METHOD OF ASTIGMATISM ANALYSIS

Is a refraction-based, wavefront-guided, or topography-guided strategy best?

BY NOEL ALPINS, AM, FRANZCO, FRCOPHTH, FACS; LEELA RAJU, MD; AND MAHIPAL SACHDEV, MD

NOEL ALPINS, AM, FRANZCO, FRCOPHTH, FACS

My method of analyzing astigmatism outcomes uses intuitive parameters to provide an understanding of the success or failure of surgical procedures. It also suggests how treatments could be improved with nomogram adjustments or with realignment in cases involving toric IOLs. Vector mathematics lies at the heart of the process. The necessary calculations occur in the background and use the mathematical constructs of double-angle vector diagrams (DAVD), but the information is presented in a clinically relevant way, using either numerical values or the polar diagrams (0°–180°) to which clinicians are accustomed.

In the past, the fundamental origin of surgical change was derived by noting the difference between pre- and postoperative astigmatism. The change in magnitude and orientation of astigmatism was quantified by the surgically induced astigmatism (SIA) vector to complete the triangle on a DAVD. By introducing the nonzero target that commonly prevails (see the previous Practical Astigmatism column, "The Nonzero Target," http://bit.ly/0519nonzero), the relationships of the target induced astigmatism (TIA) vector, the SIA vector, and the difference vector (DV) become obvious by this triangle's expansion.

The nonzero target identifies the limitations of astigmatism surgery and quantifies it with a vector value, otherwise known as the ocular residual astigmatism (ORA). ORA values that are greater than 0.90 D have been shown to cause adverse visual outcomes, even in the presence of a normal visual acuity of 20/20 or 6/6.

The key element of vector planning is the management of ORA: The surgeon can leave it all on the cornea, as is common with refraction-based strategies; leave it all in the resultant refractive cylinder, as with topography-guided laser strategy; or portion it on the cornea and in the resultant refractive cylinder in a visually beneficial way, with vector planning. The benefits of this technique were demonstrated by Arbeleaz et al.[1]

The questions for the panel are:

No. 1: What proportion of your laser treatments are topography-guided, what proportion are wavefront-guided, and what proportion are based totally on the refraction?

No. 2: What parameters determine whether you treat with a topography-guided, wavefront-guided, or solely manifest refraction-based strategy?

LEELA RAJU, MD

Proportion of treatments. I have used both wavefront-guided and refraction-based laser treatments. The great thing about wavefront-guided is that it allows us to fine-tune the spherical or astigmatic values. In some patients, this can create the high-definition vision result that we want in every case. Alternatively, when we are sure of the quality of the ocular surface, the patient's refraction, and the patient's amount of accommodation, a refraction-based treatment often can result in a successful outcome.

Topography-guided treatments can have wonderful results also, and I look forward to using that approach to treatment in our keratoconus patients who have a stable refraction after CXL or who already have some scarring or irregularity that we can account for.

Parameters of treatments. In eyes that require very little astigmatic correction, I often use a refraction-guided treatment. In the presence of higher-order aberrations (HOAs), I consider topography- and wavefront-guided treatments. In eyes with irregular astigmatism, I incorporate a topography-guided treatment with the understanding that there is an art to deciding on the best treatment for the patient, as described by A. John Kanellopoulos, MD,[2] to achieve the best spherical correction. With the uptick in interest in refractive surgery, savvy patients might look for a treatment that reduces HOAs. Topography-guided treatments offer the potential for patients to achieve their best possible vision.

MAHIPAL S. SACHDEV, MD

Proportion of treatments. Until about a year ago, I performed most of my treatments with a wavefront-optimized approach based

on the manifest refraction, and eyes were left with the same HOA profile they had before treatment. Evidence shows that slight residual coma and spherical aberration can provide increased depth of focus.

Now that we have access to new topography planning systems, I treat a large proportion of my patients with topography-guided treatments. The perceived advantages include correction of HOAs and lower-order aberrations on the cornea, which provides a smoother, more regular corneal surface postoperatively. In the presence of a stable tear film, repeatable preoperative measurements will produce superior outcomes. We have almost entirely given up the wavefront-guided treatment approach due to vagaries in capturing a repeatable and reliable wavefront.

Parameters of treatments. When planning a topography-guided treatment, the quality of the data captured on the WaveLight Topolyzer (Alcon) should be assessed. A good correlation between the scans captured and the scans subsequently used to compute the corneal HOAs is imperative. An ideal head position and a stable tear film can help to ensure accurate corneal imaging.

The next important step is to determine the extent of correlation between the manifest refractive cylinder and the astigmatic error captured by the Topolyzer. For treatment, the axis of cylinder is derived from the Topolyzer if the difference between the two values is 5º or less. The magnitude of astigmatism correction must also be determined by factoring in the posterior corneal astigmatism captured on Scheimpflug corneal tomography and the impact of coma (HOA profile with zero refractive correction) into the Topolyzer astigmatism and correlating it with the manifest cylindrical error. A topography-guided treatment is planned if the factors assessed correlate well. If not, I prefer a wavefront-optimized approach. ■

PROFESSOR ALPINS REPLIES

I commend Dr. Sachdev for his preoperative evaluation of the ocular residual astigmatism (ORA) by correlating the manifest refractive cylinder and the corneal astigmatism. This is key to determine how much astigmatism can be corrected in excimer laser surgery. It is also helpful when explaining the likely astigmatic outcome to patients. They must be advised preoperatively that, because all of the astigmatism cannot be corrected if the ORA is greater than 0.90 D, spectacles might be needed in some situations.

The method of vector planning can maximize the amount of astigmatism correction. In the event that there is more than 5° difference between astigmatism measurements—if manifest refraction is adopted with a wavefront-optimized approach—then the high ORA will result in excess corneal astigmatism and can possibly lead to glare, starbursts, and halos.

When irregular astigmatism is associated with a correctable spherocylinder that provides a visual acuity of 20/20 or better, a PRK treatment could potentially reduce spherocylindrical myopic correction and improve UCVA and BCVA. These patients' eyes may have subclinical or mild keratoconus, which usually demonstrates larger discrepancies between corneal and refractive cylinder values quantified by the ORA. Whereas the average ORA in healthy astigmatic eyes lies somewhere between 0.73 and 0.81 D,[1,2] in the presence of keratoconus, on average, the ORA is 1.34 D.[3]

Less astigmatism on the cornea in the presence of an irregularity such as keratoconus is beneficial, as the regular component of astigmatism is not well tolerated when irregularity coexists. This would explain previous suboptimal results in the early days of PRK on keratoconic eyes when only refractive parameters were used in the treatment.

When topographic data is used either alone or combined with refractive parameters, the target spherical equivalent is an exact mathematical exercise with vector planning, with little requirement for physician adjustments, as is required with Dr. Kanellopoulos' approach. However, coupling factors need to be included, particularly when mixed astigmatism is present. Corneal coupling and mixed astigmatism will be discussed in a future installment of the Practical Astigmatism series.[4]

1. Alpins NA. New method of targeting vectors to treat astigmatism. *J Cataract Refract Surg*. 1997;23(1):65-75.
2. Alpins NA. Astigmatism analysis by the Alpins method. *J Cataract Refract Surg*. 2001;27:31-49.
3. Alpins NA, Stamatelatos G. Customized photoastigmatic refractive keratectomy using combined topographic and refractive data for myopia and astigmatism in eyes with forme fruste and mild keratoconus. *J Cataract Refract Surg*. 2007; 33:591-602.
4. Alpins N. *Practical astigmatism planning and analysis*. SLACK Incorporated; Thorofare, New Jersey; 2018.

1. Arbelaez MC, Alpins N, Verma S, Stamatelatos G, Arbelaez JG, Arba-Mosquera S. Clinical outcomes of laser in situ keratomileusis with an aberration-neutral profile centered on the corneal vertex comparing vector planning with manifest refraction planning for the treatment of myopic astigmatism. *J Cataract Refract Surg*. 2017;43(12):1504-1514.
2. Kanellopoulos AJ. 10 year outcomes of CXL combined with partial topo-guided excimer laser (TGL) Athens protocol (AP) for keratoconus (KC). Paper presented at: the ESCRS Winter Meeting; February 15-17, 2019; Athens, Greece.

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

LEELA RAJU, MD
- Clinical Associate Professor, NYU Langone Health, New York
- rajulv25@gmail.com
- Financial disclosure: None

MAHIPAL S. SACHDEV, MD
- Chairman, Medical Director, and Senior Consultant Ophthalmologist, Centre for Sight, New Delhi, India
- Professor of Ophthalmology, T.S. MISRA Medical College, Lucknow, India
- drmahipal@gmail.com
- Financial disclosure: None