil decreases the patient's ability to read because the lens becomes more distance dominant. I actually have Rezoom patients who say, "I can read, but I have to turn down the lights."

**Bucci:** I have bilaterally implanted 56 Acrysof Restor IOLs, and I was pleased with patients' reading vision. It was everything they did not have with the Array lens. The night vision problems were minimal, but a significant number of patients had pronounced problems with their intermediate vision.

The older cataract patients who do not use computers often and who are thrilled to read a book tolerate the Acrysof Restor lens better than younger people who spend more time on the computer. I started a study in which I implant the Rezoom lens in a patient's nondominant eye and the Acrysof Restor lens in the dominant eye. When the pupil is small, the Acrysof Restor IOL provides good reading vision. As the pupil dilates, the Rezoom lens takes over and creates reading synergy. So far I have performed 30 of these procedures and have at least 8 weeks' follow-up for 21 patients.
Chang: For those of you who have tried or are using both, do you see a difference between the Rezoom and Acrysof Restor IOLs as far as nighttime halos and visual symptoms?

Packer: In the US Food and Drug Administration (FDA) data, the IOLs performed almost identically, which is fascinating. It is about 30% moderate and severe combined. The study of the Acrysof Restor lens began with the three-piece platform and went to the single piece. There are slightly fewer halos with the three-piece platform. Perhaps, one might speculate, because of better centration.

Bucci: You can get different numbers depending on how you ask about nighttime images. It is difficult for people to explain what they see, categorize that information and make a comparison.

Chang: Imagine that you are counseling a young, somewhat demanding patient with big pupils. He/she is interested in reducing spectacle dependence for near tasks but is worried about halos. Which lens are you going to implant?

Bucci: The engineer would expect to be independent of spectacles because of frequent computer work. I have not yet implanted the Rezoom lens bilaterally, so I am unfamiliar with how patients may describe the pattern of halos with it. I would be confident about placing the Acrysof Restor lens in a patient's dominant eye and the Rezoom lens in the nondominant eye. I think that the patient would adapt to slightly more halos perceived by the Rezoom eye versus fewer rings and halos in the Acrysof Restor eye. The patient would have excellent near, intermediate and distance vision and would depend less on pupillary size for excellent reading. The patient would be able to read under almost any circumstance.

Lindstrom: For a truck driver at night, I would probably choose an aspheric monofocal lens or I would implant a Crystalens for blended vision. I probably would not choose a multifocal IOL, although a multifocal lens in one eye could be an option.

Lindstrom: I think the likelihood of explants will be slightly higher with multifocal versus standard lenses. A few patients will not achieve the outcome they want and will have unwanted night vision symptoms. During the Array era, I had patients who accepted unwanted nighttime symptoms to achieve excellent near vision. Patients who had night vision symptoms but not good near vision asked, "I've got all these problems at night for what?"

Kohnen: The European trial of the Acrysof Restor lens reported more glare symptoms than the US trial (approximately 8% vs 4%). Our experience was with the three-piece design, which was in the European more than in the US trials. I never had a patient request an explant. In the European trial, there were two explants — one due to an incorrect IOL power calculation and one because of disturbances. Like Dick, I would probably avoid multifocal implants and choose a monofocal IOL in eyes with large pupils. Monovision may be the best option.

Kohnen: I had the same experience as Dick. I was frustrated with some of the Array lenses because I had to take them out. Then came the Acrysof Restor lens with its apodized diffractive optics and then the Tecnis Multifocal IOL. From a clinical standpoint, however, results are even better than in the trials.

Packer: Even so, the engineer and the nighttime driver have always been on our watch list for multifocal implants. As Steve said, there is always a compromise with multifocality. People who have high demands and who want to read their micrometer scopes may be better off with monovision or with binocular vision and reading glasses. If quality of vision is what they are after and spectacle independence is secondary, it is a different sort of person than the one who really just wants to be free of glasses and will put up with the slight blur or reduced contrast that multifocality always engenders.

Bucci: Effective preoperative communication with patients is critical. If I assess a patient's personality and realize that I will never make this individual happy, I...
practically talk them out of multifocal IOLs. If they beg me to implant this lens type, I can always remind them that I said halos may prevail.

**Packer:** Especially because the patient is spending so much, he/she needs to know the truth about the technology and what its limitations are.

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**Bucci:** I inform them that there can be astigmatism in either their cornea or their crystalline lens. I point to a cross-section diagram of the eye at the time of this discussion, and they see that light passes through both of these anatomic entities. I make it clear that we are removing the crystalline lens but that there is still a 35% chance that they will have enough residual astigmatism in their cornea to require an enhancement. I explain that this procedure is necessary for them to achieve the maximum outcome with these implants and that, if they are unwilling to undergo the enhancement, the multifocal IOL is probably not a good option for them. Usually, patients are receptive to the straightforward explanation.

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**Chang:** Have you seen a difference in the tolerance or intolerance of halos between your refractive lensectomy patients and your cataract patients? Presumably, cataract patients are already having nighttime images due to the cataract.

**Lindstrom:** Most of the Array lenses that I implanted were in cataract patients, and they did not hesitate to complain. I am not sure I can tell the difference. I think perhaps cataract patients have more to gain, so they may be more accepting. They still notice the negative side effects, however.

**Kohnen:** We have a different population because refractive lens exchange is usually for high myopes or high hyperopes, at least in my practice. We are not yet treating presbyopic emmetropes.

**Lane:** People who have cataracts are obviously disabled by them. People coming in for refractive lens exchange are disabled by their refractive error. The people who are -1.00, -2.00, -3.00 D are usually opting for LASIK when they are younger, or they are getting along pretty well if they are in the presbyopic age group.

**Packer:** I have infrequently treated the mildly hyperopic (+0.50 D) presbyope. The low myopes, I think, are very happy. I tell patients who are 50 years old with -0.75 D that they already have what I would consider a successful result from refractive surgery.

**Lindstrom:** We perform a lot of monovision LASIK on those patients, maybe not for -0.75 D but for -1.25 to -1.50 D. What do you do for a -1.50-D 50-year-old? I do not perform a refractive lens exchange. If I do something, I only treat one eye for distance with the excimer laser.

**Chang:** What about an emmetrope who really hates wearing glasses? Are any of you using presbyopia-correcting IOLs in these patients?

**Bucci:** I tell them that I am conservative and respectful of intraocular surgery and the 20/20 eye. I do not want to perform two refractive lensectomies. If they are adamant about undergoing treatment, I may agree to operate on one eye, but I insist on waiting 6 months to see if they adapt to any light phenomena and if they are happy with their reading vision before performing a refractive lensectomy on the second eye.

**Lane:** If they were a good candidate with monovision contact lenses, I would try that modality first. Then, I would not hesitate to try conductive keratoplasty, LASIK or PRK. I think that is the way to go with that patient.

**Lindstrom:** There are a lot of presbyopes. What if a 44- to 55-year-old patient loved monovision contact lenses but was becoming contact lens intolerant? Would you be willing to duplicate that approach with surgery? I would.

**Kohnen:** I might, but this is not a concept that is very popular in Europe.

**Nichamin:** I think your point is well taken in the context of the multifocal discussion. If a patient was successful with monovision, why broach multifocality? Why not go with monovision?

**Lindstrom:** I usually do.
**IMPACT ON CLINICAL PRACTICE**

**Chang:** For those of you who have busy LASIK practices, how have these new IOls changed your approach to patients between 50 and 60 years of age who request LASIK for their refractive error?

**Nichamin:** We rarely perform LASIK as a primary procedure on patients older than 55 years. The hyperopes, I believe, should lose their crystalline lens. They are in a healthier state as pseudophakes. It is so disappointing to perform successful LASIK, for example, on a 54-year-old myope who returns 2 years later complaining about quality of vision. One might think that perhaps it is induced higher-order aberrations from the LASIK procedure. Instead, the problem more often is a change in the crystalline lens that then must be removed to alleviate the symptoms. In such a case, of course, one faces the additional task of a challenging IOL power calculation because of the patient’s previous refractive surgery.

Approximately 7% of our total implants now are refractive lens exchanges, and the number is slowly growing. I realize that we are probably more aggressive than most. We track our data, and I truly believe that the risk/benefit ratio favors lenticular surgery in many presbyopic ametropes. As we continue to see improvements in IOL technology, this trend will continue, and I believe it is the wave of the future. I think the age range of our LASIK population is definitely shrinking.

**Lane:** I would agree. I discuss the possibility of restored near vision with all presbyopic 45- to 55-year-old patients who come in asking about LASIK. They were unfamiliar with this kind of lens technology, and most walk out having decided that they really want refractive lens exchange, which will give them more than they had hoped for LASIK alone.

We all have patients on whom we would not operate because they have an unusual-looking cornea. We may even be nervous about PRK for that group. They come back year after year with no change in topography. If you perform refractive lens exchange on those patients, they love you.

**Kohnen:** The complications of IOL surgery are currently low compared with laser surgery on a cornea with potential pathologies. I agree that, if we had patients who have this corneal problem or potential corneal problems, then I am always more inclined to use phakic IOLs or refractive lens exchange.

**Lindstrom:** I do not have an exact age cutoff, but the closer the patient gets to having cataracts, the more logical it is to perform cataract surgery.

**MACULAR DEGENERATION**

**Chang:** How does mild age-related macular degeneration (AMD) or the possibility of AMD affect your decision to implant a presbyopia-correcting IOL in a cataract surgery patient?

**Lindstrom:** I implanted my first multifocal IOL in 1985. AMD was always a concern. I have some patients now who have developed meaningful AMD who had none at the time of surgery. My clinical impression is that receiving a multifocal implant was not a bad thing for them. When they look through the top of a standard bifocal spectacle, they have their standard multifocal vision. When they look through the bottom, they more or less have a built-in low-vision aid. I do not think I have harmed anyone’s near visual function. If anything, I think I have helped them. I do believe, however, that a few of these patients will lose their driving privileges a little earlier than if they had not received a multifocal IOL. I do not put multifocal IOLs into the eyes of patients who have frank macular degeneration, but I feel comfortable that I am not harming those who later develop AMD.

**Lane:** I think it is a controversial subject and will continue to be until we get some good studies. The bottom line is that we do not know for sure, but I do not believe that a multifocal IOL is contraindicated in a patient who has some drusen and/or maybe a little pigmentary mottling but still has vision consistent with the level of cataract or good vision because of refractive lens exchange.

The issue, of course, is that there is some splitting of light that occurs with any multifocal system. Patients with AMD need as much light as possible to maximize their vision. Realize, however, that there is some loss of energy even going through the optical system of a monofocal IOL.

As Dick just mentioned, the near portion of a multifocal lens may actually give a telescopic effect that aids patients with age-related macular degeneration (AMD).
I do not think we are doing a disservice to patients with early macular changes whose decrease in vision is consistent with their cataract.

Lindstrom: If a patient with AMD and 20/30 visual acuity strongly desired to maintain independence and the ability to drive, I would be uncomfortable putting in a multifocal IOL. I would select an aspheric monofocal IOL. If a person had already given up driving, I could argue that the multifocal IOL would be beneficial.

Lane: The concern I have is for the patient who has some macular changes but is not yet symptomatic. Some people would not want to implant a multifocal IOL because the patient may develop macular degeneration. Although studies need to be performed, I do not think the implant would be detrimental.

Packer: Even in the clinical trials, patients with slight changes in the retinal pigment epithelium or atrophic changes who had a potential acuity of 20/20 were considered candidates. I think that is fair. There is no way of knowing whether or not these people are going to suffer in their driving. If it is a huge benefit now to be free of spectacles, maybe that is a reasonable tradeoff.

Lindstrom: As a clinician, I have learned that these patients are not unhappy with you later if they get AMD.

Bucci: I am not extremely worried about these patients. If they have macular changes, I diligently document a potential acuity meter (PAM) reading of 20/20, if they can achieve it. It is somewhat harder to get reliable PAM readings in patients with dense cataracts because the PAM is not quite as accurate through more severe nuclear sclerosis. If the patients have heard about multifocal lenses, it is a judgment call as to the true health of their retinas.

AGE

Chang: For those of you using the Crystalens, do you see a difference in its performance between younger and older patients?

Packer: I think there is a greater difference with various refractive errors when using the Crystalens. I have found that long eyes tend to do well, which is counter to what we would have expected had we thought the lens' actual mechanism was movement. I think this observation comes together, Dick, with what you said and with what Jack Holladay, M.D., has said about how the Crystalens may increase the depth of focus in a standardized fashion. Then, in a long eye with the posterior placement of the optic and small optic diameter, it will be more forgiving; you will get a much longer depth of focus. I had the opportunity to implant the Crystalens bilaterally in an ophthalmologist who confirmed that impression. He was a high myope and is now spectacle independent. He said, "I do not get the idea that I am changing my focal distance. I just feel like everything is in focus all the time." I found that high myopes do well with the Crystalens, better than I would have expected.

Lindstrom: The clinical trials confirmed that hyperopes did not do better than myopes. In addition, if this IOL works primarily through forward movement of the optic, a higher-powered lens should work much better. A +30.00-D lens should work better than a +10.00-D, but that has not been found. It is clear to me that the Crystalens does not primarily shift focus by having the optic move forward and backward. It is also clear to me, however, that with the Crystalens, we get greater depth of focus than a multifocal IOL and better near vision than with a monofocal IOL but not as good as a multifocal IOL. I think a good part of it is inherent in the lens. I have observed that the Crystalens may tilt with accommodation, and, if the lens tilts 5°, that increases the depth of focus by about 1.00 D. Maybe that is the difference between the patients who get +1.25 D of increased depth of focus and J3 and the ones who get J1 and do not need spectacles.

Some patients get a little lens movement, but there is an increased depth of focus inherent in the lens' design versus the monofocal. There is no doubt about that because their increased depth of focus persists under cycloplegia.

Packer: Near vision is somewhat less predictable than with multifocal lenses, possibly because of variations in position due to the capsule's size.

THE MONOCULAR PSEUDOFAKE

Chang: Let us take the monocular pseudophake with good uncorrected distance vision who is back for a second cataract surgery. Assuming that the patient is interested in reducing spectacle dependence, are you willing to implant a multifocal IOL or a Crystalens in the other eye?

Kohnen: I would. For example, I have obtained successful results when implanting the Acrysof Restor lens
in a patient’s second eye, and I would give the patient the option. We know that spectacle independence is better with bilateral multifocal lenses, but it is beneficial if even one eye can read. A glaucoma patient of mine had read in the newspaper about the option of the Acrysof Restor lens. I told him I did not want to implant the IOL because he had glaucoma and a small pupil. He insisted on having an Acrysof Restor lens. I implanted it, and he is 20/20. He is the happiest patient I have seen in a long time.

Lindstrom: The Acrysof Restor lens is symmetric distance and near with a 1-mm pupil, but it offers the best near vision with about a 2-mm pupil. Patients do get an increased depth of focus from a small pupil. In the days when we used to give people phospholine iodide, I had a lot of pseudophakic eyes with 1.8-mm pupils that saw 20/20 and J2 without corrections from the pinhole effect.

Lane: I would also implant a presbyopia-correcting IOL. I have a number of those patients now, as well as patients who are phakic in one eye from trauma. Patients who are in their 40s so far have done extremely well. It is the old monovision idea, and statistically, about 30% of people do not tolerate monovision. Patients have to know what to expect and what monovision means, and they must be willing to proceed.

Nichamin: The quality of presbyopia-correcting IOLs is so much better. All of us who have implanted the Array lens know that after operating on the first eye, you would have to beg a patient to have the second procedure. Knowing that probably one out of three patients cannot tolerate monovision, I would never have thought that a patient could have a Crystalens in one eye and a Rezoom or Acrysof Restor lens in the other eye. Dick has shared his experience, and the fact is that these patients are doing extremely well. We have a lot to learn about cortical adaptation, but I will be interested to see further studies about this phenomenon and a better assessment of these combinations.

Bucci: When the Acrysof Restor lens became available in the United States, I started offering it for the second eye of patients who had undergone cataract surgery on one eye before the IOL was available. I have at least 20 people who have the Acrysof Restor lens in one eye, and most are tolerating it just fine. A few patients are complaining of waxy vision, however, when only one Acrysof Restor lens is present. Nevertheless, they are thrilled to have some reading ability.

In contrast, when I implanted one eye with the Array lens, patients were grateful to have near and intermediate vision, but they frequently complained about halos, although the phenomenon lessened with neuroadaptation in time. The patients with the Acrysof Restor IOL in one eye do not have any overwhelming nighttime problems in my experience. This lens has been amazing in my estimation as far as how little patients complain about the halos.

MIXING IOLS

Chang: Certainly, most surgeons will bilaterally implant the same IOL, as manufacturers would recommend. What has been your experience with mixing different multifocal or refractive IOLs in the same patient?

Bucci: I have been tracking the number of voluntary complaints about intermediate vision for the bilateral Acrysof Restor patients. There are two levels of severity: one I call a voluntary spontaneous complaint to indicate patients who complain immediately when they enter the examination room; and the other I call a voluntary complaint with inquiries to indicate a complaint when I ask how they are but do not suggest problems with intermediate vision. Of my first 56 patients with bilateral Acrysof Restor IOLs, 13 offered a voluntary complaint about their intermediate vision. None of my first Rezoom/Acrysof Restor patients issued a voluntary intermediate complaint.

The probability of a patient’s complaining about his/her intermediate vision increases with decreasing age. Ten of the 13 patients who complained were <60 years of age and underwent refractive lens exchange, not cataract surgery (population with approximately 35% cataract surgery vs 65% refractive lens exchange patients). The older patients were less likely to complain and to use computers.

Combining the Acrysof Restor and Rezoom lenses appeared to satisfy the intermediate requirements that frequently are not met in my patients who received the Acrysof Restor IOL bilaterally. I have not found significant problems with glare or halos in patients who receive the Rezoom lens in only their nondominant eye.

Chang: Do people notice and describe a difference in what they see?

Bucci: I have been testing the Jaeger near and intermediate vision, both unilaterally and bilaterally, in the bilateral Acrysof Restor cohort and the Rezoom/Acrysof Restor cohort. I measure near vision at patients’ best focal point and intermediate vision at arm’s length to represent their true function.
This new Bausch & Lomb IOL is modeled after the Akreos Adapt lens.

By Ann Haustermans, M D

Traditional IOLs have a spherical design that induces positive spherical aberration. As a result, patients who undergo IOL implantation have a large amount of spherical aberration that significantly affects contrast sensitivity.

The Akreos Advanced Optics IOL (Adapt AO) is the new aspheric IOL from Bausch & Lomb (Rochester, NY). This lens has aspheric anterior and posterior surfaces and therefore creates no additional spherical aberration after implantation. As it is truly aberration-free, this IOL is suitable for all patients, independent of their preexisting corneal aberrations. Because the Adapt AO leaves the eye with a small amount of positive spherical aberration from the cornea, it may allow for a better depth of field resulting in some degree of pseudoaccommodation.

In addition, the Adapt AO provides a uniform power from the centre to the edge of the lens. Therefore, this IOL is independent from the optical alignment of the eye and less affected by decentration. As a result, the refractive and visual outcomes are more predictable, even in patients with zonular weakness or eccentric pupils (Figure 1).

The Adapt AO is based on the Akreos Adapt lens that has been on the market in Europe for 6 years. I have been implanting the Akreos Adapt routinely since 2000, and I particularly appreciate the stable refractive outcome and perfect centration of this lens. Because of Antiglare Technology and a moderate refractive index, patients do not complain of dysphotopic symptoms after implantation of this IOL.

As part of a European multicentre, randomized, prospective study, I have been implanting the Adapt AO since January 2005 (Figure 2). Study participants received an Adapt AO in one eye and a conventional Akreos Adapt in the fellow eye. Patients were masked so as not to influence their performance testing and answers in the 3-month postoperative questionnaire. The outcomes measured in this study are high- and low-contrast UCVA and BCVA in LogMAR, photopic and mesopic contrast sensitivity, higher-order aberrations, as measured by the Zywave aberrometer (Bausch & Lomb) and posterior capsular opacification, evaluated by the Evaluation of Posterior Capsule Opacification scoring system.

Clinical data from 120 patients in six European centres are being collected and will be presented at future meetings worldwide. I have observed a clinical benefit with the Adapt AO in terms of improved photopic and mesopic contrast sensitivity as well as a lower rate of higher-order aberrations in my group of 20 patients. Furthermore, many patients prefer the eye where the aspheric IOL is implanted, even if non-dominant.

Since the availability of the Adapt AO, I stopped using the Akreos Adapt and have made a complete switch to this new aspheric lens. Except for patients who have undergone hyperopic laser surgery with resultant negative spherical aberration in their cornea, all patients that require cataract surgery may benefit from an aspheric IOL over a traditional IOL with spherical optics. I believe aspheric lenses will become the standard in high-quality modern cataract surgery.

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I had four unilateral Array patients who never had the second surgery for various reasons. In general, they wanted better reading vision without an increase in halos. I implanted the Acrysof Restor lens in their other eye, and they are some of the happiest patients I have ever seen because they have the reading vision that they desired with essentially no more halos. They had adapted neurologically after having the Array for many years.

Generally, they could read J1 in their Acrysof Restor eye and, on average, approximately J2 comfortably with the Array lens. Intermediate vision was usually J5 or J6 in the eye with the Acrysof Restor lens and J1 or J2 in the eye with the Array lens.

My success with mixing the Array and Acrysof Restor lenses prompted me to combine the Rezoom lens with the Acrysof Restor IOL. I place the Rezoom lens in a patient’s nondominant eye.

Packer: It also depends on whether you are talking about the best distance vision during the day in bright sunlight or the best distance vision at night.

Kohnen: We actually have two principles here, diffractive and refractive optics. You would think that the brain would have some problems working out these two different kinds of optical designs. We really do not know enough yet about putting different multifocal IOLs in each eye.

Lindstrom: We are learning. My original experience was much what Frank described. I have patients with the 3M diffractive multifocal IOL in one eye and an Array lens in the other. Those patients have done well. I also have patients with the 3M diffractive multifocal lens in one eye and a monofocal lens in their other eye, and those patients have done well. I am confident that you can mix and match these lenses.

I think we still have a lot to learn as to what the best choice is for the individual patient. Usually, the patient is ecstatic with the first IOL, whichever it is, and most of us would put the same lens in that person’s second eye. The issue is if the patient has a multifocal IOL in the first eye and is unhappy with night vision symptoms. Should you put another multifocal IOL in and tell him/her to get used to it, or might you consider implanting a Crystalens or a monofocal lens in the patient’s second eye? My experience is that you can do that successfully and patients are less unhappy with the night vision symptoms. As I mentioned, my major complaint with the Crystalens is that patients are unhappy with their near vision. As a result, I have the most experience implanting the Crystalens in patients’ first eye and a multifocal IOL in their second. That combination is working well also.

Packer: I had a refractive lens exchange patient who was about a +4.00-D presbyopic hyperope and who opted for the Crystalens. She had a plano distance refraction, 20/20 UCVA OU and cycloplegic 20/20 uncorrected distance vision. She saw only about J11 at near. At about this time, the zero-powered Array lens was introduced, specifically for piggybacking.

I explained this development to her. She had actually turned down the multifocal option earlier because of a concern about halos. Now that she lacked near vision she was more willing to consider something else.

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I piggybacked Array lenses on top of her Crystalens implants. The only problem was that her pupils were too small. When she had dilated pupils, she could read just fine. In bright sunlight, she could not. I performed photomydriasis to enlarge her pupils, and finally she saw 20/20 and J1.

Lane: I have concerns about mixing and matching IOLs. I am certainly open-minded about the idea, but thinking about all of these different combinations and trying to optimize results for an individual patient is difficult. I also think you have to look at it from a practical standpoint, at least in the beginning. I have patients who had LASIK, and I have patients who had refractive lens exchange. No matter how many times you tell them not to compare their two eyes, they all do it. When they have the same lens in each eye, they still tell me that they like one better than the other.

I would not know what to do with a patient in whom I had implanted different IOLs who said, “I don’t like this eye.” I do not want to give him/her an excuse to make me consider interventional measures. With the Acrysof Restor IOL’s US FDA clinical trials, 80% of the patients never needed to wear glasses when they received the lens bilaterally. With that high a percentage of spectacle independence, mixing and matching IOLs does not currently make sense to me. I am willing to
look at all of the data on combining different multifocal lenses as they are generated, but really what we are talking about is a modification of a modification of a modification. I am currently not willing to open this Pandora’s box.

PERSONAL CHOICES

Chang: Let’s say you have cataracts and you cannot wait for an accommodating lens but you really want to be spectacle independent. What are you going to have bilaterally? Let us assume that the Tecnis Multifocal IOL is available in the United States.

Lindstrom: I would choose a Crystalens with mild blended vision because that approach has worked best for me in combination with contact lenses. I do not wear contact lenses well because I have mild dry eye and some blepharitis, but I do not like the halos that I see through the multifocal contact lenses I have tried.

Kohnen: When in that situation, I would choose bilateral Acrysof Restor lenses.

Nichamin: I had LASIK. I also have one eye that is rather dry, so I would be a little reluctant to get a multifocal lens at this point. I have some higher-order aberrations, which I would like to eliminate. I would not want to sacrifice any distance vision. So, I am awaiting the next chapter, which is aspheric. Perhaps I would consider a little bit of blended vision.

Packer: I am a fanatic for quality of vision, and I know I would not like multifocal vision. Frankly, I do not find reading glasses to be a big problem.

Lane: I also had LASIK, and I thought I was fairly finicky about my quality of vision. I thought I would hate any sacrifice in my vision whatsoever. I never thought I would be able to tolerate monovision, but I am trying it with contact lenses and finding it is not so bad. I would probably first have an Acrysof Restor IOL implanted in my nondominant eye. If I were happy with the result at near and distance, I would probably request a monofocal lens for my dominant eye.

Chang: Let’s say a family member with a cataract really values spectacle independence. Based on your experience, which of the presbyopia-correcting IOLs would you choose?

Packer: I do not have experience with the Acrysof Restor lens, but based on my current experience of achieving spectacle independence, the Tecnis Multifocal IOL is more successful than any of the other IOLs that we have used.

Lindstrom: But, you might implant a Crystalens in one eye and a Tecnis M multifoical IOL in the other?

Packer: Thinking back, many patients in whom I implanted an Array lens came back not wanting their second eye done. After the second procedure, they all agreed that the result was great. I am still a little nervous about mixing and matching IOLs.

Bucci: With the continued success of my Rezoom/Acrysof Restor patients, I think that might be my first choice if I had to use presbyopia-correcting lenses, however, I would like to see the long-term results. If the Tecnis M multifocal IOL is a choice, I might replace the Acrysof Restor lens with it for the advantages of asphericity.

Lane: I would not hesitate to choose an Acrysof Restor lens for my second eye if I felt that I wanted to have better binocular near vision and if I were happy with the near vision in my first eye.

Bucci: Would you be willing to wear glasses for intermediate distance such as for the computer?

Lane: Yes, I would.

Kohnen: Although I said I would choose bilateral Acrysof Restor IOLs, I should note that I am not presbyopic yet. The best option for me would be reading spectacles because I am emmetropic.

Lindstrom: In the United States, the majority of patients’ first choice is monovision or blended vision. Number two is modified monovision (a monofocal lens in one eye and a multifocal lens in the other). The least commonly chosen alternative is bilateral, symmetric, multifocal contact lenses. The option gaining popularity the fastest is the asymmetric multifocal contact lens, which would be like combining the Rezoom and the Acrysof Restor lenses. In other words, one eye has a little better distance vision (I like the Rezoom lens for distance vision, and intermediate vision will be better as well), and the other eye has stronger near vision (like the Acrysof Restor lens). I think maybe I learned something.
This familiar IOL platform adds a negative spherical aberration of 0.2 µm.

By Warren E. Hill, MD

The history of IOLs represents a fascinating journey. After solving many of the mechanical problems associated with keeping the lens in place without inflammation or physical damage to the eye, we have returned to Sir Harold Ridley’s original intent of emulating the natural lens. The Acrysof IQ lens (Alcon Laboratories Inc, Fort Worth, Texas) is one recent example. The strategy of this lens is to mimic one specific aspect of the normal youthful eye by reducing the total amount of positive spherical aberration in the pseudophakic state to enhance the performance of the human optical system.

The IQ lens, or the SN60WF (Figure 1), has a thin aspheric design with blue-light filtering and a high refractive index. This IOL is based on the SN60AT Acrysof Natural platform (Alcon). This single-piece technology and material are familiar to many surgeons who have used the Monarch injector (Alcon) combined with a small incision.

Copying the human optical system at its peak performance, this lens introduces a small amount of negative spherical aberration to approximate the posterior surface of the cornea and the natural lens. As the human eye ages, positive spherical aberration increases in response to changes in the crystalline lens and cornea. Recent studies have suggested that visual performance may peak in the presence of approximately 0.1 µm of positive spherical aberration.1,2

ADDS NEGATIVE ABERRATION

To optimize visual performance and to counteract the effects of the aging crystalline lens and cornea, the IQ lens adds approximately 0.2 µm of negative spherical aberration — the amount of negative spherical aberration found in the posterior corneal surface and the natural lens of a typical 20-year-old patient.3 By addressing the positive spherical aberration, the IQ lens can keep up with lenticular and corneal changes and return the eye to something close to a youthful amount of positive spherical aberration. Studies have shown that a slight amount of residual positive spherical aberration correlated with peak visual performance.1,2

Mester et al4 concluded that in the absence of positive spherical aberrations, patients were unable to achieve supranormal vision when compared with patients who presented with slight positive spherical aberration. There are exceptions, however. Patients who have undergone prior myopic LASIK or prior RK are likely to have higher amounts of positive spherical aberration. For these patients, the Tecnis Z9000 aspheric lens (Advanced Medical Optics, Santa Ana, California) may be a more appropriate choice with its -0.27 µm of negative spherical aberration. And for patients with prior hyperopic LASIK, the Bausch & Lomb L61AO (Rochester, NY), with no correction for positive spherical aberration may be the better choice.

For the majority of cataract patients, the IQ provides an excellent alternative to spherical or simple aspheric IOLs. This is my present IOL of choice. I have performed more than 300 surgeries with this lens, and it is the lens that I would choose to have in my own eye.

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ADVICE FOR CATARACT SURGEONS

Chang: A lot of cataract surgeons have never performed LASIK and have never dealt with refractive surgery patients. Many have never implanted an Array lens. Give me one piece of advice for that surgeon on how to get started in this arena.

Bucci: I suggest visiting a refractive surgeon for help developing communication skills and strategies for managing expectations. The communication techniques used with pure cataract surgery patients will be insufficient for patients undergoing refractive lens exchange.

The physician should also address the meticulousness of his/her surgery. Their capsular breakage rate should be in the range of one to two per 500. Breaking three capsules for every 100 surgeries will likely be unacceptable in lens-based refractive surgery patients.

Lane: I think that it boils down to commitment. If the cataract surgeons who want to implant these lenses are not willing to make the commitment of becoming refractive surgeons, then they should not implant these lenses. I think they are setting themselves and their patients up for disappointment. They need to think of it not just as another IOL to implant. They really need to assume the mentality of a refractive surgeon.

Nichamin: Surgeons have to become a refractive cataract surgeon with monofocal lenses first and be absolutely sure that they have a tight range on both spherical and astigmatic outcomes. Because the majority of surgeons still are not performing limbal relaxing incisions (LRIs) and let the astigmatism go, I think they have to be proficient at and capable of achieving excellent refractive outcomes with monofocal IOLs before they can tackle presbyopia-correcting implants.

Packer: Many times I Howard Fine, M D, has stood up and asked a room full of people, “How many of you know your surgically induced astigmatism by vector analysis?” Usually, two or three surgeons in the room raise their hands. Measure your outcomes. That is the only way you will know what you are doing and how to make improvements.

Kohnen: You have to know a lot about refractive surgery, and you have to visit somebody who is in that field to learn about all of these techniques. Precision is the key point. Consider refractive lens exchange for which we have to make two large capsularhexes. We may cause PCO and a long-term increase in the rate of retinal detachment. It is a different story from normal cataract surgery.

Lindstrom: Meticulous surgery is fine, but after speaking with numerous surgeons through the years, I think the major barrier is learning to achieve outcomes within 0.50 D of emmetropia. Most surgeons lack an enhancement strategy. They need to learn how to deliver relaxing incisions, implant piggyback lenses and perform laser refractive surgery. The alternative is to partner with someone who can. These patients will want enhancements if you miss on the biometry or the astigmatism.

ASPHERICITY

Chang: Let’s talk about what percentage of the monofocal IOLs you implant are aspheric. How compelling is the evidence that asphericity is clinically important?

Lane: I am using the SN60WF Acrysof IQ aspheric lens (Alcon) on the vast majority of patients now, and I think that the evidence for clinical importance is less compelling than I would like it to be. When you test these patients in a lane (measure contrast sensitivity and spherical aberrations and perform aberrometry), the results indicate that aspheric lenses are better than spherical IOLs.

I have been underwhelmed by patients’ ability to perceive advantages, however, especially those who have a spherical IOL in one eye and an aspheric in the other. Nonetheless, the theoretical advantages of these lenses coupled with the improvements in contrast sensitivity compel me to use these lenses. Currently, we are doing more sophisticated testing to see if any clinical differences can be appreciated.

Lindstrom: I am using a lot of aspheric IOLs because it is logical that they will offer some improvement in quality of vision. In the United States, the extra cost is not that much, so for most patients, one of the aspheric lenses makes sense. We have the Tecnis IOL, and we have the Sofport AO lens (Bausch & Lomb). I like the latter because I do not have to worry about making anyone worse if the lens decenters or tilts. I use both.

There are patients who should receive a standard IOL, such as those who have undergone hyperopic LASIK or perhaps someone with keratoconus. I do not have patients who have an aspheric lens in one eye and a standard lens in the other who can tell much differ-
ence themselves. I have heard other people say they have such patients.

**Packer:** All of the available data from clinical studies is all BCVA. If 90% of your outcomes are within ±0.50 D of emmetropia, as they can be with accurate biometry and IOL power calculations, then most of those people are not wearing glasses. If they have a defocus of 0.50 D in one eye, then they might not see the difference. If they are ±0.50 D in their aspheric eye, the quality of vision in that eye is going to be worse than that of the emmetropic, spherical eye. Because this is a higher order, it gets less significant. You start with defocus and astigmatism, and it is a finer level of detail. Population-based studies have been done, and evidence shows that there is an advantage to aspheric lens designs. It certainly seems to be the way the field is headed.

**Kohnen:** I agree with Steve that you can measure a difference in higher-order aberrations but that most patients do not see a difference. In Germany, because the lens costs more, we currently only use spherical lenses for government-paid cataract surgery. I agree that the concept of aspheric lenses is logical, and most likely in 5 years, we will only have aspheric lenses.

**Bucci:** Between 20% and 25% of my cataract surgery patients have chosen a multifocal technology since June 1, 2005. The majority of the lenses were Acrysof Restor IOLs until I began combining that lens with the Rezoom IOL. I also implanted approximately 20 Tecnis Multifocal IOLs as part of the FDA trial. I have put my faith in the scientific reasoning that these individuals probably have better quality of vision, but the extra cost in my circumstances is always a consideration.

**Nichamin:** I am using it for nearly 100% of our monofocal cases. I am using the Sofport AO lens. I think, at least theoretically, there is convincing evidence. Wang et al showed several years ago that a significant percentage of patients within the general population may not have an average amount of positive corneal asphericity, which the negative aspheric IOLs are designed to correct. In a growing number of modified corneas from LASIK, we could theoretically make the optical system worse by implanting such a lens.

I was involved in the early study of the Sofport AO lens in which we assessed IOL decentration and its theoretical implications. The modulation transfer function test for a lens that has either positive or negative asphericity declines precipitously with decentration of 0.4 mm. Alternatively, the aberration-free Sofport AO IOL is immune to these effects and will not induce further higher-order aberrations if it decenters, if it tilts or if it is slightly misaligned with the patient’s visual axis.

Thomas, your mentor Dr. Koch recently suggested that decentration of as little as 0.25 mm may be a real problem and that, theoretically, less than half of the patients who received IOls with negative spherical aberrations actually benefit. I think we have to sort through this information. At this point, I agree with Dick’s approach of do no harm. I think that the most forgiving lens out there is the Sofport AO.

You can measure a difference in higher-order aberrations, but most patients do not see a difference.

— Thomas Kohnen

**Packer:** We have no direct evidence yet in patients on the Tecnis IOL in terms of decentration. Those data are still being gathered. In the meantime, the best we can do is to use indirect evidence based on higher-order aberrations. Actually, Wang and Koch showed what happens when an aspheric lens decenters, and they used a model of the Tecnis IOL with -0.27 µm of spherical aberration. They demonstrated that decentration of 0.50 mm induced about as much coma as spherical aberration was eliminated. So, an indirect measure of decentration is induced coma. On a population basis in the studies that have been done with the Tecnis IOL, the mean spherical aberration was zero, and there is no significantly induced coma. Both a study by Ulrich Mester, MD, and our FDA study showed that. We are not getting large amounts of decentration, or at least not enough to induce significant coma. It would be nicer to have direct evidence of the amount of decentration. To me, if the lens decentered significantly, we would see induced aberrations. Therefore, it must not be decentering that much.

**Kohnen:** My colleagues and I studied the decentration of the Acrysof MA60BM lens (Alcon), the Phacoflex S40 lens (AMO) and the Ceeon 911A (AMO), which is basically the Tecnis IOL. The average decentration was 0.29 ±0.21 mm.

**Packer:** Wang and Koch pointed out that the average decentration is 0.10 to 0.30 mm, but the thing is you cannot just take the average. You must look at the standard deviation.
Nichamin: We also have to add into the mix that, if the visual axis does not correspond to the center of the pupil, then we are judging centration incorrectly. Do we need to be measuring angle Kappa?

Packer: Scheimpflug photography measures decentration from the visual axis, so it takes care of that issue.

Lindstrom: In the present, we have monofocal, multifocal and three types of aspheric IOLs for clinical use and evaluation. In terms of a quality-of-vision index, the bottom line is that the benefit of an aspheric versus a monofocal IOL, as compared with the deficit of a multifocal IOL versus a monofocal lens, is the deficit of the multifocal lens is four times what you gain on a plus side with aspheric IOLs as measured by contrast sensitivity.

Regarding quality of vision and distance, the amount gained with an aspheric IOL is one-fourth the amount lost with a multifocal IOL compared with a monofocal IOL. Again, we seem to think multifocal lenses are okay, yet they reduce contrast sensitivity much more than aspheric IOLs improve it. Most patients tolerate multifocal IOLs. That suggests the benefit of the aspheric IOL is relatively small. I believe it is real, but it is comparatively minor. Nonetheless, if I were treating an overland truck driver, that is where the difference might show up. Some of these patients have really demanding night vision tasks.

Packer: I have been an advocate of preoperative topography and corneal wavefront measurements from the start of the whole aspheric discussion as a means to determine who is a candidate for each lens. People who have zonular compromise or have complicated surgery are not good candidates for a lens that requires excellent centration. Some degree of patient selection is necessary, and you certainly must be able to address lower-order aberrations effectively before delving into the area of aspheric lenses.

Lindstrom: Although we do not have customization, we do have four choices. We have the standard monofocal lens with positive spherical aberrations (our standard IOL), we have the zero aberration IOL and we have two negative spherical-aberration IOLs (one at -0.17 µm [Acrysof IQ lens] and the other at -0.27 µm [Tecnis IOL]).

Packer: With the Acrysof IQ lens, the amount of negative sphericity is sort of between the Sofport AO and the Tecnis IOLs. It is about -0.13 µm for a 20.00-D lens. You have four choices: a spherical IOL; a purely aspheric lens; a mildly negative aspheric lens; and a moderately negative aspheric lens. All you have to do is measure the cornea preoperatively to decide which fits best.

Kohnen: You must perform the preoperative measurements and then select an aspheric lens. No IOL is appropriate for all patients, but you can select different IOLs based on corneal aberrations.

BLUE-BLOCKING IOLs

Chang: I would like to ask each of you for what percentage of your cases you are selecting a blue-blocking IOL.

Nichamin: Zero.

Lane: One hundred percent of my patients receive a blue-light-filtering IOL after cataract surgery or during refractive lens exchange. Frequently referred to as blue blockers, these lenses filter rather than block light from the blue spectrum.

To me, the implantation of these lenses is a logical, value-added process. Certainly, the subject of blue-light-filtering IOLs is controversial. Has the hypothesis that a blue-light-filtering lens implant will reduce a patient’s likelihood of developing AMD ever been proven? The answer to that is clearly no. It is going to take a lot of work over a long period of time by many people to prove a benefit, if it can be shown at all. Those people opposed to blue-light-filtering IOLs, however, say that eyes with these implants lose the ability to perceive blue under scotopic conditions. They claim that patients who receive these lenses cannot distinguish blue from black socks and suits in their darkened closets. There is not a shred of clinical evidence proving this assertion.

I try to balance the two arguments. I see no harm in blue-light-filtering IOLs. None of my patients had an ill effect from one of these implants. They cannot tell a difference in color perception. If the theory is right that blue-light-filtering IOLs protect against AMD, I am taking a preventive measure for the benefit of my patients. That is why I use these lens implants.

Lindstrom: I agree with Steve that there is no problem with color discrimination, but that is not the same as color perception. I am an advocate of blue-blocking sunglasses. I like them for daytime use during sports. For me, they also reduce glare, but I do not like wearing...
them at night when I am reading in bed. I also do not like using them to drive at night. They change my color perception, but I can still tell blue from green or black. I will pick the right socks even when I am wearing my sunglasses. I think the current blue-blocking IOLs are a step in the right direction, but they may be a little overdone. I think the best of all worlds may be a violet-blocking IOL, perhaps with a few more vertical lines so that it is limited to the rays at a higher energy level to protect our retinas, if that claim turns out to be true.

Kohnen: We are also doing a study in Germany of a blue-blocking lens from Hoya Vision Care Europe (Uithoorn, Netherlands). The study has two arms. One is looking at color perception for a 1-year period. The other one is assessing patients who have the beginning phase of AMD and subjects always receive a nonblocking IOL in their other eye. In the 5-year study, the advantage may be evident. I am in a situation in which I use some of the different blue-blocking IOLs. I do not see a big downside. But, as everyone has said, there is no evidence currently that we have to use this type of IOL. I think it is critical to say that because cataract patients may return to us in 5 years with AMD and ask why they did not receive a blue-blocking IOL. We have to be careful at present not to make these IOLs a must for a cataract procedure.
Bucci: I have implanted some Acrysof IQ lenses, but my experience is relatively limited. Some of my patients have the yellow IOL in one eye and a non-yellow lens in the other. I have not observed that they are making a big distinction between the two lenses.

Packer: I learned that the results of the Age-Related Eye Disease Study demonstrated that there was no increase in the incidence of exudative macular degeneration after cataract surgery. That had been a question in the back of my mind because the Blue Mountains Eye Study and others such as the Beaver Dam Eye Study had shown some potentially increased risk for progression to wet AMD. A recent review determined that no current evidence conclusively supports a relationship between cataract surgery and the progression of AMD.

I do not see evidence that we should be using a blue-blocking lens, and I do see a potential downside in terms of some of the work that has been done with scotopic vision. I believe, too, that these lenses must change a patient’s color perception to some degree. It may be that an IOL with a different cutoff is a good idea. There is an interesting technology from Medennium Inc (Irvine, California). It is a photochromic lens that turns yellow in the light, much like transitional sunglasses do. Maybe something like that...
This IOL has both a distinct near and distance focus.

By Manfred R. Tetz, MD

Tecnis (Advanced Medical Optics Inc, [AMO], Santa Ana, California) was the first IOL that considered pseudophakos as part of an optical lens system (cornea plus IOL). As a result, the original Tecnis IOL was designed to reduce the spherical aberration of an average human cornea and increase the contrast sensitivity under mesopic conditions.

With its multifocal successor, Tecnis M F, the diffractive rings are located on the posterior surface. The IOL is based on a diffraction principle similar to that in the Restor lens (Alcon Laboratories Inc, Fort Worth, Texas). It gives the patient a near and a distance focus, each of which is very distinct. Because the rings start close to the centre and continue toward the periphery — usually with increasing distance between the rings — one gets an effect that is not as pupil dependent as a refractive multifocal IOL. In smaller pupils, some diffractive rings are still effective, partially explaining the good near performance of this IOL.

COMBINING PRINCIPLES

The best innovation with the Tecnis M F lies within the combination of two optical principles, multifocality and a prolate anterior optic surface. Generally, multifocal IOLs — inherent in such optical principle — are known for their loss of contrast sensitivity under dim light conditions. The Tecnis M F IOL, however, improves contrast in such conditions by reducing higher-order aberrations, compared with a normal monofocal optic. Tests have been undertaken to evaluate the Tecnis M F IOL under daytime driving and night driving conditions. This may be an advantage seen with monofocal IOLs, and hopefully this advantage may be expected in its multifocal successor.

In addition, there seems to be a limited amount of near addition one can incorporate into either a refractive or diffractive system. The refractive lenses, such as the Array and Rezoom (AMO), usually have +3.50 D on the lens level, about +2.80 D on the corneal plane and about +2.40 D on the spectacle plane. This is less than the +3.00 D near addition at the spectacle plane that some patients need. Diffractive lenses such as the Restor and the Tecnis M F have +4.00 D on the IOL plane, which is equivalent to +3.00 D at the spectacle plane. Both have a better near focus. Even if the final refraction is slightly off (ie, +0.25 D or +0.50 D), these IOLs work quite efficiently.

INJECTORS

The acquisition of Pfizer/Pharmacia Surgical by AMO has helped insertion technology for the Tecnis IOls. The AMO Silicone IOL injector works well with these lenses. All three AMO ophthalmic viscosurgical devices based on hyaluronic acid — Healon, Healon GV and Healon 5 — may be used.

Clinical studies since 2002 show an increased performance of the Tecnis monofocal IOL under mesopic and scotopic light conditions. Personal results with the Tecnis M F over the past 2 years have been good in hyperopes because the cornea is closer to the average corneal asphericity in the lens design. Patients’ reading capabilities are generally excellent. Distant visual acuity may vary, but it usually remains in the 20/25 to 20/20 range unaided.

As for optical aberrations, lenses with more than one focus will have some glare or halo effects because one image is laid over another. With the Tecnis M F, if the patient has a Tecnis eye with a Tecnis cornea (meaning it fits into the typical corneal shape design Pharmacia/AMO originally used for asphericity of the lens), then the patient is not as affected by halos.

With the Tecnis M F IOL, an interesting new design has been added to our armamentum of implants to fight cataract and especially for hyperopic and emmetropic presbyopia.

Manfred R. Tetz, MD, professor of ophthalmology, is director of his private surgical Eye-Center-Spreebogen Berlin. He also is scientific director of the newly founded Berlin Eye Research Institute (BERI), Germany. He has no financial interest in any product mentioned, however, he cooperatively performs several studies on modern IOLs and consults with IOL and OVD companies. Professor Tetz may be reached at info@augentagesklinik-spreebogen.de; BERI@atk-spreebogen.de or +49 30 398098 0.
will be of value, but I do not see evidence for it. I see some evidence against it, so I am not using it.

**TORIC IOLs**

_Chang:_ What role is the Acrysof Toric IOL (Alcon) going to play in your practice?

_Kohnen:_ I use toric IOLs now more. I started with the Microsil Z-haptic IOL (Humanoptics AG, Erlangen, Germany). It is a silicone lens, and you need to be a sophisticated surgeon to use it because the IOL is difficult to implant and, if you are not careful, you can rupture the capsule while inserting it. The next step for me was the Rayner toric 571T lens (Rayner Intraocular Lenses Ltd, East Sussex, UK). That is a toric hydrophilic acrylic lens. For both of these IOLs, the outcomes in highly astigmatic corneas are fabulous. Patients are thrilled with the results the next morning. We have been implanting them for 1.5 years on an unselected basis, but it seems like these lenses are stable. Now with the Acrysof Toric lens, I think that we will use toric IOLs more, but we have to have a more thorough preoperative examination. My volume of toric IOLs will increase when the reimbursement for this kind of lens is defined.

_Lane:_ I am enthusiastic about toric IOLs, and I think that we have designs now for lenses that will not rotate and will produce predictable results. Although LRIs have been a big part of my surgical armamentarium, I think I can be more accurate with toric IOLs. As we consider mixing and matching IOLs and talk about toric multifocal and toric accommodating IOLs, I think we are getting closer to that Holy Grail.

_I think that we will be using toric IOLs on a more regular basis, but they will be demanding of the surgeon in terms of measurements. It will be critical for ophthalmologists to know what their degree of surgically induced astigmatism is, where it is and how it changes with the location of the incision. We are seeing that toric lenses are more predictable and stable than LRIs and that they produce excellent results. I foresee their use in the United States increasing and that of LRIs decreasing._

_Bucci:_ I have not yet used toric IOLs, but I am impressed by the stability of the Acrysof Restor lens. It stays where I put it, so I have a new attitude about trying the Acrysof Toric lens.

_I am aggressive about treating astigmatism. Although some fine-tuning may be necessary after implantaing a toric IOL, these eyes will require less surgery, and accuracy should increase. I think the reason I did not use toric IOLs before was due to rotation. You could not fix that problem easily._

_Lindstrom:_ We used the STAAR Toric IOL (STAAR Surgical Company, Monrovia, California) in a moderately sized series, and 10% of them rotated enough to produce an undesirable outcome. I have many years of experience with corneal-relaxing incisions, so I went back to using them. Excimer laser biopsies or conductive keratoplasty will let me do something on top of that. I will be interested in trying the next generation of lenses. I was happy with the outcome of the STAAR Toric IOL when it stayed in position.

_I have used the STAAR Toric IOL, and I learned to put it in upside down, which seemed to help with rotational problems._

— Mark Packer

_Packer:_ I have used the STAAR Toric IOL, and I learned from Stephen Bylsma, MD, to put it in upside down, which seemed to help somewhat with the rotational problems. I definitely had some IOLs that rotated and had to be repositioned. I limited my use of the lens to cases when I needed something in addition to LRIs, which can correct up to 3.50 D of corneal astigmatism. I implanted a STAAR Toric IOL in a patient with prior RK who had a cornea that could not withstand any more surgery, and the results are successful so far. From what I have seen of the Acrysof Toric lens, that design is more stable, and the IOL will probably be available in a greater range of powers. I think the Acrysof Toric IOL is going to increase surgeons’ use of toric lenses.

_Chang:_ I have always used the STAAR Toric IOL in the two populations for whom LRIs do not work well. One is the young patient who has a lot of astigmatism (i.e., young myopes who have a large amount of with-the-rule toricity). Because of the patient’s youth, incisional keratotomy does not have much effect. The other population includes patients with unusually high amounts of cylinder. The STAAR Toric IOL’s longer TL model is quite stable and has produced some phenomenal results in these eyes. I published my series of 80 consecutive patients with the longer toric IOL and reported a repositioning rate of 2.5%.18
**Nichamin:** I had the fortune of being an investigator in the Acrysof Toric IOL's FDA study, and, as Steve indicated, the lens performed well. All of you know I am an LRI guy. My comfort level with peripheral corneal-relaxing incisions is high. Although I implanted many single-piece first-generation silicone lenses years ago, I no longer favor that lens platform. I reserve the STAAR Toric IOL for cases like Mark's RK patient. We perform topography on nearly 100% of our cataract patients, and it is not rare to discover a mild cone, which would also contraindicate the use of LRIs.

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— Louis “Skip” D. Nichamin

**Historically, our use for the STAAR Toric IOL would be in these types of cases in which LRIs are contraindicated or, as Mark mentioned, for a higher correction of astigmatism in combination with LRIs. We have performed maximal LRIs along with a STAAR Toric implant followed by excimer laser treatment, and we have corrected up to 8.00 or 9.00 D of astigmatism. The issue is rotation. If it is more than 5º, one sees a marked decrease in effect. With rotation of more than 15º, one is pretty much cooked. My colleagues and I, on average, had to reposition 24% of our STAAR Toric IOls, typically at the 1-week mark, but the results were still quite good.

The Acrysof Toric lens is another matter. The IOL does indeed stay where you put it, as we know occurs with the SA60 (Alcon Laboratories Inc). The axial centration of the SA60 may not always be perfect, based on bag sizes and other capsular/zonular considerations, but I am excited that the Acrysof Toric lens is now available in the United States.

**Kohnen:** I am currently conducting a study in which my colleagues and I have implanted the SA60AT lens (Alcon) in one eye and the AR40e lens (AMO) in the other. We are studying the lenses at 1 year with Scheimpflug imaging. At 6 months, both lenses seem to show similar decentration and tilting. We hope to present our 1-year results at the 2006 American Academy of Ophthalmology meeting. The question remains of whether the one- or three-piece Acrysof design is more stable in the capsular bag. That issue is important for all of the types of lenses we have discussed — toric, aspheric, etc. We do not want rotation.

**THE FUTURE**

**Chang:** Which IOLs currently in the pipeline do you think will have the greatest impact on your practice?

**Lane:** I think the addition of toricity, combined with one of the various multifocal lenses and/or potentially accommodating lenses, will be a significant breakthrough. I also think that low-powered multifocal lenses to be used in a piggyback fashion will have a major impact. If these lenses incorporate toricity, they may be used in an enhancement procedure to correct residual cylinder.

**Packer:** The first thing I think is going to have an impact on our practice is the clinical investigation of the dual-optic accommodative IOL (Synchrony IOL; Visiogen Inc, Irvine, California). This second-generation accommodative lens is a fascinating new twist on lens technology. Research has already demonstrated that the IOL moves and provides approximately 3.25 D of accommodation. The challenge is eliminating defocus, because now there is a new factor, the separation distance of these two optics and how far apart that is going to be. We also do not know the exact volume or diameter of the bag into which we are implanting the IOL. Certainly, based on the data I have seen presented outside the United States, the lens is approvable. I think the Synchrony IOL will entail a bioptics approach because surgeons will have to perform LASIK or another refractive procedure in order to eliminate residual ametropia.

The Light Adjustable Lens (Calhoun Vision Inc, Pasadena, California) represents a fascinating and exciting technology. This IOL could be of real benefit if it takes the form of an injectable polymer that fills the bag. You could insert it through a tiny capsulorhexis, refill the bag, control the amount of polymer you inject, let the eye stabilize for about 6 weeks, and then adjust any refractive error with ultraviolet light. The Nulens (Nulens Ltd, Herzliya Pituach, Israel), a unique accommodative concept based on the eyes of water birds that see both in air and in water, has a cylindrical deformable optic that could provide large amounts of accommodation.

I anticipate a paradigm shift in what lens-based surgeons do, a move from high-volume low-cost care to high-quality, personalized care.

**Bucci:** I think Mark summarized all of the new technologies quite well. Obviously, a true accommodating lens that provided a free-flowing blending of vision would be great.
If we surgeons step back and take an overarching look at the world of IOLs today, we are likely to agree on the similarities between the current period and one several years ago, when we transitioned from conventional LASIK to wavefront-guided customized ablation. Our criteria for success in lens-based surgery is moving away from standard Snellen acuity and toward more sensitive measures of quality of vision, because we understand that pseudophakic patients may also suffer from various levels of higher-order aberrations. Fortunately, we now have technology available that can improve the quality of vision in our pseudophakic population.

Conventional lens implants impart additional positive spherical aberration to the optical system that further degrade image quality. One solution is to incorporate negative asphericity into the implant to counter the cornea’s inherent positive spherical aberration. There are, however, potential problems with this approach. First, the amount of positive spherical aberration within a patient’s cornea may vary. Furthermore, a growing number of patients have undergone some form of keratorefractive surgery, and these individuals definitely do not have an average amount of spherical aberration. In these cases, the amount of negative asphericity of the IOL will not match the amount of positive spherical aberration of the patient’s cornea, so the optical system will have an unpredictable amount of spherical aberration as well as potentially degraded optical quality postoperatively.

Perhaps more importantly, any lens that incorporates spherical aberration, positive or negative, may induce additional higher-order aberrations, particularly coma, if the lens decenters or tilts. One recent study indicated that this problem occurs with as little as 0.25 mm of decentration. In addition, most studies that examine IOL centration grade the position of the lens in relation to the pupil and not the visual axis, but we all would firmly acknowledge that angle Kappa can vary widely throughout the population.

In order to obviate these concerns, an alternative approach is to implant a totally aberration-free IOL, one that imparts neither positive nor negative spherical aberration. Patient selection becomes a moot point; how many surgeons are prepared to perform wavefront testing on their cataract patients in order to determine whether a given lens will be beneficial or detrimental? Furthermore, an aberration-free lens such as the Sofport AO (Bausch & Lomb, Rochester, NY) is essentially immune to the pejorative effects of decentration (Figures 1 and 2), tilt and varying degrees of angle Kappa. Plus, a patient’s prior keratorefractive surgery is not an issue with this IOL.

Anecdotally, my colleagues and I have queried several hundred patients who have a standard implant in one eye and the Sofport AO lens in their fellow eye. Admittedly, approximately 60% could not discern a difference. Nevertheless, 40% preferred the eye with the aberration-free IOL, and none preferred the conventional lens. Far more important, however, will be objective proof that this lens technology works. A prospective, randomized trial is well underway comparing these lens styles. The most useful information will come from properly conducted and veracious clinical study.
I am still waiting and evaluating accommodating IOLs. I would like to see more long-term outcomes. I am concerned about PCO with these lenses. If a study clearly shows the advantage of accommodating lenses, then I will use them more.

Lindstrom: It will probably take surgeons 5 years to figure out how to use all of these technologies properly. We have aspheric, multifocal and accommodating IOLs. I think the next breakthrough will be an adjustable, accommodating IOL, maybe a photochromic lens. The technology is possible, and such a lens would change our practice.

Chang: Dick, please mention incision size, because no one has talked about bimanual microincisional phacoemulsification and ultra-small-incision IOLs.

Lindstrom: We are going to reduce our incision size incrementally. I do not think the field will be dominated by bimanual microincisional cataract surgery, but probably by coaxial microincisional surgery and a transition down to the 2-mm incision. That improvement is not a big deal.

Chang: We are all aware of exciting projects for accommodating IOLs that are under development, but most of these designs are going to raise questions about lenses’ long-term behavior because they are such radical departures from the well-tested, traditional IOL designs. Although they are far from perfect, multifocal IOLs will always have one advantage, which is that they behave like our standard IOLs during and after implantation. Ophthalmologists do not have to change their surgical technique to implant multifocal lenses, something that probably will not be true with many of the accommodating IOL designs under development.

We have not talked at all about the IOL materials, which is a sign of how much the issues have changed. Whereas our concerns used to be about PCO, biocompatibility, and safety, today the focus is on the IOL’s optic and how it affects the patient’s quality of vision. Ours has been a higher-order discussion. I have learned a lot, and I thank you all for participating.

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**Nichamin:** I expect our volume of refractive lens exchanges to continue to increase. I think that we will continue to see a higher quality of vision through advanced optics, eventually with personalized lenses, perhaps within 5 to 7 years. Of course, the Holy Grail will be a true accommodating lens that changes shape much like the natural crystalline lens does. Several companies may achieve this feat by 2010.

**Kohnen:** We are being influenced by the different aspheric designs, and there will be some customization. I expect to be greatly influenced by the multifocal technology of the future. Toric lenses will allow us to do more in one procedure by requiring less corneal surgery.

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