PRACTICAL APPROACHES TO THE MANY-HEADED BEAST OF ASTIGMATISM

In this debut column, practitioners discuss at what degrees of astigmatism they adjust their approaches to LASIK and cataract surgery.

BY NOEL ALPINS, AM, MBBS, DO(MELB), FRANZCO, FRACS, FRCOPHTH, FACS; MASSIMO CAMELLIN, MD; MICHAEL GOGGIN, MD; AND DAVID SMADJA, MD, FEBO

It is a pleasure and honor to launch a series of articles on astigmatism for *CRST*. In each article, we will pose an astigmatism-related question to a panel of experts and present their responses. Through the course of the series, the questions will roughly reflect the chapters of my book, *Practical Astigmatism: Planning and Analysis*.[1]

The combination of a number of my publications over the years has come to be called the *Alpins Method*, and it now forms the basis for astigmatism-related reporting in major journals.[2-6] The expert contributors to this column may or may not be familiar with the Alpins Method or may not use it at all; my purpose will be to describe how the method relates to each month's topic and seek the practical viewpoints of the panelists.

ASTIGMATISM BASICS

Ophthalmologists typically think of astigmatism as being against-the-rule or with-the-rule and regular or irregular. Clinically relevant astigmatism is common. Cylinder of 1.00 D or greater, based on manifest refraction, has been reported in 10% to 50% of patients, differing with age and race or ethnicity.[7-11] One study has suggested that as many as 20% of eyes with cataract have at least 1.50 D of corneal astigmatism.[12]

The Alpins Method amounts to a comprehensive analysis system for both corneal and refractive measurements. It provides consistent treatment parameters for ophthalmologists faced with patients whose corneal and refractive astigmatism measurements do not coincide, and it helps users to avoid the potential adverse effects of excess residual corneal astigmatism. It more closely approximates refractive cylinder based on anterior corneal topography (CorT) or anterior and posterior corneal measurements (CorT total) than simulated keratometry or any other corneal measures available. The method could be applied to both sides of a cornea with irregular astigmatism (nonorthogonal and/or asymmetric) in lasers with this capability.

The approach offers insights into corneal coupling. This effect of astigmatism treatment on spherical outcome was previously misunderstood to apply only to incisional techniques. The Alpins Method can also be applied to determine complex treatments of mixed astigmatism, treating myopic and hyperopic astigmatism simultaneously.

MORE TO COME

This series will also address planning for toric IOL implantation and the explanation of (and/or solutions for) refractive surprises that occur even when the surgery was perfectly performed and the implant seems to be in the correct, planned position.

I offer the above as a thumbnail of the Alpins Method, and I thank this month's panelists (and panelists to come) for what promises to be an informative and exciting journey, as astigmatism truly is a many-headed beast.

And now for the first question: As a practical clinical matter, what degree of astigmatism prompts you to adjust your approach in (1) LASIK and (2) cataract surgery, and what adjustments do you make?

MASSIMO CAMELLIN, MD

LASIK and LASEK. I generally prefer LASEK instead of LASIK, but the problem is more or less the same. I set the astigmatism in the platform that I use, the Amaris (Schwind eye-tech-solutions) as measured by refraction. If the cylinder value is more than 2.00 D, I prefer to use custom ablation to improve cyclotorsion control. It is feasible that the eye can rotate during surgery, and 30° of rotation reduces the correction of astigmatism by 100%. It is common to observe 5° of rotation, and even in eyes with a small amount of astigmatism this can lead to an acceptable error (10% residual astigmatism). In short, we must reduce the residual error if the astigmatism is high; otherwise, we can ignore it.

In eyes with internal astigmatism that does not correspond to corneal astigmatism, I prefer to correct midway between the two readings. Usually in these cases the astigmatism is greater than 3.00 D, and is possible to have imperfect results. However, even if the correction is not complete, generally the patients are satisfied.

Cataract and lens surgery. If the astigmatism is with the rule and greater than 2.00 D, and this is confirmed by previous refractions and corneal topography, I usually correct it with a toric IOL. The power is easy to calculate, as it corresponds to the refraction. It is important, however, to determine whether the astigmatism is caused by the lens, in which case it should be ignored. In these cases, there is poor correspondence between refraction and topography.

If the astigmatism is against the rule (previous refraction generally not more than 2.00 D) and the cornea has a spherical shape, I usually implant a toric IOL with 1.50 D astigmatic correction against the rule. In these cases, commonly, it is difficult to predict the perfect axis, but we are satisfied if the residual astigmatism is between 0.50 and 1.00 D due to an imperfect alignment.

In short, I tell patients that it is impossible to achieve perfect emmetropia in many cases. I don't like corneal astigmatic incisions, even those made with a femtosecond laser, because they can lead to higher-order aberrations and a progressive effect, as we have seen over the years with radial keratotomy and conductive keratoplasty. It is possible, however, to reduce small amounts of astigmatism (0.50–0.75 D) by making 3-mm corneal incisions on the steepest refractive axis.

MICHAEL GOGGIN, MD

LASIK and PRK. My basic approach to LASIK or PRK in all eyes with refractive astigmatism with normal corneas is to correct the cycloplegic refractive astigmatism exclusively. I do not attempt to treat more than 5.00 D of refractive astigmatism with corneal ablation.

Treating refractive astigmatism exclusively, of course, sometimes creates increased corneal astigmatism, if the refractive and corneal astigmatism are sufficiently dissimilar. I am aware of Dr. Alpins' work in this area, treating by using some input from the cornea values, but I await independent corroboration of the advantages in corneal shape with no refractive loss that he has reported.

For the present, I continue to rely on the correction picked by the patient during cyloplegic refraction as suiting his or her vision best.

Cataract surgery. As the eyes of patients who have had LASIK and PRK age, I see these patients returning for cataract surgery with increased corneal astigmatism compared with their status before excimer laser ablation because of this approach. These patients need toric IOLs. If their corneal astigmatism had remained unchanged, they might not have needed such lenses. I do not regard this as a clinically significant problem, given the success of toric IOL insertion.

In the past few years, it has become evident that toric IOL outcomes can be improved by accounting for the effect of posterior corneal astigmatism in the calculation of the IOL cylinder.[13] Currently, we are still unable to measure corneal astigmatism accurately, and we rely on nomogram adjustments based on population averages and regression statistics. This may change with the advent of new devices.

In a number of studies of our method including these calculations, we have demonstrated that these adjustments are necessary with lower corneal astigmatism powers but not with higher values.[14-16] In summary of that work, if an eye requires a toric IOL of 2.50 D of cylinder or greater based on anterior corneal astigmatism measurement, the posterior corneal astigmatism effect is below clinical relevance, whereas below this value an adjustment should be made.

DAVID SMADJA, MD, FEBO

LASIK. In laser refractive surgery, the challenge is often to decide which magnitude and axis of astigmatism to treat when there is a significant discrepancy between an eye's refractive and corneal astigmatism. In conventional excimer laser surgery, it is the refractive cylinder that is being treated onto the cornea, which, in many cases, does not correspond to the corneal

astigmatism. The ocular residual astigmatism precisely describes the difference between the refractive and corneal astigmatism, and this measure has been highlighted as a key parameter in astigmatism treatment plans in many reports.[17,18] When treatment is based on refractive cylinder alone, without considering the amount and orientation of corneal astigmatism, this may result in increasing aberrations and decreasing visual quality.[19]

With recent advances in excimer ablation profiles, such as topography-guided profiles, the question of which astigmatism to follow for treatment has been widely discussed. So far, no clear guidelines have been adopted, but our understanding and awareness about the topic has increased, and we know that a large preoperative ocular residual astigmatism is highly correlated to less predictable postoperative outcomes.[17]

Although the concept of using total corneal astigmatism in toric IOL calculation has been widely accepted as best practice for IOL calculation, paradoxically, in refractive laser surgery, practitioners have not adopted this concept. Our group is currently working on adoption and incorporation of new metrics such as CorT, as described by Alpins et al.[20,21] That parameter is based on the total corneal astigmatism measurement, and it has been shown to be closer to the manifest refraction cylinder and therefore to reduce the magnitude of ocular residual astigmatism. Meanwhile, we have adopted the common practice that, in the event of a large disparity in cylinder magnitude, we treat between the refractive and corneal astigmatism according to the 60/40 rule, toward the topographic astigmatism.

Cataract surgery. In cataract surgery, the previously mentioned work on including posterior corneal astigmatism in the IOL power calculation has significantly improved results and changed the rules of the game. It is now commonly accepted that not taking into account the influence of posterior corneal astigmatism in the total corneal astigmatism leads to less accurate outcomes.

In our daily practice, however, we use the endpoint of predicted residual astigmatism, as calculated by various toric calculators, as the key parameter in our decision process. It has been widely demonstrated that residual astigmatism greater than 0.50 D induces a significant decrease in visual acuity and visual quality; therefore, we always target the patient to be under this threshold postoperatively.[22] This calculation is done after incorporating the total corneal astigmatism and the surgeon's own surgically induced astigmatism from the main incision. Patients who will fall over the threshold of 0.50 D of residual astigmatism after simulation through the toric online calculator will therefore be good candidates for toric IOL implantation.

In a recent study, we incorporated the CorT metric, based on total corneal measurement, into our toric IOL calculation.[23] We demonstrated significant improvement, as observed by vector analysis, using this method. Our next step will be to optimize our performance even more by use of newly elaborated regression formulas, such as the Abulafia-Koch or Barrett formula,[24,25] which have been demonstrated to provide more accurate and predictable outcomes than older formulas for toric IOL calculation. ■

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DR. ALPINS REPLIES

The panelists have discussed useful points for measurement of astigmatism and how the multitude of readings can be used in an effective mode of treatment. Two of the three took corneal measurements into account as well as refractive values when planning refractive laser surgery and the third, who seeks an independent evaluation of combining corneal and refractive values, would be assisted with reading the recent work by Maria Arbelaez, MD, published in the *Journal of Cataract & Refractive Surgery*,[1] that compared refractive cylinder treatment with vector planning that also employed corneal values. She found that the vector planning group had superior visual results, less corneal astigmatism, and less refractive cylinder remaining.

There is some existing confusion with how much loss of effect is caused by off-axis astigmatism treatment. The loss quoted by Dr. Camellin is a scalar comparison between postoperative and preoperative astigmatism; the actual loss of correction is much less than this when calculated by vector analysis. When the treatment is misaligned by 30°, for example, only 50% loss of astigmatism correction occurs; this gives the surgeon much more latitude of error for misaligned treatment. A misalignment of 5º causes only 2% loss of correction. For more information on this, the reader may refer to Figures 7A and 7B in a study I published in 1997.[2]

Dr. Smadja's comment bypasses simulated keratometry (SimK) as a reliable measure of astigmatism, which is well-founded. We have all experienced cases in which the magnitude or meridian of SimK is unreliable in the presence of any irregularity. Dr. Smadja makes an excellent point that total corneal power has been adopted in cataract and toric implant surgery, but for inexplicable reasons has been omitted from refractive laser surgery. Anterior corneal topographic astigmatism and total anterior corneal topography (the latter includes the posterior cornea) have been shown to be superior to SimK and other measures when looking for the most accurate corneal reading.

Using a toric calculator to help the surgeon decide which implant to use based on the targeted spherocylinder make a lot of sense. The toric calculator that incorporates the most variables will ultimately end up with the most accurate choice most often.

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NOEL ALPINS, AM, MBBS, DO(MELB), FRANZCO, FRACS, FRCOphth, FACS
- Medical Director, NewVision Clinics, Melbourne, Australia
- Clinical Professor, Melbourne University, Department Ophthalmology
- alpins@newvisionclinics.com.au
- Financial disclosure: Developer and CEO (ASSORT Surgical Management Systems)

MASSIMO CAMELLIN, MD
- Health Director, SEKAL Rovigo Microsurgery Center, Rovigo, Italy
- massimo.camellin@sekal.it
- Financial disclosure: None acknowledged

MICHAEL GOGGIN, MD
- Associate Professor in Ophthalmology at the University of Adelaide, Australia
- Michael.Goggin@sa.gov.au
- Financial disclosure: None acknowledged

DAVID SMADJA, MD, FEBO
- Director Refractive Surgery, Clinical Research and Innovation Unit, Ophthalmology Department, Shaare Zedek Medical Center, Jerusalem, Israel
- smadj.david@gmail.com
- Financial disclosure: None acknowledged