

PERSPECTIVES ON
Advanced Technology IOLs:
Recommending the right IOL
for optimal outcomes

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Introduction

More often than ever, patients undergoing cataract surgery demand spectacle independence, indicating a need for more effective IOL options. As new IOLs become readily available, surgeons continually require education to remain informed of the latest technological advances that meet patient expectations.

OCULAR SURGERY NEWS Europe Edition, through the sponsorship of Alcon Laboratories, Inc., assembled a panel of experts to review leading trends in advanced technology IOLs, and to provide perspectives on recommending the right IOL for patients undergoing cataract surgery. This supplement is based on a roundtable discussion held during the 2011 American Society of Cataract and Refractive Surgery Symposium and Congress. I thank the faculty members for their participation, and Alcon Laboratories, Inc., for sponsoring this OCULAR SURGERY NEWS Europe Edition supplement. For more educational activities on this topic, visit www.OSNSuperSite.com/edulab.

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Perspectives on advanced technology IOLs

Recommending the right IOL for optimal outcomes

Richard L. Lindstrom, MD: With surgeon perspectives from the United States and abroad, this discussion reviews leading trends in advanced technology IOLs and provides insight on the selection of appropriate IOLs for patients undergoing cataract surgery. Topics include material considerations, design, meeting patient expectations and astigmatism correction with several types of IOLs.

Material considerations

Richard L. Lindstrom, MD: Over the years, ophthalmologists have evaluated IOL platforms based on three key criteria: material, design and optics. Recently, hydrophobic acrylic IOLs have become a leading choice. In terms of the key criteria, which IOL do you prefer to implant?

Phillip McGeorge, MD: I have used various types of IOLs with PMMA, silicone, and acrylic hydrophilic and hydrophobic IOLs from several manufacturers. I prefer the AcrySof IOL (Alcon Laboratories, Inc.), a hydrophobic acrylic IOL, because it is easy to implant, unfolds in a controlled manner and has the lowest YAG rates.^{1,2} Hydrophilic material has a higher biocompatibility than hydrophobic material, which can be a weakness because epithelial cells often regrow over the front and posterior surface of the IOL and degrade the patient's quality of vision.³ As a result, I have needed to perform YAG capsulotomy more than once on some patients. However, this is rarely seen clinically with the AcrySof IOL material.^{4,5}

Warren E. Hill, MD: I prefer the AcrySof IQ SN-60WF IOL (Alcon Laboratories, Inc.). Its material has a high refractive index at 1.55, allowing for a thin design that fits through small corneal incisions. Once in the eye, it adheres nicely to the posterior capsule. For multifocal and toric IOLs, this almost immediate interaction with the posterior capsule allows the surgeon to properly center the IOL.

Virgilio Centurion, MD: In terms of material, I prefer hydrophobic acrylic IOLs, and in terms of

design, I prefer the AcrySof IQ platform's monofocal (SN60WF), multifocal (ReSTOR SN6AD1) and toric (SN6ATT) IOLs. The IOL is thin and can be implanted through a 2.2-mm incision. In addition, it has excellent biocompatibility, and one study has demonstrated its low propensity for capsular opacification.⁶



"For multifocal and toric IOLs, this almost immediate interaction with the posterior capsule allows the surgeon to properly center the IOL."

— WARREN E. HILL, MD

Bonnie An Henderson, MD: Linnola and colleagues⁷ examined fibronectin adhesion to different IOL materials and found that the AcrySof IOL hydrophobic acrylic had the most adhesive property, allowing a "sandwich effect" that sealed the IOL and prevented migration of cells to the posterior capsule. Additionally, the AcrySof IOL material is soft, making it a rare occurrence to tear the posterior capsule during IOL insertion.⁸

Lindstrom: The AcrySof platform includes aspheric monofocal, monofocal toric, multifocal and multifocal toric IOLs. Do you find this to be an advantage?

McGeorge: A platform with multiple IOLs is important because the surgeon can use the same incision size, insertion technique and injector for all patients.

Lindstrom: Surgeons have several options for incision size with the hydrophobic acrylic IOL. What size do you prefer? Do you perform a wound-assisted injection?

Hill: I use a 2.4-mm, wound-assisted injection, which results in 0.48 D of surgically induced astigmatism (SIA). To achieve the lowest residual refractive astigmatism, I change the incision location by as much as 20° to 30°, depending on the toric calculator results.

Centurion: I currently use a 2.2-mm incision. In my practice, my colleagues and I use the AcrySof IOL Toric Calculator (Alcon Laboratories, Inc.) to correct astigmatism. I always make the incision at 125° in both eyes, and most of my cases fall below 0.25 D of residual astigmatism.



“Werner reported that, although glistenings have been described, IOL explantation due to glistenings have rarely been reported.”

— BONNIE AN HENDERSON, MD

Henderson: I prefer a 2.2-mm incision, and I follow the steep axis of astigmatism. I move the incision on a case-by-case basis, depending on the location of the steep axis. My SIA factor is approximately 0.25 D to 0.37 D.

McGeorge: I typically perform a temporal incision because every position around the cornea has a different SIA level. If the surgeon can minimize the variation, then he will achieve a more predictable result. I prefer a 2.2-mm, wound-assisted IOL injection using a long tunnel, which results in 0.1 D of SIA. Astigmatism is then dealt with using a toric IOL.

Lindstrom: As incision sizes and SIA decrease, there is a reduced benefit of moving the incision, especially at 0.1 D. At the 0.1 to 0.2 D range, it may be best to keep the incision in the same position.

McGeorge: The femtosecond laser may enhance predictability because it creates corneal incisions and works synergistically with toric IOLs.

Lindstrom: Clinically speaking, have you seen a problem with glistenings?

Henderson: Glistenings are visible because of the difference of the refractive index of water (1.33)

and that of the IOL material. The higher the refractive index, the more obvious the glistenings are. The highest refractive index is found in the hydrophobic acrylic IOL (1.55), which explains why glistenings are commonly discussed with this IOL type. Clinically, however, there is no difference. A study by Mönestam and Behndig⁹ found that glistenings with AcrySof IOLs had no impact on patients' best-corrected visual acuity or low-contrast vision. Werner¹⁰ reported that, although glistenings have been described, IOL explantation due to glistenings have rarely been reported.

McGeorge: Glistenings appear in most IOLs, whether they are silicone, acrylic or PMMA. In my experience, however, glistenings have not been clinically significant.

Design considerations

Lindstrom: What are some additional features of hydrophobic acrylic IOLs, in terms of asphericity, centration and tilt?

Hill: A study by Beiko and colleagues¹¹ showed that the median value for anterior corneal spherical aberration was approximately +0.274 μm . An IOL that helps to neutralize the naturally occurring anterior corneal spherical aberration is helpful for improving contrast sensitivity. This is better than adding positive spherical aberration, as would be the case with a standard spherical IOL.¹²

Lindstrom: Based on the research, a 0.2 μm spherical aberration difference may be enough to enhance mesopic contrast sensitivity to improve object recognition and reaction time, thus enhancing night vision.

McGeorge: Generally, an aspheric IOL enhances night vision, particularly in the elderly.

Henderson: Jim Davison¹³ examined the AcrySof IQ IOL and found that it centered well, even if the capsular bag was larger or smaller than normal. This may relate to haptic design and fibronectin. If the IOL is placed properly, it will not move.

McGeorge: The AcrySof one-piece IOL has an advantage over the three-piece IOL. As the capsular bag contracts during the first month after surgery, the optic will not move forward because

there is no posterior haptic angulation, as seen in a three-piece IOL. Visual results with the one-piece IOL are more consistent from day 1 post-operatively.

Lindstrom: Data suggest that one-piece IOLs have better centration and less tilt than three-piece IOLs.¹⁴

McGeorge: A three-piece IOL can be implanted in the sulcus when a single-piece IOL cannot be used.

Blue light filtration

Lindstrom: Blue light-filtering IOLs mimic the level of filtration provided by a healthy eye by filtering out ultraviolet (UV) and portions of high-energy blue light. In your clinical experience, how have your patients reacted to blue light-filtering IOLs?

McGeorge: Initially I was concerned, as were many surgeons, about the effect of blue light-filtering IOLs compared with clear IOLs. I was concerned that patients may lose some blue light perception, but several studies have shown that not to be the case.¹⁵⁻¹⁷ Farnsworth-Munsell 100 hue tests have consistently shown the same results with both clear and blue light-filtering IOLs.

Henderson: My colleagues and I recently conducted a survey¹⁸ of all published, peer-reviewed literature on light filtration over the past 40 years. Despite surgeons' and patients' concerns, the evidence shows no significant clinical scotopic vision loss, color perception loss or contrast sensitivity loss. Surgeons have debated whether these IOLs are beneficial in protecting the macula.

Until the past 18 months, there were no studies that investigated the potential benefits of blue light-filtering IOLs. However, Nolan and colleagues¹⁹ examined macular pigment density in humans in vivo, and patients with blue light-filtering IOLs had an increase in the macular pigment density.

Lindstrom: Literature shows the benefits of blue-blocking sunglasses in terms of contrast sensitivity, glare and visual function in certain environments.^{20,21} Some surgeons may be hesitant to implant blue light-filtering IOLs based on their relative effectiveness at night. Have you seen data that suggest environments in which blue light-filtering IOLs are not ideal?

Henderson: UV light extends from 350 to 400 nm, whereas blue light ranges from approximately 400 to 480 nm. Blue-blocking sunglasses are different than blue light-filtering IOLs, in that blue-blocking sunglasses block 100% of blue light, while blue light-filtering IOLs do not. Blue-blocking sunglasses are often orange or red in color, and are generally worn by patients who have crystalline IOLs, which already filter blue light, thus compounding this effect.

Concerns of scotopic vision loss with blue light-filtering IOLs have been raised because of Purkinje shift. In lower light, the peak spectral sensitivity of the Purkinje cells shift to a shorter wavelength. However, the clinical effect of the shift is debated. Depending on the study, the decrease of scotopic vision ranges from 14% to 25% in the laboratory.^{22,23} When light enters the eye, the eye absorbs all the light rather than differentiating between wavelengths. This concept is exemplified by Rush-ton's principle of univariance, which states that once light is absorbed, all wavelengths produce the same effect. In a clinical situation, the amount of scotopic sensitivity loss is relatively small and inconsequential in normal illuminations.



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— RICHARD L. LINDSTROM, MD

Lindstrom: Have you noticed a difference between clear and light-filtering IOLs in your practice?

Hill: Two patients in my practice are commercial pilots and each have a clear IOL in one eye and a blue light-filtering IOL in the other. When asked to spot traffic in the distance, which essentially is locating a small black spot against the clear blue sky, both of them prefer the blue light-filtering IOL for this difficult task.

Meeting patient expectations

Lindstrom: With today's patients with presbyopia leading more active lifestyles, how do you assess patient history and visual needs for those who want to maximize visual performance at all distances?

Michael C. Knorz, MD: I initially ask if the patient wants reduced or total spectacle independence. For a high likelihood of spectacle independence, multifocal IOLs are the best choice. There is a potential for growth in multifocal IOLs because patients are more often selecting the IOL that provides the best range of vision. In my experience, the ReSTOR IOL with 3 D add power provides the best range of vision.

Hill: We direct the patient to our website for information on IOL options. In addition, we also are developing an educational brochure that we will mail to our patients. By the time the patient arrives at our practice, he has a good idea of the services and IOLs we offer to suit his needs.



“The most important step is the last interview with the surgeon, who makes a final recommendation.”

— VIRGILIO CENTURION, MD

Centurion: We manage an educational website for patients, administer questionnaires, provide informational packets and perform preoperative exams, all of which improve patient confidence. The most important step is the last interview with the surgeon, who makes a final recommendation. Patients who are candidates for presbyopia correction most likely opt for advanced technology IOLs, and we have a conversion rate of more than 80%.

Henderson: In Boston, we tend to lag behind the rest of the country in adopting advanced technology IOLs, such as presbyopia-correcting IOLs. I still find that many patients are uneducated about these IOLs, so I spend a lot of time introducing the technology and presenting the pros and cons. We also use many educational methods, including a brief targeted questionnaire that asks about the patients' jobs, hobbies, and their desire for spectacle independence. After visiting the technician and undergoing testing, patients watch educational videos such as those produced by Eyemaginations or IOL Counselor. These modalities allow patients to understand the material before meeting with the surgeon.

McGeorge: If surgeons set appropriate expectations, they will have many satisfied patients. In our practice in Australia, our staff offers a range of options that meet the patients' needs. Then, the surgeon suggests the most appropriate treatment. Multifocal IOLs are a great way of gaining distance and near vision in many patients. However, if multifocal IOLs are not deemed suitable, I may downgrade patients' expectations and suggest a simpler solution, such as monofocal IOLs with or without monovision correction for reading.

Knorz: Surgeons tend to over-value 20/15 or 20/10 vision. However, patients appreciate quantity of vision, in that they would rather see at 20/25 for all distances rather than see 20/10 at distance only.

Multifocal vs. monofocal IOLs

Lindstrom: Multifocal IOLs are a majority choice around the world for patients who wish to see clearly at all distances. However, monovision is an option as well. When would you recommend monofocal over multifocal IOLs? Are there occupational considerations?

Knorz: If the patient has high demands for quality of distance vision or is accustomed to monovision with contact lenses, then I may recommend monovision. However, I find that multifocal IOLs help hyperopic, purely presbyopic and even low-myopic patients alike. Although I am always more careful with these patients, these conditions are no longer contraindications.

Hill: Patients with -1.50 D to -3.0 D of preoperative myopia may be underwhelmed by multifocal IOLs, due to a mild decrease in contrast. However, this is less of an issue with aspheric multifocal IOLs that add negative spherical aberration, which helps to improve contrast.

Henderson: Preoperatively, I always identify the dominant eye. If the patient requires bilateral cataract surgery, I operate on the nondominant eye first, regardless of which cataract is worse. For presbyopia correction, I prefer a multifocal IOL. By operating on the nondominant eye first, I learn how the patient reacts and it informs my decision on an appropriate IOL for the second eye. I will place either a monofocal or accommodating IOL in the dominant eye. With this two-step approach, my patients are satisfied and

appreciate the excellent near vision from the multifocal eye and are not disturbed by halos when both eyes are open.

Knorz: I have operated on hyperopic noncommercial pilots, taxi drivers and truck drivers, and they are all satisfied with their results. In my experience, if the patient experiences halos, it is typically not related to the multifocal IOL only, but to some abnormality, i.e., the IOL was poorly centered or the IOL tilted because it was not fully covered by the capsular rim.

Lindstrom: What do you look for during an eye examination that may cause you to recommend monovision?

McGeorge: I look for conditions that would exclude the use of multifocal IOLs, such as asymmetric astigmatism or forme fruste keratoconus using topography. Also, previous radial keratotomy is a contraindication for multifocal IOLs. Patients who are amblyopic should have lower expectations with multifocals, as well as patients with macular diseases, premacular fibrosis, macular edema or macular degeneration of any sort. Likewise, for patients who have corneal edema or early Fuch's dystrophy, I would hesitate to implant a multifocal IOL because small amounts of edema can rapidly degrade image quality, resulting in larger halos and difficulty with near vision. The best candidates for monovision have an alternating strabismus without strong dominance, but highly motivated patients may tolerate monovision sufficiently for their needs.

Henderson: It is reasonable to implant multifocal IOLs in patients with mild macular changes as long as patients fully understand that the rate or severity of their macular disease cannot be predicted. However, if the patient has a disciform scar or significant dry eye disease, then I advise against a multifocal IOL. I would not recommend multifocal IOLs in patients with pseudoexfoliation. I have had patients whose multifocal IOLs have decentered months to years after surgery. If the zonular apparatus is weak, whether it is due to trauma or pseudoexfoliation, then I believe surgeons should be cautious about using a multifocal IOL.

Knorz: Patients perform well with a multifocal IOL even if they have slight changes in the

macula. It can be argued that, if the macular degeneration increases, the patient will be at a disadvantage. However, the worst thing that can happen is that they lose their near vision, which can be restored with reading glasses.

Lindstrom: Are multifocal IOLs an option for patients who have had previous LASIK and PRK?



"Patients perform well with a multifocal IOL even if they have slight changes in the macula."

— MICHAEL C. KNORZ, MD

McGeorge: Although IOL calculations have improved in my patients with previous LASIK or PRK, there are always difficulties with IOL strength calculations, which are still around ± 1 D. In particular, those who have had previous hyperopic LASIK procedures are more problematic than myopic patients who have had LASIK or PRK. Over time, the apex often shifts because of small variations in the epithelium, resulting in a slightly decentered cone with asymmetric astigmatism, and subsequent poor multifocal IOL results. Patients should be warned that additional laser treatments are often necessary to fine tune results.

Hill: Surgeons should use their discretion on a case-by-case basis when deciding whether to use a multifocal IOL. If the patient has 2 D or less of a perfectly centered ablation, and there is no irregular astigmatism, I may implant a multifocal IOL.

We generate an anterior corneal aberration profile using the Zeiss Atlas 9000 corneal topography system (Carl Zeiss, Inc.). If the patient has had a moderate to high amount of laser vision correction, exhibits a multifocal cornea, shows flat or steep islands, has abnormalities such as significant vertical or horizontal coma, large amounts of spherical aberration values, or strange power distributions, implanting a multifocal IOL behind a multifocal cornea is not a good idea.

Centurion: I do not use multifocal IOLs in patients with glaucoma because of the loss of

contrast sensitivity. However, in patients who have undergone LASIK, deciding whether to implant a multifocal IOL depends on the curvature of the cornea. In addition, if the patient is myopic or hyperopic, the decision depends on the high-order aberration. Furthermore, patients who underwent corneal refractive surgery 10 to 20 years ago are now motivated to correct presbyopia, and I find it difficult to make this indication.

McGeorge: As a patient ages, it is unlikely that the multifocal IOL will provide the same level of near vision as he requires. In my experience, patients need a +2.5 reading add power in their 60s and a +3, +3.5 or +4 add power in their 80s, and they are still reading large-print books. Although patients could achieve J2 or J1 at near vision during testing, they are generally reluctant to do so in practice.



“There is no one lens that fits every patient. If a patient has a very flat cornea, for example, then -0.3 or -0.35 μm of negative spherical aberration would help to increase contrast sensitivity.”

— WARREN E. HILL, MD

Lindstrom: How important is ocular surface for the success of multifocal IOLs? In addition, what percentage of your multifocal patients have undergone YAG laser capsulotomy 1 to 2 years postoperatively?

McGeorge: Ocular surface is an important factor for success with multifocal IOLs. I look for scarring on the corneal surface, and individuals with severe dry eye may need punctal plugs or drops, such as Systane Ultra or Systane Balance (Alcon Laboratories, Inc.), as well as antibiotics to treat meibomian gland dysfunction. Vision can improve dramatically and visual complaints decrease with an improved tear breakup time.

Lindstrom: Do you find yourself performing more YAG laser capsulotomies?

McGeorge: Not necessarily. I find near vision deteriorates before distance focus with multifocal IOLs because patients experience some early posterior capsular opacification. In these

patients, I perform YAG capsulotomy at an earlier stage with multifocal IOLs than with monofocal IOLs, but my overall incidence of YAG capsulotomies is less than 5%.

Centurion: In the past 3 years, the incidence of capsular opacification with AcrySof monofocal, multifocal and toric IOLs within my practice has been below 1%. For younger patients who previously underwent refractive IOL surgery, the percentage is higher with any kind of IOL.

Knorz: I have a much higher YAG rate with multifocal IOLs, about twice that of a monofocal IOL, because the same amount of opacification will affect two foci and, therefore, cause more damage. The indication to perform YAG laser capsulotomy occurs when the patient reports some loss of near vision or distance vision and I see some opacification of the posterior capsule.

Hill: Not only are we trading contrast for two focal points, but opacification of the posterior capsule takes place near the nodal point of the eye, so the need for YAG laser capsulotomy is going to be earlier with the multifocal IOL than for a monofocal IOL.

McGeorge: I think we are always looking for the best in a continuously accommodating IOL and further research and development may help. As of now, that technology does not exist. In my opinion, the best available lens is the ReSTOR multifocal IOL.

Hill: We need to implement a range of spherical aberrations added to the aspheric platform. There is no one lens that fits every patient. If a patient has a very flat cornea, for example, then -0.3 or -0.35 μm of negative spherical aberration would help to increase contrast sensitivity.

Presbyopia-correcting IOL selection

Lindstrom: Which multifocal IOL do you prefer and why?

McGeorge: I have used the Tecnis +4 (Abbott Medical Optics Inc.) and the ReSTOR +4 IOL (Alcon Laboratories, Inc.), but I prefer ReSTOR +3 IOL. I found that, with +4, the near add power was too close, at about 33 cm, making, for example, a computer screen difficult to see. The +3 provides near vision at about 40 to 42 cm, so computer use is more comfortable (Figure 1).

Knorz: I prefer the diffractive ReSTOR +3 add power IOL. In my experience with refractive multifocal IOLs, they cannot provide full reading ability due to variations in pupil size. I cannot promise that the patient will be spectacle independent because 30% still require reading glasses.

With diffractive multifocal IOLs, my patients have found reading distance to be too close at +4 add power. More importantly, the two foci in +4 D add power IOLs are further apart, causing visual acuity to drop below 20/40. With the ReSTOR +3 IOL, focus for near vision is about 10 cm further than with the +4 D version, and the intermediate vision does not drop below 20/40, allowing patients to see well at all distances (Figure 2). I have always included patients with astigmatism as candidates for a multifocal IOL. Because the ReSTOR IOL does not correct astigmatism, some of my patients had to undergo a limbal relaxing incision (LRI) a few weeks after IOL implantation to correct residual astigmatism.

Astigmatism correction in presbyopic patients

Lindstrom: What level of postoperative residual astigmatism is acceptable with multifocal IOLs?

Knorz: The goal is to achieve the lowest level possible, but patients will be satisfied with less than 0.75 D of residual astigmatism. The advent of modern toric multifocal IOLs has introduced more sophisticated placement tools. Several targeting systems are available that register the pre-operative pupil size and axis alignment image, and provide an overlay in the operating room, allowing surgeons to come within 1° or 2° of axis error. With these systems, manual marking will become antiquated within the next 2 to 3 years.

Hill: With aspheric designs, the ideal refractive target is hard plano and no longer +0.25 D. Even at 0.5 D, I may perform a small LRI at the slit lamp because the amount of residual astigmatism impacts the outcome of the multifocal IOL.

Centurion: Although younger patients are motivated to have refractive surgery, they are very sensitive to 0.75 D, 0.5 D or 0.25 D of residual astigmatism. Elderly people tend to care most about correcting near vision because they prefer to read without glasses.

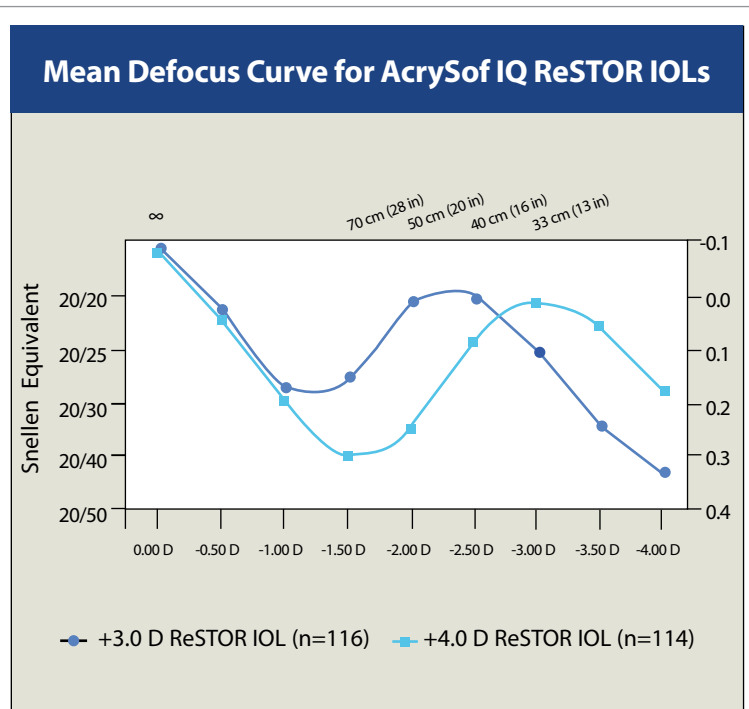


Figure 1: Mean defocus curve for AcrySof IQ ReSTOR IOLs (Alcon Laboratories, Inc.), showing binocular, best case, 6 months postoperative visual acuity.

Reprinted with permission from: Lane SS. The Latest Trends in Presbyopia-Correcting IOLs: Why I prefer an apodized, diffractive, multifocal lens for presbyopes. Insert to: Cataract & Refractive Surgery Today Europe. November/December 2010.

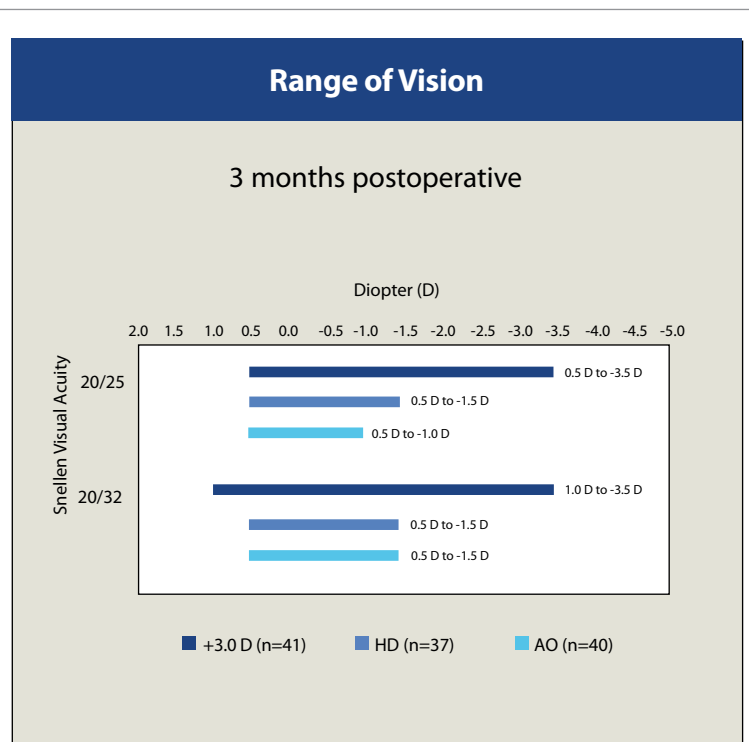


Figure 2: The apodized diffractive IOL provided a greater range of vision at 20/25 and 20/32 when compared with accommodating IOLs.

Source: Alcon Laboratories, Inc.

McGeorge: I have used the ReSTOR Toric T2 through T5 with excellent results. The ReSTOR +3 Toric IOL has expanded the range at which we can use multifocal IOLs. Previously, if patients had more than 0.75 D or 1 D of astigmatism, I would not use the multifocal IOL because any amount of astigmatism would degrade vision quality, particularly for near vision, and would require secondary procedures such as PRK or LASIK. With the toric now available in Australia, I would consider using a toric multifocal +3 ReSTOR IOL for any cylinder of more than 0.75 D.



“With the toric now available in Australia, I would consider using a toric multifocal +3 ReSTOR for any cylinder of more than 0.75 D.”

— PHILLIP MCGEORGE, MD

Henderson: One of the most significant changes over the past 2 years has been the focus on astigmatism with the advent of the toric and multifocal IOLs. Previously, patients accepted astigmatism as a byproduct of cataract surgery, but surgeons now need to be accurate in astigmatism correction. I have found that a significant percentage of cataract surgeons do not fully understand astigmatism, confusing corneal and lenticular astigmatism. When I speak with surgeons who are just beginning to use toric IOLs, some are still using the manifest refraction as a guide for deciding whether to implant a toric IOL. They do not realize that the manifest refraction takes into account the total astigmatism of the eye and that, after cataract surgery, the lenticular astigmatism is removed. Therefore, the decision to implant a toric IOL should be determined by the corneal keratometry (K) measurements.

Hill: Surgeons who use multifocal IOLs should be comfortable performing LRIs at the slit lamp. Some patients may have 1.0 or 0.75 D of astigmatism after surgery, and performing an LRI in this manner can significantly improve outcomes.

Lindstrom: My practice performed early research on diffractive multifocal IOLs and found that for American, European and Latin American

patients, +3 to +3.5 add power was preferred over +4 to +4.5, and some Asian populations seemed to prefer the +4 add power.²⁴

Hill: When I first started using the +3 add power, I viewed it mostly as an intermediate add multifocal IOL. I did not expect that patients' near vision would be so good. The defocus curves show that they are 20/25 at the equivalent of a +3 add power, and because reading is a high-contrast activity, patients are doing better than in a low-contrast situation. For the most part, patients are completely spectacle independent for all but the smallest type with a +3 add power IOL.

Knorz: I use the same add power IOL in both eyes and implant them on two consecutive days. There is a risk that the patient may not be satisfied after the first implantation but, typically, 90% will be satisfied after the second implantation.

Henderson: Patients who have a monofocal IOL implanted in one eye have done well with a multifocal IOL in the second eye. However, if the patient has bilateral multifocal IOLs, the satisfaction increases dramatically.

Lindstrom: If surgeons use this advanced technology IOL and they are careful to clean up the ocular surface, treat residual defocus and astigmatism, have a clear or open capsule and a healthy macula, where do patient satisfaction rates fall?

McGeorge: With appropriate patient selection and counseling, satisfaction is high, with a high word-of-mouth referral rate.

Knorz: Multifocal IOLs require a perfectly placed, perfectly centered and perfectly sized capsulorrhexis. If the surgeon makes the capsulorrhexis irregular, this results in IOL tilt, with 5° to 6° significantly affecting the multifocal IOL. A laser-created capsulorrhexis, on the other hand, is always perfectly sized and centered, almost guaranteeing a perfect IOL placement.

Hill: Previously, I thought that the capsulorrhexis was simply a hole in the anterior capsule. However, as the number of studies using femtosecond laser capsulorrhexis increases, early postoperative refractive accuracy is improved.²⁵

Lindstrom: Even with toric IOLs, some small, perfectly placed, accurate LRIs may slightly enhance the astigmatism outcome, and perhaps serve as an enhancement to capsulorrhexis rather than having to perform LRIs at the slit lamp. However, many surgeons find this difficult.

Hill: Yet, with the femtosecond laser, surgeons can now take into account the corneal radius, rigidity and thickness, and make LRIs that are truly meaningful instead of using a 600-micron blade for every patient.

McGeorge: The use of LRIs will diminish over time because the new toric IOL is more effective and predictable. The AcrySof IOL material characteristics allow the IOL to stay in place once aligned within the bag. The perfect capsulorrhexis produced with femtosecond lasers should give surgeons greater confidence in the effective IOL position and allow them to predict more accurately a final outcome closer to plano.

Treating astigmatism with toric IOLs

Lindstrom: Discuss the treatment of astigmatism with toric IOLs.

Hill: In my practice, we looked at 6,000 patients from our keratotomy database and found the peak incidence of astigmatism to be at approximately 0.5 D to 0.75 D (Figure 3, page 12). Although we all have high astigmats in our practices, we mostly will be implanting the AcrySof IQ Toric T3 model. I am also looking forward to the addition of higher diopter powers.

When educating patients who have 0.75 D with the rule or 1 D against the rule, I inform them that they are candidates for toric IOLs, which provide excellent unaided distance vision.

Ernest and Potvin²⁶ also have shown that even low amounts of preoperative corneal astigmatism can be effectively treated with a toric IOL.

McGeorge: Just as the appropriate cylinder should be incorporated into the spectacle prescription, this should also be done when performing IOL implantation by using a toric IOL to neutralize corneal astigmatism. As a result, the patient will no longer need spectacles for distance vision.

Henderson: Astigmatism is not a difficult concept for patients to understand because they already

wear spectacles to correct it. Therefore, they understand the value of a toric IOL. The key is for the physician to make the recommendation personally to each eligible patient.

Lindstrom: How do you properly position the IOL?

McGeorge: Preoperatively, I look at the corneal astigmatism rather than any refractive astigmatism because this may have been affected by lenticular changes. Additionally, I use topography to examine astigmatism quality and determine whether it is regular, asymmetric or a forme fruste keratoconus. I then use the AcrySof Toric IOL Calculator website to calculate IOL toric power.



“Even with toric IOLs, some small, perfectly placed, accurate LRIs may slightly enhance the astigmatism outcome....”

— RICHARD L. LINDSTROM, MD

At surgery, I align the axis with the patient sitting upright on the operating table, rather than at the slit lamp, and have him gaze directly at a far point in the room. I then make a mark at the 180°, 0° and 90° positions. To begin the procedure, I apply an astigmatic rule, such as a Koch Mendez Fixation Ring (Mastel Precision), and place a mark at the steep axis. Finally, I perform surgery by making a 2.2-mm incision on the temporal side with a known SIA level, rotating the IOL to the steep axis and setting the IOL into the plus cylinder axis.

Henderson: Surgeons and their technicians must take K measurements before the patient receives any drops. Secondly, I take several types of K measurements to make sure they are consistent and reproducible. To determine the steep axis, I rely on auto Ks, IOLMaster (Carl Zeiss Meditec), topography and manual Ks, respectively. However, to measure the magnitude of the power, I use the modalities that measure the largest surface area, i.e., manual and auto Ks, IOLMaster, and then on topography. The IOL Master accurately measures both power and axis if other methods are not available.

It is important to mark the cornea while the patient is seated upright to avoid cyclorotation. If I have a commercially made marker available, then I will mark the cornea as the patient looks straight ahead. If not, then I mark the 6-o'clock position by hand, having the patient look straight ahead, rather than marking the 3- and 9-o'clock positions manually. After the patient lies down, I mark the steep axis.

Finally, I do not have silicone irrigation/aspiration (I&A) tips, so I recommend removing viscoelastic material by placing the I&A tip on the top right side of the IOL because, when pressed on the right side, the IOL will rotate

slightly counterclockwise. I then press on the top left side of the IOL, which rotates it slightly clockwise, thus bringing the IOL into position to avoid overriding the mark. If the surgeon overrides the mark, then oftentimes he will need to add more viscoelastic and rotate the IOL an additional 180° because IOLs cannot easily rotate backwards. I believe that any cataract surgeon would find the toric IOL simple to use and easy integrate into his practice.

Hill: Our practice participated in the original FDA study²⁷ for the AcrySof Toric IOL in 2002. Nine years postoperatively, these IOLs have not

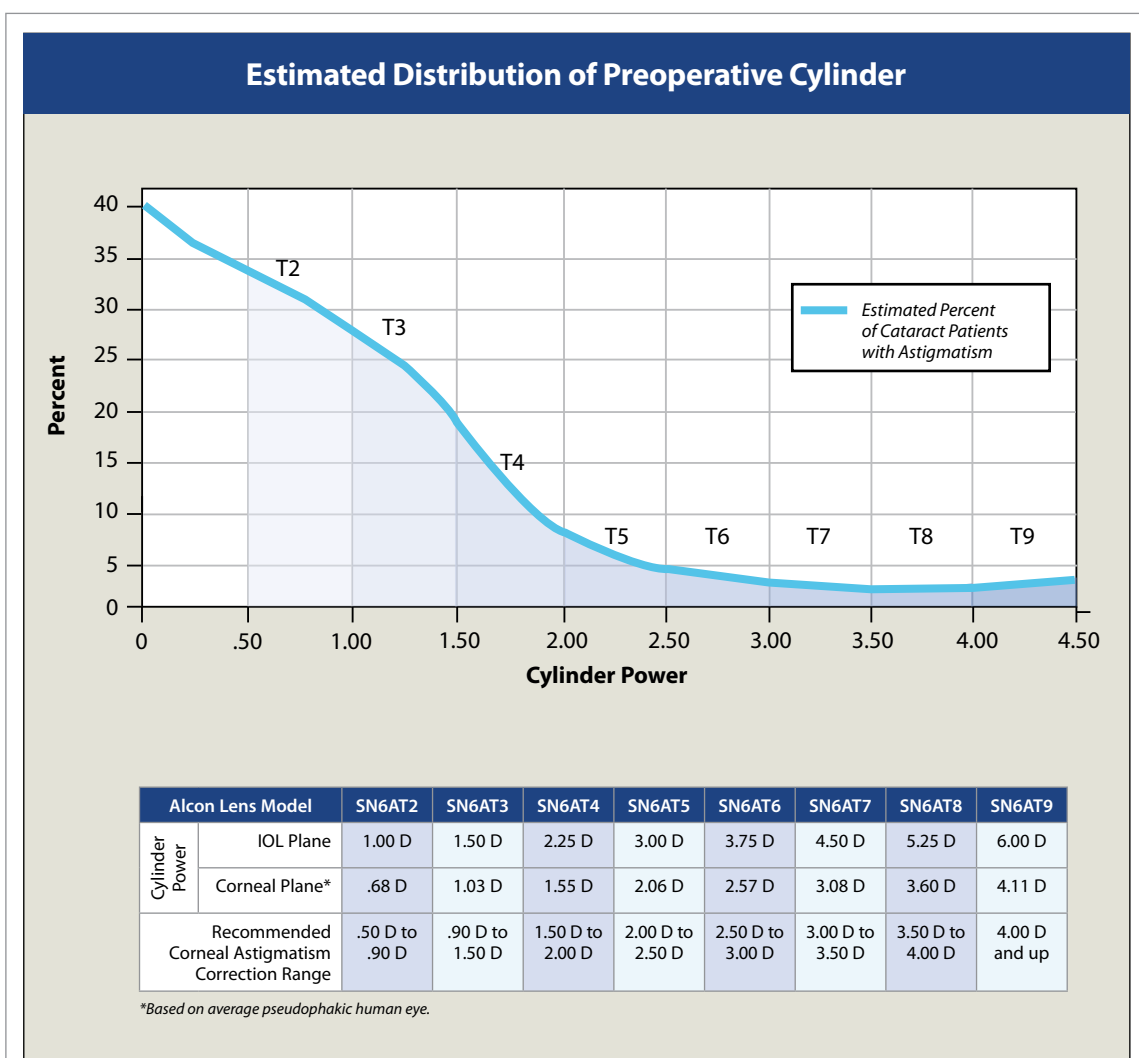


Figure 3: Out of 6,000 patients, Dr. Hill and his colleagues reported a peak incidence of astigmatism of approximately 0.5 D to 0.75 D.

Source: Alcon Laboratories, Inc.

Adapted from data published in: Lane SS, Ernest P, Miller KM, Hileman KS, Harris B, Waycaster CR. Comparison of clinical and patient-reported outcomes with bilateral AcrySof toric or spherical control intraocular lenses. J Refract Surg. 2009;25(10):899-901.

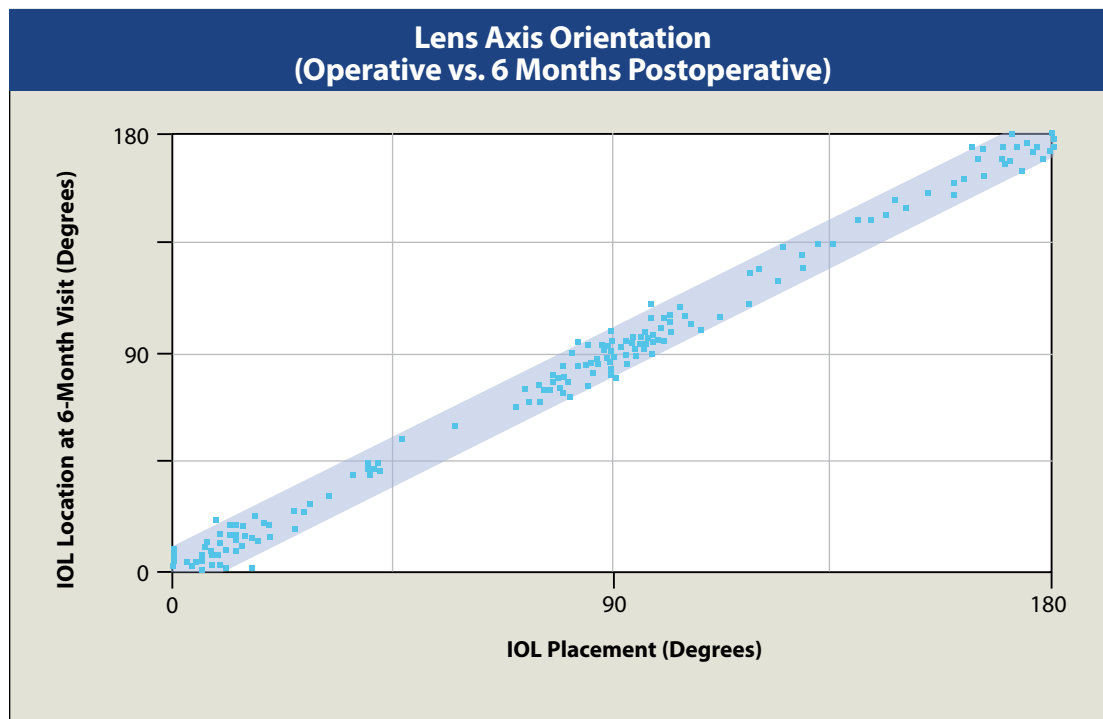


Figure 4: 81.1% of patients were $\leq 5^\circ$ of intended axis, and 97.1% were $< 10^\circ$ of intended axis.

Source: Alcon Laboratories, Inc.

rotated (Figure 4). For preoperative measurements, the toric calculator first requests the power difference between principal meridians, and then the steep axis, in addition to SIA and spherical power.

McGeorge: Rotating a toric IOL postoperatively is a very straightforward task. At the slit lamp, the surgeon can see the marks on the IOL by dilating the pupil and identifying the location of the displaced IOL axis, thus providing a reference point for subsequently marking where the IOL should be relocated during surgery.

Lindstrom: Monofocal, aspheric and toric IOLs are all more forgiving of mild residual astigmatism. With multifocal IOLs, 0.5 D or less is a good target, but patients with toric IOLs seem satisfied, in most cases, if we simply reduce their astigmatism and tolerance of residual astigmatism.

Hill: The average surgeon has approximately 0.5 D of residual refractive astigmatism using the toric IOL, and patients are satisfied. If the pa-

tient desires a better outcome, I perform an LRI on the steep refractive axis at the slit lamp.

The toric IOL is a good introduction to advanced technology IOLs, where 30% of patients are immediate candidates.



"Our practice participated in the original FDA study for the AcrySof Toric IOL in 2002. Nine years postoperatively, these IOLs have not rotated."

— WARREN E. HILL, MD

Lindstrom: However, for surgeons uncomfortable with LRIs, PRK and LASIK, this lack of an enhancement strategy remains an obstruction to adoption. The femtosecond laser may help in this case by allowing minimally invasive, in-office enhancements for residual defocus and astigmatism, thus working synergistically with the toric IOL.

Dr. Hill, you are experienced in incisional refractive surgery. When do you use an LRI vs. a toric IOL?

Hill: I may use LRIs for low amounts of corneal astigmatism with a multifocal IOL but, generally, I would prefer to use toric IOLs.

Lindstrom: It seems that surgeons will increasingly choose toric IOLs over incision refractive surgery as the toric IOLs become more available.

Conclusion

Lindstrom: The demand for vision quality at all distances increases as new IOL options become available to our patients. The information presented here further educates surgeons about the latest IOL choices and surgical methods in an effort to improve patient satisfaction.

I thank the panel for their time and expertise, as well as Alcon Laboratories, Inc., for their support.

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