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EyeWorld

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Update on the latest in refractive cataract techniques and technologies

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- New diagnostics for driving custom LASIK
- The future of the LVC marketplace
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- Achieving success with multifocal IOLs

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Pearls for success with toric IOLs

by Ike Ahmed, MD

"At the conclusion of the case, keep eye pressures on a more physiologic level, not a very high level. This promotes early adhesion of the capsule to the IOL optic and haptic material."

The goal is to leave as little residual refractive cylinder as possible, even if it means flipping the axis

The first key to optimizing outcomes with toric IOLs is patient education. I explain to patients that toric IOLs give them a greater chance of spectacle independence and provide improved vision quality.

Most surgeons will agree that a patient who has 2.00 D to 3.00 D of corneal cylinder needs to have a toric; however, surgeons have questions about lower amounts of cylinder (1.25 D or less). Data have shown that leaving patients with even 0.50 D of cylinder with a monofocal lens will knock their vision down a line, possibly more. If our goal is the best visual acuity, with the least amount of spectacle dependence, then a toric may be appropriate for those lower amounts of cylinder.

The key to calculations

The actual K values I enter in my toric calculator are from optical biometry. I then use corneal topography to verify the approximate axis and the magnitude, rather than solely relying on optical biometry.

Any device that measures corneal power will have variation, for many reasons. Therefore, when I compare my optical biometry keratometry against my corneal topography, I look for some relationship between the magnitude and the alignment. I like to see the steep axis within 10 degrees to 20 degrees of what I found on optical biometry. I like the magnitude to be in the 15% to 20% range.

As we've gotten comfortable with toric calculators, we have seen a number of different benefits. Some of these calculators include the ability to choose among a variety of toric lenses, giving me a residual cylinder and letting me choose whether to maintain the axis of refractive cylinder or flip the axis and leave the patient with less net residual cylinder. We need to have a better understanding of the cylinder correction with effective lens position, and these calculators allow us to do that.

The Tecnis Toric calculator (Abbott Medical Optics, Santa Ana, Calif.) incorporates the Holladay formula with the cylindrical correction based on the effective lens position calculated. These formulas have benefits, particularly for patients with eyes that are out of normal range. Based on these calculations, I can determine which toric IOL to use and what the residual cylinder is expected to be. Looking at the IOL options, I may choose to flip an axis and leave the patient with less net residual cylinder.

It is important to note that flipping the refractive axis with a high enough magnitude can be an issue for some patients when prescribing spectacles. However, if I'm faced with a choice between leaving a patient with 0.45 D of refractive cylinder on the preoperative axis versus flipping him or her to 0.03 D or 0.05 D, at 90 degrees of that original axis, I will flip the axis. The goal is cutting down the cylinder. I believe that flipping a small amount and leaving the patient with a smaller amount of residual cylinder is better than leaving him or her with a larger amount at the same axis. Flipping the axis with these small values is visually insignificant. My goal is to leave the patient with the least amount of net residual cylinder, and sometimes that requires flipping the axis.

With-the-rule versus against-the-rule

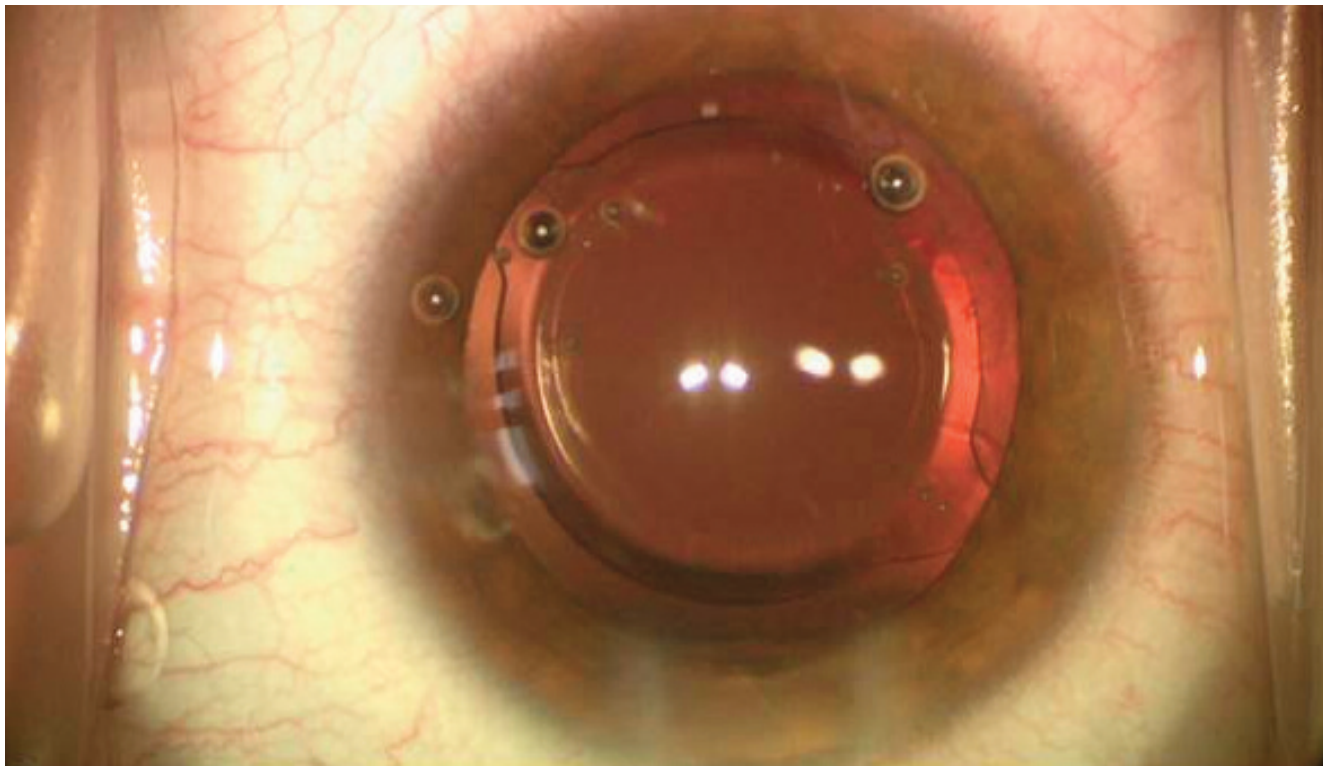
I almost always operate on the horizontal or the 180 degree axis. The location of the steep axis will factor into my IOL selection. For example, if there is 0.5 D of cylinder against-the-rule, my surgically induced astigmatism (SIA) will take care of that. On the other hand, if I have the same amount of with-the-rule astigmatism, with the SIA, I may leave the patient with a net result of approximately 0.75 D of cylinder. For that correction, there is value in using a toric to get that cylinder down to less than 0.5 D. My IOL choices will vary depending on the axis cylinder because I maintain my incision at one position.

Preoperative pearls

Some of the most important aspects of successful toric IOL implantation occur during the preoperative period. In addition to our calculations and incisions, another critical aspect is the preoperative/intraoperative marking. I've found that the one-step system basically identifies and marks the steep axis while the patient is sitting in the holding area. This avoids the need to then place a second mark while the patient is lying down. I have gone away from using ink, because ink distorts the precision and the ability to delineate the exact axis for implantation. We

Chart: Intraoperative and postoperative pearls

- Use a one-step preoperative/intraoperative marking technique.
- Use smaller incisions.
- The capsulorhexis should be smaller than the IOL's optic.
- At the conclusion of the case, keep eye pressures on a physiologic level.



Placement of a toric IOL in the eye

Source: Ike Ahmed, MD

use an inkless system with a beveled marking tip that indents the epithelium. This precisely identifies the axis itself.

Toric IOL choices

It is great to have choices among toric IOLs. It has been well established that the one-piece acrylic design is ideal for rotational stability. Some of the distinguishing characteristics include open haptic versus plate designs. Some of the differences, in terms of optical material, are the design of the actual optic-haptic junction. Asphericity, blue filtering, and other visual quality differences also distinguish some of the different torics. Remember, a variety of different toric powers are available, depending on the manufacturer. First, we select the right IOL, then we pick the specific toric correction based on the patient's needs.

Implantation

Toric IOL implantation is very similar to non-toric IOL implantation. However, it is important to pay attention to incision location and size. I like to keep the size down. We are moving toward 2.4-mm and 2.2-mm incisions to reduce the SIA. Also, keeping the incision farther back at the limbus rather than the anterior cornea reduces the amount of SIA. Knowing the amount of SIA is important for toric IOL calculation.

One of the most important aspects of toric IOL positioning is the capsulorhexis. Ideally, the rhexis should be smaller than the IOL's optic. The IOL's haptics are designed to unfold nicely in the capsular bag. I position the toric lens within the capsular bag, inflate it with viscoelastic, rotate it into the approximate position, usually within about 10 degrees slightly under-rotated, and then let the haptics open up. Once the haptics have opened and secured themselves in the peripheral capsule at the equator, tilt the lens, remove the viscoelastic from behind the lens, let the lens come back down, and then do final maneuvering, using either the I/A handpiece, Kuglen hook, or cannula.

At the conclusion of the case, keep eye pressures on a more physiologic level, not a very high level. This promotes early adhesion of the capsule to the IOL optic and haptic material. It also allows the toric IOL to settle quicker than if the eye was overpressurized. As with any IOL, centration is important, and specifically with toric, we want to make sure the alignment is correct at the end of the case. Postoperatively, IOL rotation is rare.

At the end of the day, it's about satisfying our patients and meeting expectations. We want optimal visual quality and uncorrected visual acuity, and I use that primarily as the basis for whether further treatment is required. For small amounts of residual cylinder, I will consider using an astigmatic or limbal relaxing incision. For higher amounts of residual astigmatism, especially if the lens is rotated or if the marking has been off, one may need to consider surgical intervention.

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"I almost always operate on the horizontal or the 180 degree axis. The location of the steep axis will factor into my IOL selection."

Daniel H. Chang, MD

Toric IOLs and the ANSI guidelines

by Daniel H. Chang, MD

The group has published guidelines recommending that toric IOLs not exceed 5 degrees of rotation postoperatively. Here's what that means for clinicians

"The toric lenses currently under FDA review will have much better optical properties than those available now."

As ophthalmic surgeons, we have enjoyed increasingly predictable outcomes with cataract surgery. The intraocular lenses (IOLs) that we use have become so precise that patients are now demanding excellent uncorrected visual function, which we provide with more advanced and complex IOLs. The American National Standards Institute (ANSI), a private not-for-profit organization that creates standards for diverse fields of science and engineering, has released guidelines on IOL manufacturing standards, including a specific set of guidelines for toric lenses. This standard (ANSI Z80.30-2010) "applies to any monofocal [IOL] whose primary indication is the reduction of astigmatism either with the correction of aphakia or the modification of the refractive power of a phakic eye."[1] Issues covered include optical properties, mechanical properties, labeling, clinical investigations, and the like.

A key point with these ANSI standards is that they do not stand alone—they are built upon other standards and guidelines, including the international ISO standards. While some of the details may be more relevant to IOL manufacturers than to surgeons, many specifications do affect our routine clinical use of toric IOLs. For example, the recommended tolerance limits of 0.3 to 0.5 D of sphere and cylindrical power for most labeled dioptric power ranges directly affect our ability to provide accurate outcomes for our patients. Effectiveness analyses, including the percentage of eyes achieving specified ranges of MRSE, UCVA, and cylindrical correction, are specified as well.

Toric lens rotational stability

Toric IOLs are unique in their requirement for proper axis orientation. From a manufacturing standpoint, ANSI Z80.30-2010 specifies axis orientation marks to be within 5 degrees of the cylindrical axis. This standard is important in giving surgeons the means to align a toric IOL accurately. It is well known that every degree of rotation in a toric lens will result in a 3% loss of power, so IOLs that rotate as little as 5 degrees will lose upward of 15% of their astigmatic corrective power.

Ultimately, the accurate alignment of a toric IOL requires good surgical skills in conjunction with tight manufacturing tolerances. An IOL manufacturer cannot ensure that a surgeon places a toric IOL accurately. However, assuming a toric IOL is implanted on-axis, good materials, design, and manufacturing should allow that IOL to stay on-axis. The ANSI guidelines for rotational stability are defined by the consistency of the IOL axis on two consecutive visits at least three months apart. Stability of the toric IOL axis is considered achieved if 90% of IOLs rotate no more than 5 degrees. It's the design of the IOL, including its material and haptic configuration, that will determine rotational stability. Toric IOLs that are too slick or perhaps with plate haptics may not be able to conform to the ANSI's rotational guidelines.[2]

In my personal experience, I've moved away from IOLs with postoperative rotation issues. In my hands, some of the commercially available toric lenses are reasonably stable in the postop period, but they can be difficult to manipulate intraoperatively when I need to rotate them to the proper axis. The new hydrophobic acrylic toric IOL from Abbott Medical Optics (Santa Ana, Calif.) that has recently received FDA approval demonstrated 90+% rotational stability postoperatively with an average rotation of only 2.74 degrees in the recent clinical trial. Based on material and design similarities to the same family of one-piece monofocal and multifocal IOLs, this new toric IOL should be easy to work with intraoperatively and stay well within the rotational guidelines outlined in the ANSI standard.

In addition to rotational stability, the ANSI standard gives detailed specifications describing the wavefront sensor test methods for determining the optical quality of lenses. This is important because I find that many patients with 1.5 D or less of astigmatism do better with a low-dispersion (low chromatic aberration) monofocal hydrophobic acrylic aspheric non-toric lens than the commercially available toric lenses with higher chromatic aberration. I believe that this observation is a function of the overall optical quality of the IOL being more important than the toricity component alone.

Degree rotation	Percentage power loss
1-2 degrees	3-6%
5 degrees	15%
10 degrees	30%
15 degrees	45%
20 degrees	60%

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Dr. Chang is in private practice, Empire Eye and Laser. He is also a volunteer surgeon and founding member on the board of directors for Advanced Center for Eyecare, a non-profit clinic providing medical/surgical eyecare to uninsured and underinsured people of Kern County, Calif. He can be contacted at 661-325-3937.

Two keys for maximizing outcomes with toric IOLs

by Farrell C. "Toby" Tyson II, MD, FACS

Farrell C. "Toby" Tyson II, MD, FACS

Rotational stability and spherical aberration correction are key to high levels of outcomes with toric IOLs

Two key elements to success with toric IOLs include postoperative rotational stability and excellent visual outcomes. These elements set up the surgeon for the best chances of success with toric IOL patients.

Rotational stability

Rotation of a toric lens can have a significant impact on vision. For example, a 4-degree rotation undercorrects the astigmatism by about 14%. With a 16-degree rotation, one achieves only half the intended cylinder correction, while a 30-degree rotation results in no cylindrical correction at all.[1]

We reviewed postoperative rotational stability in a recent prospective, multicenter clinical trial of a new, single-piece, hydrophobic acrylic toric IOL called the Tecnis Toric IOL (Abbott Medical Optics, Santa Ana, Calif.). This study, conducted at 14 investigational sites in the U.S. and Canada, was designed to evaluate safety and effectiveness, including the ability to reduce astigmatism. A total of 174 first eyes were implanted with the lenses.

Overall, >93% of all first eyes had a change in axis of ≤5 degrees between stability visits (1-3 months and 3-6 months). This matches up well with the recent standards set by the American National Standards Institute (ANSI), which require that ≥90% of eyes have ≤5 degrees axis change between visits 3 months apart. (See article by **Daniel Chang, MD**, on page 4). The mean axis change, taking direction into account, was –1.35 degrees, and mean absolute change (regardless of direction) was 2.74 degrees.

The rotational stability of these lenses can be attributed to the three-point fixation with offset, forward-mounted, rigid haptics, as well as the long total diameter (13.0 mm) of the Tecnis Toric.

Visual outcomes

At six months, 97% of first eyes had monocular uncorrected distance visual acuity (UCDVA) of 20/40 or better; 41% were 20/20 or better. Best-corrected distance acuity (BCDVA) was 20/40 or better in all eyes. There was a 75% reduction in mean cylinder in the eyes implanted with the Tecnis Toric. Spectacle independence was also high with 80% reporting never needing to wear glasses for distance.

I also find that the correction of spherical aberration permits an additional degree of forgiveness, providing surprisingly good acuity even in the occasional case of residual sphere and cylinder. Better correction of SA provides crisper vision, making the lens more forgiving of minor power calculation errors. This becomes particularly important in the presence of disease processes characterized by a loss of contrast acuity, such as macular degeneration and epi-retinal membrane, where preserving contrast acuity is paramount.

In my opinion, toric IOLs represent the best option for excellent uncorrected distance vision in patients with more than 1.0 to 1.5 D of astigmatism. The more choices we have in toric lens technology, in terms of the material, design, and spherical aberration correction, the better selection we can make for our astigmatic cataract patients.

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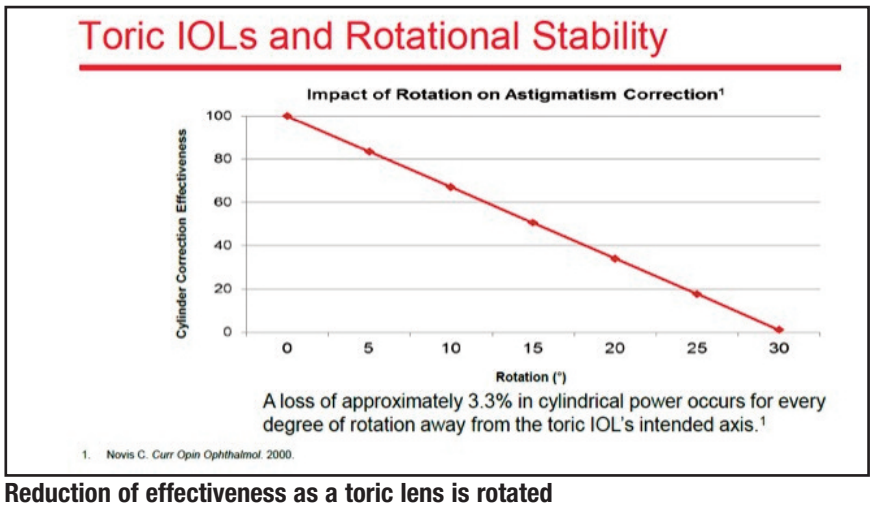
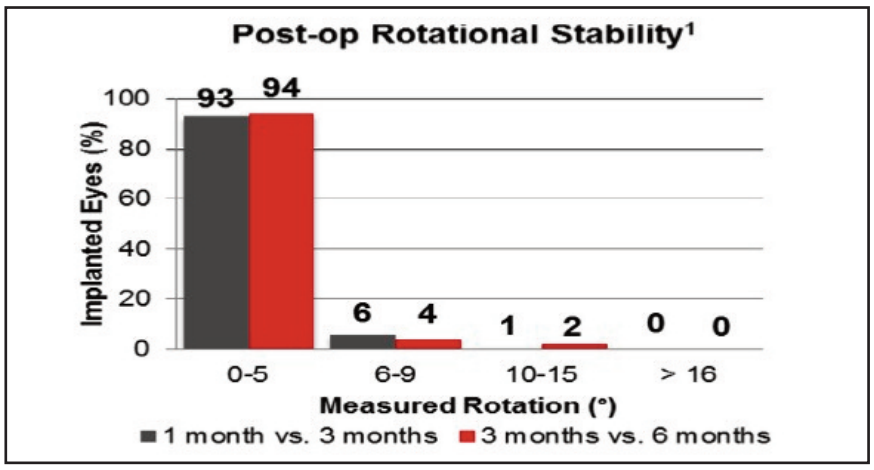


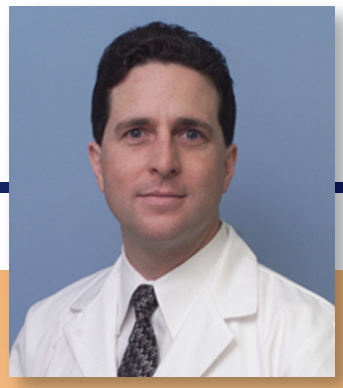
Reduction of effectiveness as a toric lens is rotated



Rotational stability data from the AMO toric IOL multicenter trial

Source all: Farrell C. "Toby" Tyson II, MD, FACS

"The more choices we have in toric lens technology, in terms of the material, design, and spherical aberration correction, the better selection we can make for our astigmatic cataract patients."



John Vukich, MD

Building a successful toric IOL practice

by John Vukich, MD

"The steps that surgeons need to take to be successful with toric IOLs are common sense, and they are things that most of us are already doing routinely."

Adding toric IOLs to your armamentarium is quick and easy

As you know, cataract surgery has now become refractive surgery. The quality of your work as a cataract surgeon is largely determined by how close your refractive outcome is to your targeted outcome. For patients with astigmatism, toric IOLs can be an attractive alternative, and adding them to your practice can be easy and beneficial.

If the astigmatic component is not corrected, the patient will be left with a residual refractive error and a less-than-optimal outcome. To correct astigmatism, we can do limbal relaxing incisions and on-axis incisions for a limited amount of correction. Unfortunately, limbal relaxing incisions are not accurate enough to provide a consistent, desirable result. The best way to approach astigmatism correction in these patients is by implanting toric IOLs.

Toric IOLs have been around for more than a decade, starting with the introduction of the STAAR (Monrovia, Calif.) toric IOL, followed by the Alcon (Fort Worth, Texas) toric lens, and most recently by the arrival of the Tecnis toric IOL (Abbott Medical Optics, Santa Ana, Calif.). These lenses have given us the ability to, in a single procedure, treat not only the refractive spherical equivalent but the astigmatic correction.

However, to achieve the best possible outcomes with toric IOLs, there are certain preconditions. For example, we must be able to get the axial length and the main keratometries correct, and we have to have a good power selection. Beyond that, we also have to place the implant into a very specific axis.

Minimal barriers to entry

The good news is that this can be easily done by any surgeon who is comfortable doing cataract surgery. It does not require expensive instrumentation, intraoperative aberrometry, or a femtosecond laser to do relaxing incisions. It doesn't require an excimer laser to deliver a postoperative corneal correction. It is a one-step procedure that can be done with minimal preparation in the office.

The only pieces of equipment needed are the IOLMaster (Carl Zeiss Meditec, Dublin, Calif.) version of the A-scan biometer and a topographer. As long as the surgeon is comfortable obtaining the image and reading the result, the type of topographer is unimportant. The steps that surgeons need to take to be successful with toric IOLs are common sense, and they are things that most of us are already doing routinely. Topography is the key to determining the patient's suitability for a toric lens.

Beyond that, it just becomes a matter of taking care to mark the axis of the intended position of the implant, and that's one additional step that is done prior to the patient lying down on the table to start the operation. This is relatively easy to do, but it requires active participation on the part of the surgeon or a skilled assistant in the preoperative area because accuracy is important. These are the only additional steps, so there are minimal barriers to entry. The rest is just a matter of delivering a consistent result.

Sophisticated patients

As cataract surgery has evolved into refractive surgery, our patient population has become increasingly sophisticated. The days of, "You're the doctor, you decide" are over. Today's patients are far more involved in their healthcare and the decision-making process than ever before. They are also more knowledgeable about the IOL options and potential outcomes.

As patients are more aware of their options, they are less resistant to the concept of delivery of a premium outcome. Most patients with astigmatism already know they have astigmatism when they present to our office. They have always paid more for their glasses. Their contact lenses have always had an additional feature and have required special fittings.

To begin the conversation about premium lenses, I typically ask patients how much they paid for their most recent pair of glasses. Generally, they will remember. With toric IOLs, there is an additional cost, but they also eliminate the cost of an astigmatic correction in patients' glasses or contact lenses, and they may eliminate the need for spectacle correction altogether. Patients understand and respond well to that.

I typically offer astigmatic correction to any patient who has 0.75 D or more of astigmatism. I draw the line at that level simply because I think that's where astigmatic contributions to refractive error become meaningful in a clinical way. However, an argument can be made for offering toric IOLs to patients with lower levels of astigmatism.

Dr. Vukich is surgical director, Davis Duehr Dean Center for Refractive Surgery, Madison, Wis. He can be contacted at javukich@gmail.com.

3 reasons to consider adding toric IOLs to your practice
Implantation can be easily done by any surgeon who is comfortable doing cataract surgery.
Offering toric IOLs does not require expensive instrumentation.
Today's sophisticated patients are knowledgeable about premium lenses.

Improving analysis and treatment of astigmatism with LASIK

Steve Schallhorn, MD

by Steve Schallhorn, MD

A new wavefront-guided system is producing strong results out of the box, before optimization

Wavefront aberrometers have provided refractive surgeons the ability to measure and treat more ocular aberrations and give our patients better outcomes. We have 20 surgical centers, each of which has wavefront aberrometry. While wavefront-guided ablations have improved outcomes to very high levels, treating precise levels of astigmatism axis and magnitude is an area where we can make incremental improvements.

We evaluated a new aberrometer (iDesign, Abbott Medical Optics, Santa Ana, Calif.) in 282 eyes (149 patients) who underwent LASIK between May 30, 2012 and August 19, 2012 in one of our centers and compared results to 18,866 eyes (8,657 patients) who underwent LASIK during the same time period at the remaining 19 centers with our current wavefront aberrometer. We matched the two groups for age and refractive error (sphere and cylinder).

Our current wavefront-guided LASIK is finely tuned and finely honed. We have undertaken a very comprehensive nomogram development and analysis over the last several years, starting almost five years ago. This evaluation consisted of more than 65,000 treatments and included one, three, and six month follow-up. We create a nomogram adjustment and then look at how well our adjustment performed and readjust when necessary. In other words, our current system represents the penultimate formulas after five years of intense evaluation and re-evaluation.

New vs. current

A review of the data shows that the iDesign immediately "out of the box" without the benefits of years of refinements produces similar or better outcomes as our current wavefront system (Figure 1). There are two distinct lessons here: Our current outcomes are exceptionally good, and the out-of-the box iDesign results are equally impressive.

Because astigmatism has magnitude and direction, cylinder correction needs to be analyzed using vector analysis; if the preop astigmatism was 1.0 D axis 180 and postop is 1.0 D axis 090, the magnitude of cylinder alone suggests no change. In reality, though, the cylinder was significantly overcorrected because of the change in axis.

Figure 1 shows very tight results with both systems. When we looked at intended refractive change versus the surgically induced refractive change in cylinder, better cylinder outcomes with the iDesign over our current system become apparent (Figure 2). The correlation coefficient (r2) is closer to 1 (ideal) with the iDesign compared to the current system.

Figure 3 illustrates similar cylinder outcomes in terms of the ratio of attempted vs. achieved cylinder

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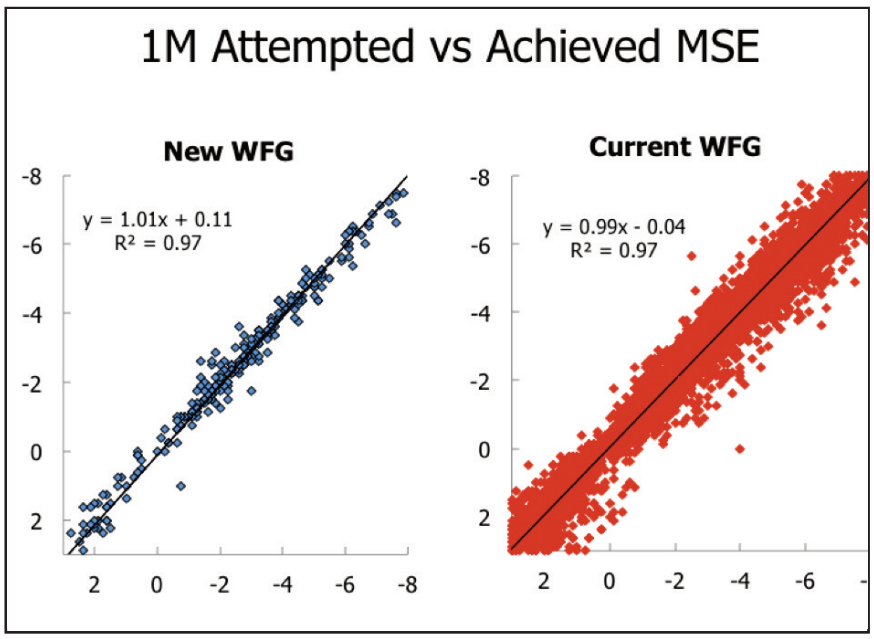


Figure 1. At one month, the manifest spherical equivalent results with the new wavefront-guided system are essentially equivalent to a wavefront-guided system with years of use and optimization.

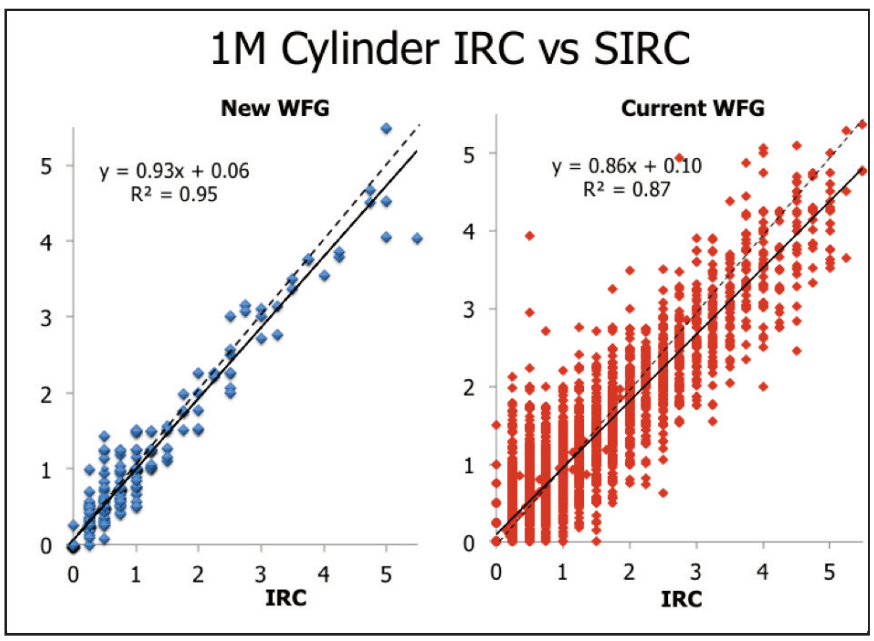
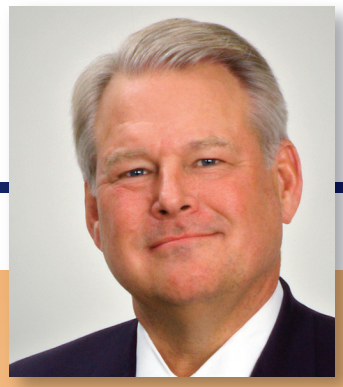


Figure 2. In this comparison of intended cylinder correction vs. surgically induced refractive change in cylinder, the new wavefront-guided system results in less undercorrection and a tighter distribution of outcomes.

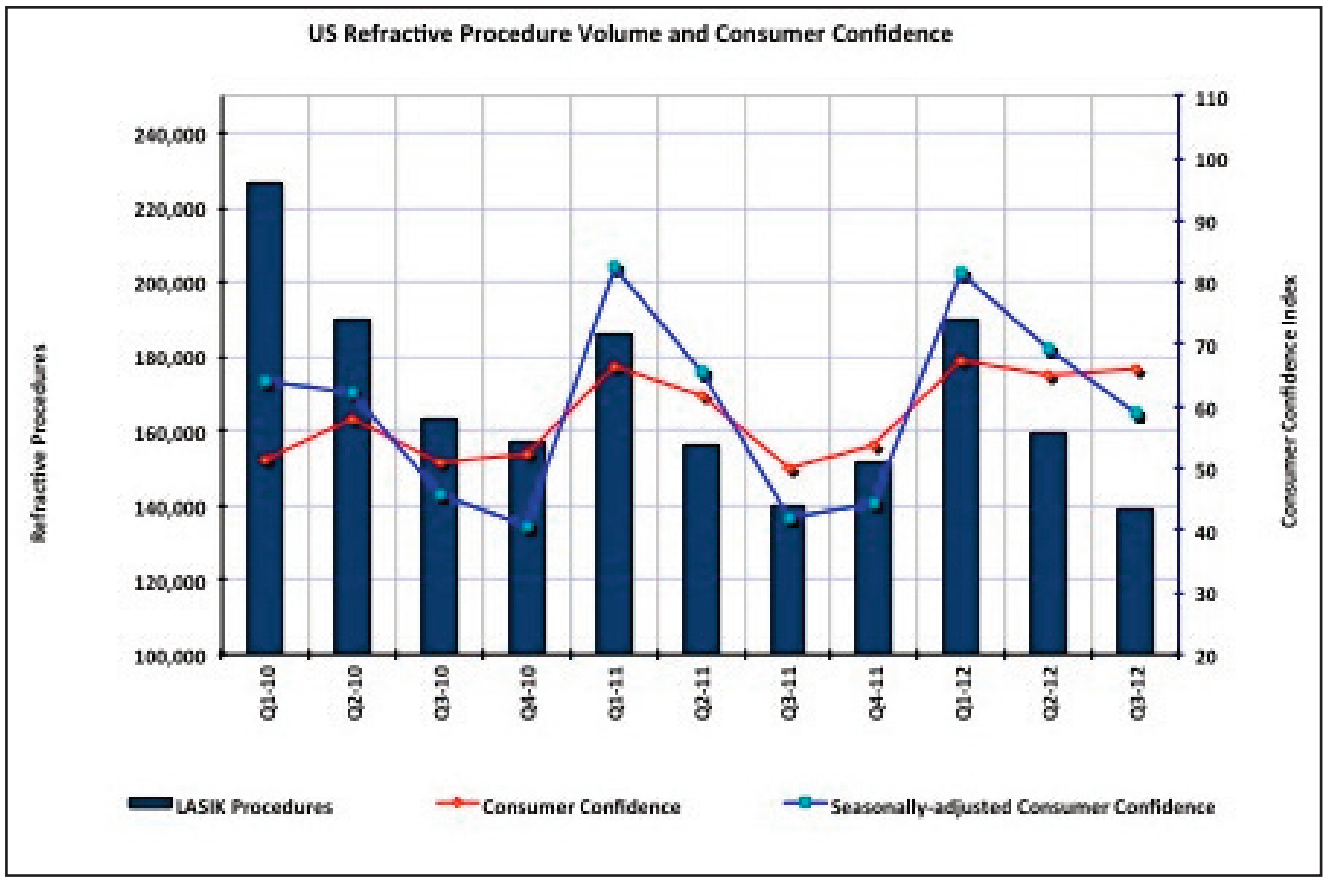
"The new aberrometer produces results at least as good as what we are currently using—and that system has undergone years of analysis and refinement."



Richard L. Lindstrom, MD

Patience is a virtue

by Richard L. Lindstrom, MD



Source: MarketScope

"The traditional LASIK patient is in his or her late 20s and 30s, and these are the people who are unemployed or underemployed, who have crushing debt and limited discretionary income."

For surgeons willing to wait, the refractive market will rebound—but probably not for a few more years

The laser vision correction market—and in particular, LASIK—saw its heyday in the late 1990s and early 2000s. Except for a rebound that was cut short by the financial crisis of 2008, the LASIK market has been on a decline. LASIK is in the category of consumer discretionary spending; that market has been severely impacted by the current economy and employment data. Consumer confidence rose a bit in the fourth quarter last year, but crashed again in the first quarter this year.

For refractive surgeons, that doesn't spell good news. Most laser centers make the majority of their annual revenue in the first quarter. And so far, we're not seeing a good first quarter in 2013. The trend has always been a strong first quarter, slower second and third quarters, and an uptick in the fourth quarter. To be blunt, I'm not bullish about recovery this year. We may have had an extremely robust stock market over the past few months, but many financial analysts are predicting a correction in the market come fall 2013, when the impact of sequestration on Gross Domestic Product and consumer confidence will be even more fully felt.

The traditional LASIK patient is in his or her late 20s and 30s, and these are the people who are unemployed or underemployed, who have crushing debt and limited discretionary income. They simply are not flocking to our centers for refractive surgery at this time.

But not all is doom and gloom. I see a great deal of potential in a few years as refractive surgeons and the refractive industry overall transition into treating more presbyopic patients, the Echo Boomers (also known as Generation Y or Millennials) age and become increasingly contact lens intolerant, and collagen crosslinking reduces the number of patients rejected as LASIK candidates.

Millennials (Echo Boomers) at a glance in 2013

- 76 million Millennials (Baby Boomers account for 25.4%)
- 25% of the total population
- 26% of U.S. adults are Millennials 18 years or older (Generation X accounts for 22%)
- 46.1% of 16- to 24-year-olds were employed in Sept. 2009 (smallest amount on record)

Sources: Pew Research Center (www.pewresearch.org/millennials/, 2010); UNC Kenan-Flagler Business School (J. Brack, Maximizing Millennials in the Workplace, 2012)

Baby Boomers galore

There are about 78 million Baby Boomers between the ages of 47 and 67—not many of whom want or adapt to monovision. These patients want the vision of their youth, and they've been lucky enough to maintain good paying jobs and manageable debt.

Corneal inlays are working their way through the U.S. regulatory process, and we'll likely have our first inlay available on a commercial basis in 2015. That will enable us to remarket back to the Baby Boomers who previously underwent LASIK and to new Boomer patients with a means to correct their presbyopia and the remainder of their refractive errors as well with LASIK.

How the market will recover

Echo Boomers are about a decade away from wanting vision correction outside of contact lenses or spectacles in high numbers. They're not yet presbyopic, but they are highly active and don't want the inconvenience of contact lenses or spectacles. Unfortunately, unemployment in the Echo Boomer group is high and most have graduated college with a heavy debt load. They need to get established in their careers, pay off some debt and have some disposable income before they consider laser vision correction in high numbers. Right now, it's anybody's guess how long that may take. I think we'll start to see the Echo Boomers come into the market in their later 20s and early 30s instead of the late 30s we experienced with the Baby Boomers. Again, I think an uptick in Echo Boomer LASIK volume is probably two to three years away, but I do think they'll start opting for LASIK in increasing numbers in the back half of this decade, 2015-2020.

Collagen corneal crosslinking will be another advancement that is going to help the laser vision correction market recover. Most of us turn away close to 15% of our potential LASIK patients because of abnormalities of the cornea, usually a thin pachymetry or an atypical topography. Patients with thin corneas or atypical topography will be able to be treated once crosslinking is available in the U.S., and with several companies pursuing U.S. approval, I believe we'll have this in our armamentarium by 2015 as well.

Refractive cataract surgeons are increasing their premium lens business, but it will continue to grow slowly. LASIK will continue to grow slowly in this market as well, as patients need enhancements. I don't expect this to become a large part of our revenue, but growth in the premium IOL sector will grow corneal refractive surgery as well.

My personal business plan

I don't see a lot of short-term promise in the LASIK market, but I do anticipate we'll start seeing more growth return around 2015. My belief is that growth will continue over a long period of time as more and more Baby Boomers take advantage of the presbyopic treatments we'll have available that are performed in conjunction with LASIK and the Echo Boomers' transition from contact lenses to LASIK.

Surgeons who want to stay in this channel will have to expand their offerings. The economic downturn discouraged new surgeons from entering this sector and may have pushed some others out. So even though there are fewer LASIK surgeries, there are also fewer of us performing LASIK. I predict even more surgeons will drop out of LASIK in the next 18-24 months. For those of us who opt to remain, there will likely be fewer than 2,000 dedicated refractive specialists by 2020.

It will be a rough ride for the next few years, but it will get better. In the interim, talented refractive surgeons should expand into other ophthalmic surgery—including cataract, aesthetic plastic surgery, or glaucoma. The good news is there is no shortage of patients for all of ophthalmology's offerings, and I have always believed fortune favors the prepared mind, so I hope these insights into the major trends affecting LASIK volume will be of use.

Dr. Lindstrom is founder and attending surgeon, Minnesota Eye Consultants, Bloomington, and adjunct professor emeritus, Department of Ophthalmology, University of Minnesota. He holds more than 30 patents in ophthalmology and is a past president of the American Society of Cataract & Refractive Surgery and currently serves on its Executive Committee. He can be contacted at rllindstrom@mneye.com.

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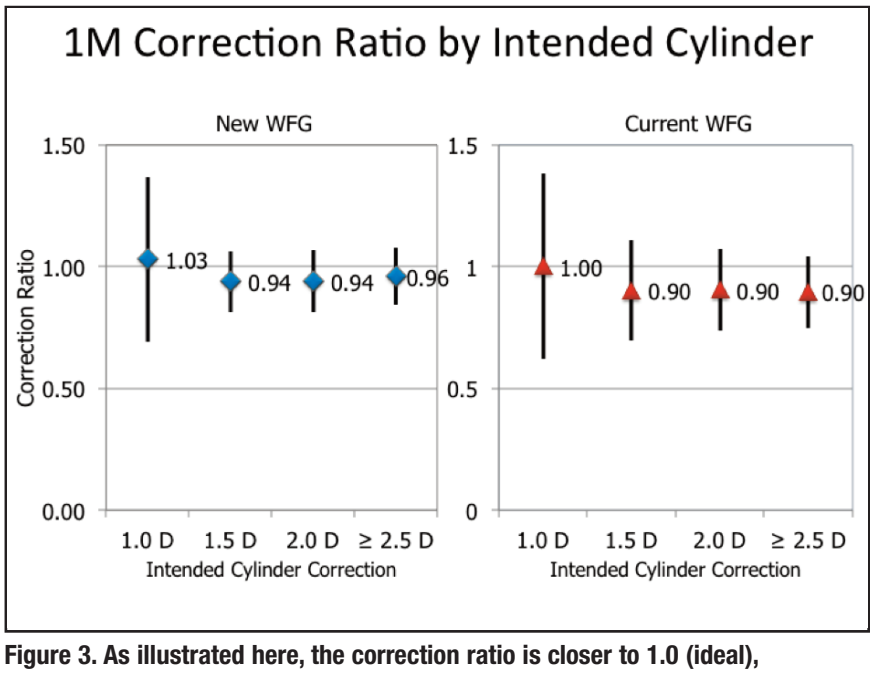


Figure 3. As illustrated here, the correction ratio is closer to 1.0 (ideal), especially for higher levels of preop cylinder, when using the new wavefront-guided system compared to the current system.

Source (all): Steve Schallhorn, MD

correction; more of the astigmatism is corrected with the iDesign and with lower variance in results (tighter standard deviation).

The outcomes show less axis deviation as well with 64% of eyes with less than 5 degrees of axis shift, compared with 55% in the current system.

What the patients say

Patient satisfaction with their outcomes is already high after a wavefront-guided procedure, but we're finding outcomes to be slightly more favorable after the iDesign.

In conclusion, the new aberrometer produces results at least as good as what we are currently using—and that system has undergone years of analysis and refinement. There is similar refractive predictability, superior cylinder correction, better uncorrected visual outcomes, and similar best corrected outcomes. Our technicians have noted they prefer the new aberrometer because the capture and interface issues are smoothed out. Chromatic aberrations have been addressed, resulting in less disparity between the manifest and wavefront sphere.

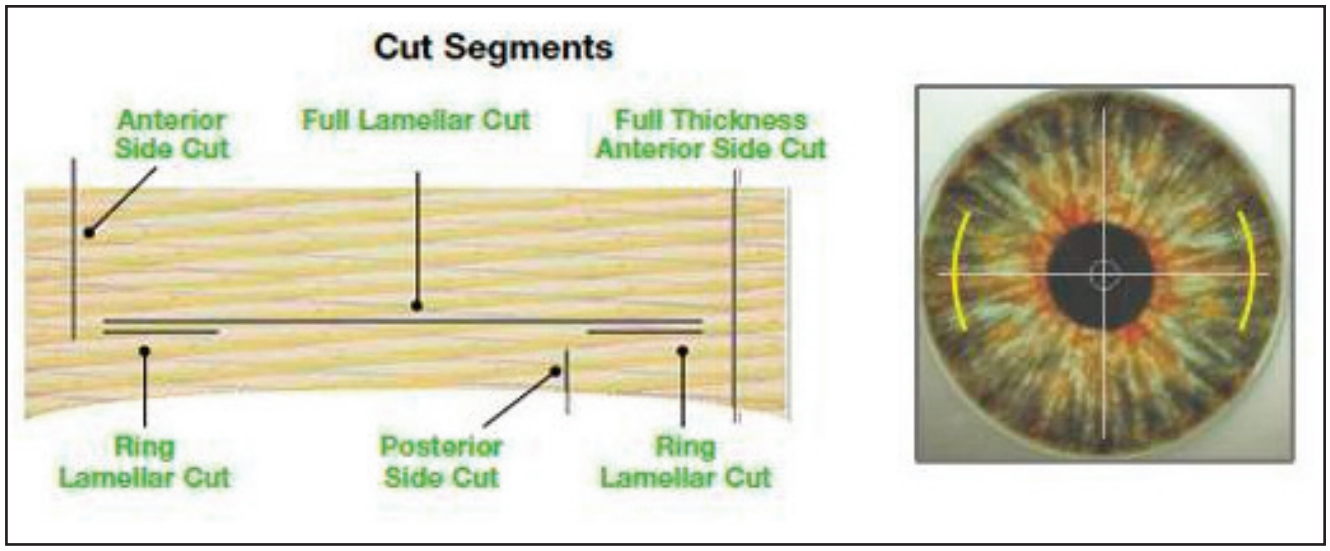
In my opinion, if a center is already using wavefront-guided technology, it is an easy learning curve to adjust to this system. I believe the results available out of the box are excellent, but undoubtedly we will still be able to improve outcomes. Currently, we are evaluating the system in several thousand eyes to determine what we need to do to even further optimize the system.

Dr. Schallhorn is global medical director, Optical Express; in private practice in San Diego; and clinical professor of ophthalmology, University of California, San Francisco. He can be contacted at scschallhorn@yahoo.com.

Kevin L. Waltz, OD, MD

Corneal applications of laser cataract surgery

by Kevin L. Waltz, OD, MD



The different types of incisions a femtosecond laser can make

Source: Abbott Medical Optics

> **"Corneal incisions created with the IntraLase are high quality, precise, and repeatable."**

Using a femtosecond laser for arcuate and clear corneal incisions increases precision

When we think about using a femtosecond laser for cataract surgery, we've been taught to think about the femtosecond laser as a kind of "fancy blade." The femtosecond laser can certainly simulate a fancy blade, but its other attributes are what make these lasers so intriguing. They will allow the surgeon to create incisions that were previously unimaginable and unattainable. We have just begun to scratch the surface of the femtosecond lasers' capabilities.

Currently, there are three types of femtosecond lasers for cataract surgery—ones developed solely for cataract surgery (Catalys, OptiMedica, Sunnyvale, Calif.; LENSAR, Orlando, Fla.), those that have been developed primarily for laser cataract surgery, but can also create LASIK flaps (LenSx, Alcon, Fort Worth, Texas; Victus, Bausch + Lomb/Technolas, Rochester, N.Y.), and one that was developed for LASIK but can create arcuate incisions (IntraLase iFS, Abbott Medical Optics, Santa Ana, Calif.).

My laser is located at a dedicated laser refractive facility about 2 miles away from my cataract surgery center. We create both partial thickness arcuate incisions and full-thickness clear corneal incisions at the laser facility; the patient then returns to our cataract facility later the same day for cataract surgery. We open the incisions at our cataract center rather than at the laser facility.

My first impression of IntraLase-created cataract incisions was they are high quality, precise, and repeatable. Many surgeons believe a Langerman style three-plane incision is a better sealing incision, but they are a challenge to create manually. During my initial case series with the IntraLase, these incisions were created with ease and sealed extremely well.

Financial considerations for femtosecond cataract surgery

For cataract-only surgeons who do not own a refractive laser, using these can be as simple as coordinating with a laser refractive surgery laser center. There's no upfront, out-of-pocket cost to the cataract specialist to use a femtosecond laser at a non-competitive site, and user fees are nominal.

From the laser refractive surgery center's perspective, letting cataract surgeons use their laser is a way of incrementally increasing revenue.

I have performed femtosecond intrastromal arcuate incisions with the IntraLase and watched the patient walk across the street to hit the gym. The patient left my laser surgery center without eye drops and without pills. This is—potentially—a completely new way of handling creating corneal incisions for cataract surgery.

Cataract surgeons who want to enter the laser refractive cataract surgery market now have an option to do so with very little financial risk.

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Lenticular applications of the femtosecond laser in cataract surgery

Ronald Krueger, MD

by Ronald Krueger, MD

The precision of the femtosecond laser makes it an ideal choice for creating the capsulotomy and for lens fragmentation

The advent of femtosecond laser-assisted refractive cataract surgery has turned a surgery with typically stellar outcomes into one with potentially phenomenal outcomes. While we've seen incremental improvements in intraocular lens technologies over the recent years, it wasn't until the femtosecond laser's applications for cataract surgery started to be explored that we realized what opportunity there was to simplify our techniques while (potentially) improving safety and enhancing outcomes.

Patients undergoing modern cataract surgery are no longer impressed with excellent results—they are demanding perfection. Using the femtosecond laser to create the capsulotomy and to perform lens fragmentation can help turn difficult cataract surgeries into simpler ones and can make even routine surgeries easier.

That's not to say these devices are not without potential drawbacks. Surgeons using these lasers will have to justify the cost of acquisition and during the early implementation may have to factor in additional time for the surgery until they develop a system that works for their practice. It is my belief, however, that the potential advantages far outweigh any drawback.

Laser capsulotomy

As refractive surgeons can attest, lasers offer a precision that manual procedures cannot. This extends to the capsulotomy creation during cataract surgery, too. As with corneal laser vision correction, the capsulotomy is best centered over the visual axis, and achieving this accurate centration is a challenge with manual rhexis techniques. **Warren Hill, MD**, has shown in several studies that a consistently round and centered capsulotomy helps the implant remain in a more stable position.[1,2]

Manual capsulorhexis will never match the precision of a laser. Although it's possible to be good at making the capsulorhexis, variability in anterior segment anatomy and pathology among patients makes it impossible to achieve a similar precision to that of the laser.

> "Manual capsulorhexis will never match the precision of a laser."

In particular, dense hypermature cataracts, eyes with zonular weakness, or hyperopic eyes with small, shallow chambers pose unique challenges when creating a manual capsulorhexis that simply no longer exist when a femtosecond laser is used. For surgeons who use premium IOLs, a capsulorhexis that is too large or imperfectly circular can create issues with lens centration and stability. That can lead to the need for premium lens repositioning or explantation to alleviate any visual distortion. In my hands, the femtosecond laser is able to create a capsulotomy that will symmetrically overlap the lens' edge, enhancing the effective lens position in nearly all cases.

Lens disassembly

In my opinion, an advantage of femto-fragmentation of the lens nucleus is that it's simply easier to disassemble the lens for emulsification, especially in denser cataracts or complex situations where excessive manipulation may jeopardize our outcomes (such as zonular dehiscence, pseudoexfoliative glaucoma, posterior polar cataracts, etc.). The LENSAR laser system (LENSAR, Winter Park, Fla.) data on lens fragmentation shows less cumulative dispersed energy (CDE) with the laser compared to conventional phacoemulsification.[3] Less CDE, in turn, results in less endothelial cell loss. Similar data suggest that reductions in CDE of up to 95% or more may be possible with grades 1 or 2 nuclear cataracts, such that only aspiration may be needed. With denser nuclei, CDE can be reduced by two-thirds in grade 3 nuclear sclerosis and by 27% in grades 4 or higher. Furthermore, the lens fragmentation can be performed on any programmed algorithm; some clinicians have advocated a "pie-shaped" fragment in cases of hard nuclei and a spherical-based fragment for softer cases. There has also been a trend toward faster visual recovery after femtosecond laser in cataract surgery compared to standard phaco.[4]

> "[There is] less cumulative dispersed energy with the femtosecond laser compared to conventional phacoemulsification, [which] results in less endothelial cell loss."

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David F. Chang, MD

Managing residual refractive errors

by David F. Chang, MD

"Emmetropic outcomes are particularly crucial with multifocal IOLs."

The most common cause of patient dissatisfaction is not always avoidable, but it is treatable

When it comes to patient satisfaction, we cataract surgeons have historically been spoiled. Who among us tires of hearing patients rave about how easy and painless the operation was; how quickly the vision improved; and how color, brightness, and uncorrected vision are so surprisingly good? Indeed, we've become very accustomed to routinely exceeding the expectations of our cataract patients.

Offering cataract patients the choice of refractive IOLs and adjunctive refractive options, such as astigmatic keratotomy or the femtosecond laser, suddenly changes these expectations and the satisfaction equation. Despite uncomplicated surgery, cataract patients may now be dissatisfied because their refractive expectations for uncorrected visual function are not met. Part of the issue is that in an effort to understand confusing concepts such as refractive error, focal point, and depth of focus, many patients tend to oversimplify the value proposition. Since insurance already covers the cataract operation, many patients simply assume that "paying extra for this lens means that I won't need glasses to drive (or read)." The need for effective preoperative counseling to set realistic expectations is widely recognized.

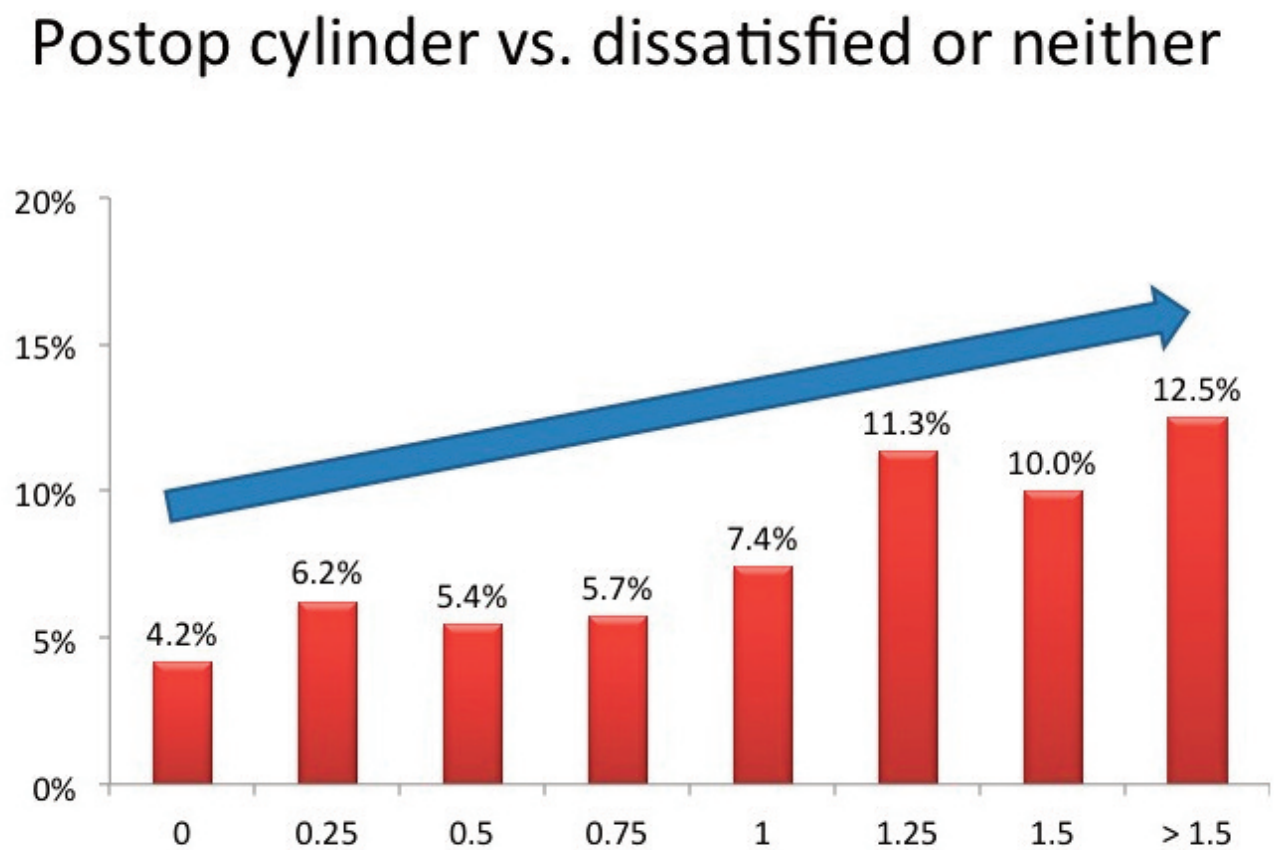
For these reasons, it also makes sense that the most common cause of patient dissatisfaction following any refractive IOL procedure is residual refractive error. For instance, while 90% of our patients are within 1.0 D of spherical target, there may only be 75% who are within 0.5 D of target. Emmetropic outcomes are particularly crucial with multifocal IOLs. In two separate studies of unhappy multifocal IOL patients, complaints of blurry vision due to residual refractive error were present in a large percentage of subjects.[1,2] In one of these studies, 28% of eyes had residual astigmatism of 0.75 D or greater.[1] With a monofocal IOL, 0.5 D of myopia or a small amount of astigmatism is tolerable and may actually increase depth of focus. With diffractive multifocal IOLs, however, the inherent loss of image contrast makes these lenses much less forgiving of the same errors.

This is an inevitable lesson that every refractive cataract surgeon learns through experience, but researchers at the University of Rochester demonstrated this in convincing fashion.[3] An adaptive optics wavefront sensing system was used to measure through-focus image quality of different presbyopia-correcting IOLs in a pseudophakic model eye. The advantage of an optical bench simulation is that it separates optical quality from other clinical variables, such as the patient's corneal surface, fovea, and brain. The image quality and depth of focus of both the ReSTOR SN6AD1 (Alcon, Fort Worth, Texas) and the Tecnis ZM900 (Abbott Medical Optics, Santa Ana, Calif.) multifocal IOLs dropped noticeably with more than 0.75 D of corneal astigmatism. In addition, optical performance of the multifocal IOLs was much more sensitive to corneal astigmatism compared to a monofocal IOL.

That so many cataract surgeons are unable to perform keratorefractive enhancement surgery on their own patients is a significant problem whose adverse effect on premium refractive IOL adoption rates is difficult to estimate or quantify. Frequent enough failure to attain emmetropia decreases the surgeon's confidence and ability to recommend presbyopia-correcting IOLs for certain patients (e.g., those with preoperative astigmatism or atypically long or short axial length). More importantly, patient dissatisfaction is much higher if expectations for reduced spectacle dependence are not met. This produces negative rather

The American Society of Cataract & Refractive Surgery has developed a new series of EyeWorld programs designed to teach cataract surgeons how to perform PRK enhancement of ammetropic pseudophakic eyes. This program was co-chaired by Richard Hoffman, MD, and Dr. Chang. You can read about it in the Tuesday, April 23 edition of *EyeWorld Today* at daily.eyeworld.org.

following refractive IOL implantation



Data on the impact of residual error on patient satisfaction rates from 4,970 eyes implanted with multifocal IOLs

Source: Steve Schallhorn, MD

"If your practice doesn't perform PRK or LASIK, establish a relationship with someone in your community who does."

than positive reinforcement for refractive IOL use by the surgeon, and similarly turns patient word-of-mouth from positive to neutral or negative.

Many cataract surgeons do not have a viable strategy for addressing residual spherical error and astigmatism in their refractive cataract patients. Several factors might potentially inhibit cataract surgeons from referring their patients to colleagues for keratorefractive laser enhancement. One might be the inability to control or specify cost. Another is a concern that patients will perceive that "something went wrong" if they are transferred to another surgeon's care. However, imagine keratorefractive surgeons trying to perform LASIK without the option or ability to enhance the initial result. In my opinion, this is the missing part of many refractive cataract surgeons' armamentarium. If you or someone in your practice doesn't perform PRK or LASIK, then I recommend establishing a relationship with someone in your community who does. Patients must then be prepared up front for the possibility of being referred to that surgeon for an enhancement (along with the estimated cost).

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Elizabeth A. Davis, MD, FACS

Achieving success with multifocal IOLs

by Elizabeth A. Davis, MD, FACS

Careful patient counseling and screening are two keys to patient satisfaction

I have had a very high patient satisfaction rate with multifocal IOLs, and the keys to optimal patient satisfaction are patient screening, meticulous surgery, and patient counseling. In addition to screening patients from an anatomy and disease standpoint, I also consider patients' needs, desires, and personality. Patients are counseled about nighttime glare and halos, which are inherent with these lenses due to their design.

Patient screening

The first step toward success with multifocal IOLs is careful patient screening. If a patient has macular degeneration, diabetic retinopathy, or severe pseudoexfoliation with phacodonesis, I may decide not to even offer multifocals as an option because the risk of a poor outcome may be high. Additionally, patients who have no desire to reduce their need for glasses or contact lenses would obviously not be interested in this technology. I also rule out any patient who appears to be a perfectionist and any patient who indicates that he or she is sensitive to glare and halos at night. I also typically don't consider multifocal IOLs in patients who have previously undergone corneal refractive surgery due to the risk of poor quality of vision.

Most patients are good candidates for multifocal IOLs. If I have not ruled patients out during this initial screening, I then pay careful attention to their ocular surface, both from the lipid layer and aqueous layer point of view. I examine the lids and lashes carefully for meibomian gland disease. If I have any suspicion about any macular abnormalities, I perform a macular OCT. I also examine the optic nerve to make sure the patient doesn't have pre-existing optic nerve disease.

> "The first step toward success with multifocal IOLs is careful patient screening."

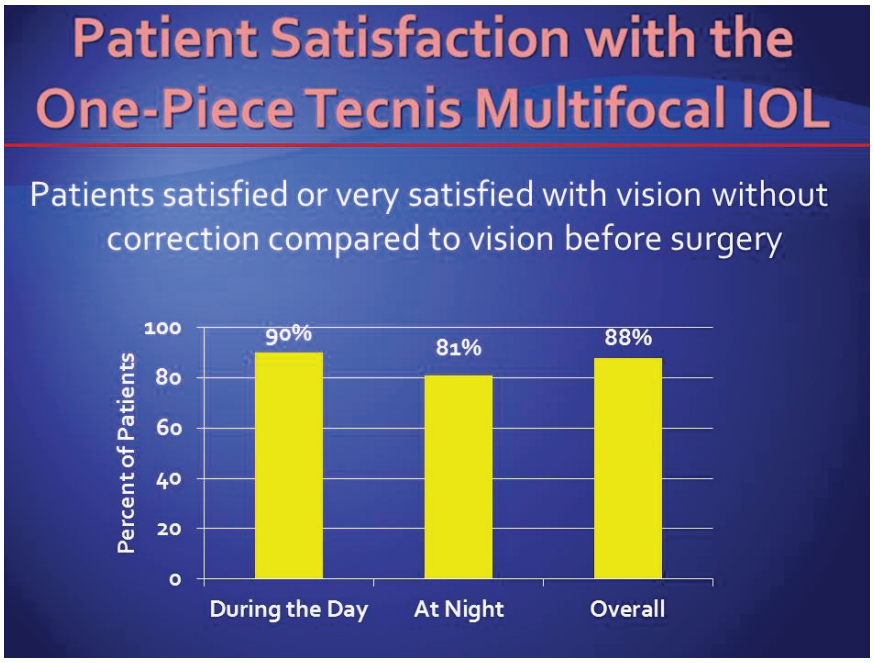


Figure 1

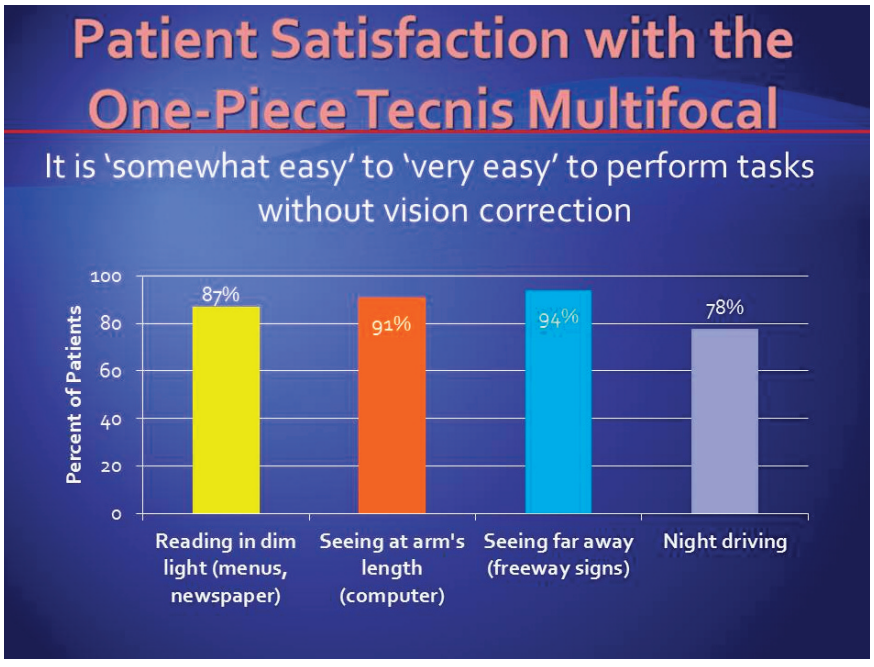
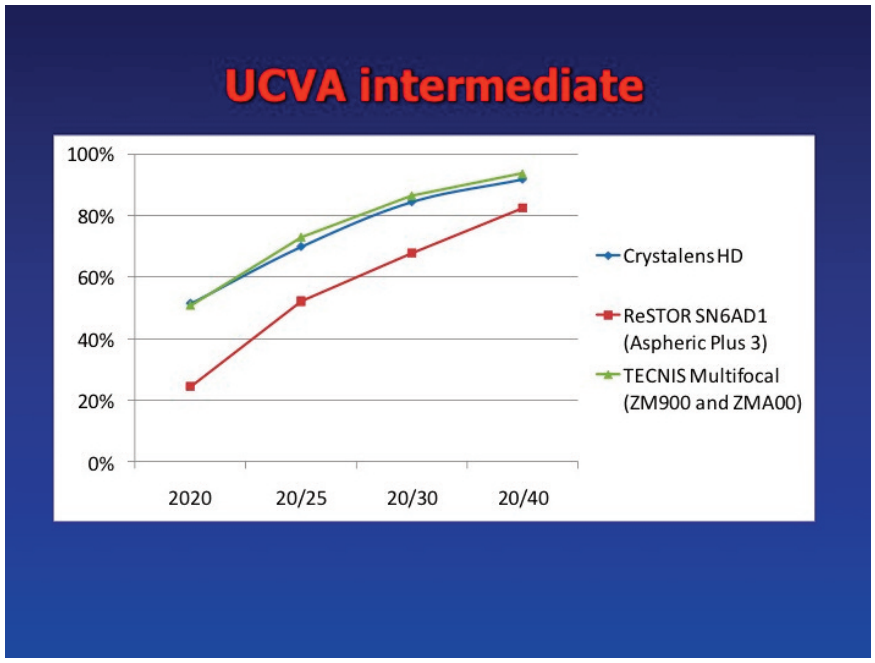


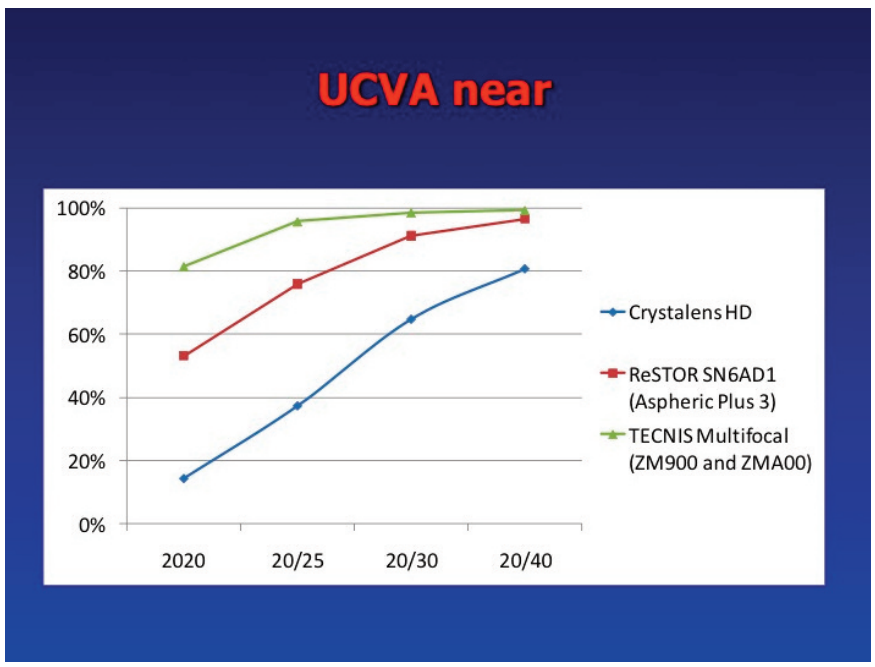
Figure 2

Source: Elizabeth Davis, MD

Maximizing the ocular surface allows us to get good keratometry and corneal topography measurements. All patients undergo corneal topography to determine how much corneal astigmatism they have. Patients with more than 0.75 D of corneal astigmatism who choose multifocal IOLs will likely require laser vision enhancement postoperatively because toric multifocal IOLs are not yet available in the United States. We also will get a pachymetry measurement. Pachymetry combined with topography determines whether a laser vision enhancement can be performed.



Intermediate UCVA data from a multicenter clinical trial



Near UCVA data from a multicenter clinical trial

Source (all): Elizabeth Davis, MD

Patient counseling

When counseling patients about IOL choices, I warn them about nighttime glare and halos with multifocal lenses. However, either because of neuroadaptation or because I have prepared them well, patient complaints about glare and halos are minimal in my practice.

Unfortunately, glare and halos cannot be completely eliminated because of the concentric ring design of multifocal IOLs. So, it is important to let patients know that they will most likely experience it to some degree. However, glare and halos can also be caused by other factors, such as ocular surface disease, PCO, anterior basement membrane dystrophy, or a poorly centered IOL. Obviously, it is important to pretreat any existing ocular surface disease and perform meticulous surgery with a well-centered IOL. Small incision surgery with a well-centered capsulorhexis contributes to good refractive outcomes.

I also tell patients that while they will have good vision overall, a certain percentage of patients may feel that their intermediate vision is not as good as their distance and near. Patients occasionally might need a pair of glasses for intermediate work, like computer work. Often, over the course of six months to a year, patients find that they rely less and less on glasses due to neuroadaptation.

Overall, I've had a very high satisfaction rate, and that's why I've continued to use these lenses. For example, in a multicenter, prospective, open-label observation registry evaluating the Tecnis one-piece multifocal IOL (Abbott Medical Optics, Santa Ana, Calif.) in 106 patients, we found that the majority of patients were satisfied or very satisfied with their vision without correction compared to their vision before surgery (see Figure 1 and 2). However, it is imperative not to oversell. Multifocal IOLs are excellent technology but patients need to understand that nothing is perfect.

Dr. Davis is managing partner, Minnesota Eye Consultants, and adjunct clinical assistant professor, University of Minnesota. She can be contacted at eadavis@mneye.com.

"Either because of neuroadaptation or because I have prepared them well, patient complaints about glare and halos are minimal in my practice."

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