

Noel Alpíns, MD, shares his opinions on what to do when topographic and refractive astigmatism cannot both be eliminated.

## EW INTERVIEW

# Optimizing approaches to astigmatism assessment

by Brad Fundingsland Managing Editor

**EYEWorld:** What is the most misunderstood concept concerning astigmatism among refractive surgeons today?

**Noel A. Alpíns, MD:** There are two fundamental ways of measuring astigmatism: by corneal means, including topography or keratometry, and by refractive means. Inevitably, there are going to be differences between these values. There is a trend to deal with just one aspect of these values and disregard the other. As long as this continues, you are only going to experience optimum outcomes at one of these diagnostic levels.

**EW:** If a refractive surgeon is happy with the results achieved using one of these astigmatic values, why should he or she change? Is this going to make treatments more complicated?

**Alpíns:** Forty-three percent of the general population with treatable astigmatism have a significant amount of corneal irregularity. In the future, I don't believe the process of treating astigmatism will become more complicated. I believe it will actually become simpler, with more adaptive and user-friendly software that will allow complexities to be unmonitored. This may not necessarily be to the surgeon's advantage, because he or she will not have to understand every step of the process to actually perform the process.

This is analogous to driving an automobile. You don't have to understand how a car works to drive it, yet, by understanding how all the parts work, and their usefulness, you are most likely to be a better driver.

**EW:** How much visual improvement can be expected with a better understanding of astigmatism?

**Alpíns:** When there are differences between corneal and refractive astigmatic values, you have to accept that all astigmatism cannot be removed from the system. Instead, the goal is to optimize the optical functioning of the eye by dealing appropriately with this remaining astigmatism.

Eventually, the limiting factors will no longer be the cornea or the lens, but the discrimination powers of the retina receptors. At the moment, corneal irregularity is a limiting factor. Noncorneal astigmatism also limits optimum ocular

function, which includes irregularities on the back of the cornea, the front and back surfaces, and retinal tilt. Even the occipital cortex and its perception of the image has an influence on the refractive astigmatism and any treatment based on it.

**EW:** Will we ever develop a machine that will combine both these topographic and refraction numbers into one value?

**Alpíns:** I don't believe a machine like this would be acceptable to the patient any more than prescribing all your spectacles off an autorefractor. You are always going to have two principal ways to measure astigmatism — one is the shape of the cornea and one is the refractive cylinder in front of the eye. They are very different parameters that will always have different values. Currently, these are the prevailing conditions and we must address them.

**EW:** Will corneal topography continue to be important with the development of wavefront refraction technology?

**Alpíns:** I think the development of wavefront refractions, as a diagnostic tool, has made topography even more important.

Wavefront technology provides a very sophisticated refraction, with between 50 and 200 ray-tracing measurements in any one eye, while corneal topography is several thousand keratometric measurements. Basically, wavefront is to a refraction as videokeratometry is to a keratometer — it is a refractive map. In the end, a wavefront refraction is still a refractive number that, in essence, disregards the corneal astigmatism it is attempting to correct.

**EW:** How do you feel about using wavefront refractions as the basis for excimer laser ablations?

**Alpíns:** When a topography is used to create a customized laser ablation, it is sometimes referred to as topolink. Therefore, I have coined the term "refracto-link" to describe an ablation based on a wavefront refraction.

With a refracto-link or wavefront-based ablation, any aberration in the eye causes the ray to be deviated, thus reproducing the aberration on the cornea. For example, if a wavefront refraction calls for a divot, the laser can do a mini-abla-

tion in that area. But what happens if the aberration calls for an elevation in the area? This can only be achieved by ablating around the periphery. Yet, this creates encroachment on neighboring areas that have their own priorities. With all these multiple treatment regions, you end up with a corneal surface that looks like a cobblestone road. This has the potential to make the astigmatism significantly worse. Furthermore, these optical aberrations within the eye, such as in crystalline lens, are not static over time, so the change induced on the cornea might become inappropriate.

Laser technology companies have attempted to use averaging techniques to smooth the differences between adjoining treatment areas, but wherever you treat, there will be junctional zones with likely conflicting treatments. Also, if you keep on averaging between these overlapping treatment zones, you end up back where you started, with the preoperative manifest refraction.

**EW:** What future diagnostic technologies have the most promise for assessing and treating astigmatism?

**Alpíns:** Vector planning is the answer. It is an analytic tool that integrates the two modalities of refraction and topography with the laser.

For example, when fitting a hard contact lens, we can use a bitoric lens. This lens with a toric surface on the back surface is placed on the eye. Then an over-refraction is performed to correct the remaining refractive astigmatism and a proportion of this correction is sculpted on the front of the lens. This optimization process makes a patient more satisfied with the contact lens.

Vector planning is similar. Instead of using the laser to make the cornea completely spherical, or completely attuned with the refraction, vector planning allows the surgeon to go through a similar optimization process and treat what is best for the individual patient's eye by effectively dealing with the remaining astigmatism.

**EW:** How can we best improve current excimer laser ablation techniques and technologies?

**Alpíns:** Excimer lasers currently treat irregular astigmatism by trimming off the top of the irregularities, and both sides of the cornea are treated the same. In fact, 33% of patients currently have up to 1 D of astigmatism remaining on the cornea after the laser procedure and 7% have more astigmatism postoperatively than preoperatively when treated by refraction.

Instead, we need an undulating shape change, in the shape of a sine or cosine curve, to make the toric ablation asymmetrical, non-orthogonal, or both. This will allow us to shift around the astigmatism when it cannot be completely removed.

In a study I conducted on 100 patients prior to surgery, I found a statistically significant, directly proportional relationship between the amount of irregularity-measured topographic disparity of astigmatism on the cornea and the non-corneal astigmatism. Therefore, as you realign the two sides of topographic "bow-tie" astigmatism and make them more regular rather than irregular, you also decrease the differences between the simulated keratometry and the refractive astigmatism values.

With shifting of astigmatism, we can improve best-corrected visual acuity up to five or six lines, depending upon what the deficit is in that patient. The potential enabled then by the retinal receptors could provide vision better than 20/10. ☺

## ABOUT THE PHYSICIAN



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# The astigmatic armamentarium

by Brad Fundingsland Managing Editor

*The various forms and etiologies of astigmatism make treatment a challenge. Yet, recent developments have improved the surgeon's ability to deal with this difficult disorder.*

**A**stigmatism can be assessed by a refraction measurement of the visual system or a keratometry measurement of the corneal curvature. Often, these measurements reveal different astigmatism values. Resolving and understanding these values is the first and, perhaps, most important step to treating astigmatism. In the EW interview on page 46, Noel A. Alpíns, MD, in private practice in Melbourne, Australia, provides his expert analysis of astigmatism diagnosis and

explains the fundamentals behind this complex disorder.

One of the first modern surgical treatments for astigmatism included corneal wedge resections, developed by Richard Troutman, MD, and sutures to modify corneal shape by removing tissue and adding tension at different meridians. As techniques advanced, astigmatism correction evolved into corneal incisions intended to relax steep astig-

matic meridians. These incisions were for patients with existing cylinder or astigmatism induced by cataract incision gape.

In 1991, I. Howard Fine, MD, clinical associate professor, Oregon Health Sciences University, Portland, introduced the clear cornea incision. This allowed the surgeon to use the incision's location, size, and shape to correct existing astigmatism and avoid it.

Today, many techniques and technologies are available or are being investigated for the correction of congenital and induced astigmatism. This comprehensive overview will restock the surgeon's armamentarium for treating this complicated visual disorder.

## Pseudophakic astigmatism treatments

### Peripheral arcuate incisions

For several years, physicians have tailored their phacoemulsification incisions to match the patient's existing astigmatic condition and account for any induced astigmatism from the incision. This involved moving around the table to place incisions at different axis locations and alternating between clear cornea and scleral incisions. "This has worked well, but it is ergonomically difficult," said Louis D. "Skip" Nichamin, MD, medical director of the Laurel Eye Clinic in Brookville, Pa.

Therefore, Nichamin and others have turned to a consistently placed single-plane, beveled temporal incision for every cataract procedure. "Keeping this

incision in the 3.5-mm range, we are approaching astigmatic neutrality."

Without any induced astigmatism, cataract surgeons can focus on treating existing astigmatism with supplemental relaxing incisions. Corneal transverse and arcuate incisions at smaller optical zones have been effectively used for a number of years, but, unfortunately, occasional problems can occur. Coupling, the term generally used to describe the ratio of flattening that occurs in the incised meridian as compared with the steepening that results in the opposite meridian, tends to be unpredictable with smaller optical zones, thus impacting the accuracy of IOL power prediction, according to Nichamin. If not perfectly centered upon the steep meridian, conventional (7.0-mm optical zone.) incisions could also lead to a significant shift in the resultant astigmatic axis. Perhaps most important, small optical zones could induce irregular flattening and, hence, irregular astigmatism.

Instead, Nichamin advocates peripheral arcuate incisions placed just inside the vascular arcade at the peripheral-most extent of clear cornea. "These intralimbic relaxing incisions have greatly improved my practice. They are forgiving, heal quickly, and are less likely to induce axis shift. I use these incisions in approximately one-third of my routine phaco cases," he said.

Alpíns agrees that these incisions preserve the sphere, and he performs astigmatic keratotony after cataract surgery. "If you are happy with the spherical equivalent, astigmatic keratotony is an excellent modality for treatment," he said.

While the peripheral location dictates that these incisions must be longer, at a maximum of 90°, long-term data show that they are stable, Nichamin said. Donald R. Sanders, MD, associate professor at the University of Illinois College of Medicine, Chicago, questioned the predictability and possible long-term effect of longer corneal incisions. "By creating a compromised cornea, you will create some weakening," he said.

