MINIMIZING THE EFFECT OF BABEL

Inconsistent terminology renders the challenging subject of astigmatism more complex.

BY NOEL ALPINS, AM, FRANZCO, FRCOPHTH, FACS; HERBERT REITSAMER, MD; AND BRYAN S. LEE, MD, JD

NOEL ALPINS, AM, FRANZCO, FRCOPHTH, FACS

Few would disagree that the subject of astigmatism is complex. In developing my method of treatment and analysis, I tried to resolve this complexity by incorporating both corneal and refractive approaches into a single consistent paradigm.

Inconsistencies in terminology that confuse rather than clarify can make a challenging subject more difficult, leading me to refer to the Tower of Babel in this article's title and in my earlier work.[1] In the second installment of this series, Jorge L. Alió, MD, PhD, FEBOphth, cited our joint opinion piece on consistent astigmatism terminology for better outcomes, an essay that I think is worth reading.[2] One need only consider the numerous alternative terms for ocular residual astigmatism, each of which relates to different phenomena of astigmatic assessment. Sir William Stewart Duke-Elder, GCVO, FRS, FRCP, FRCS, coined the term *residual astigmatism* in the fifth volume of his *System of Ophthalmology*.[3] This concept formed the basis of the descriptive term *ocular residual astigmatism*. Confusing matters, some surgeons now use the term *residual astigmatism* to describe the astigmatism that remains or results after surgery.

Sign convention is another crucial aspect of astigmatism and vector analysis; an error in sign can mean a difference of 90º and confuse analysis. Norman S. Jaffe, MD, and Henry M. Clayman, MD, effectively mandated that vectors should not and cannot in practice be negative, and it makes sense that corneal astigmatism should abide by the same rule. It is accepted practice for refractive cylinder to have either a positive or negative sign, but convention is to maintain a positive magnitude for corneal astigmatism.

The terms *axis* and *meridian* are specific to cylinder and the cornea, respectively. The representative symbols are x and @, respectively, and, for a vector axis, the symbol is Ax. Mixing symbols can cause confusion.[4]

For any astigmatic analysis, three principal vectors are required—the target induced astigmatism vector, the surgically induced astigmatism vector, and the difference vector. The difference vector has been a part of the vernacular for 25 years and has been recognized as necessary by several journals.[5] An error in toric IOL assessment, however, is commonly described as a prediction error, yet these two terms describe the same parameter.

Questions for the panel:

No. 1: What term do you use to describe the astigmatism remaining in the manifest refraction postoperatively?

No. 2: How does this term differ from how you describe the difference between refractive and corneal astigmatism?

HERBERT REITSAMER, MD

My colleagues and I use the term *postoperative astigmatism* to describe the astigmatism remaining in the manifest refraction after surgery. This is the manifest astigmatism resulting from all intentional interventions and unintentional influences (the presence of unexpected astigmatic residual refractive errors as well as factors that may add to the variability of surgical results and limit the predictability of refractive corrections). In our terminology, it is the patient who defines real zero, not refractive zero. We use a corneal topographer (Keratron, Optikon) to measure anterior corneal elevation, and we use the wavefront technologies of the Pentacam (Oculus Optikgeräte) and iDesign Advanced WaveScan Studio System (Johnson & Johnson Vision) for both anterior and posterior corneal surface analysis.

If corneal astigmatism is between 0.75 and 1.75 D, we perform femtosecond laser–assisted intrastromal keratotomy based on preoperative biomechanical calculations using Optimeyes (Optimo Medical, not available in the United States). If the measured corneal astigmatism is greater than 1.75 D, we implant a toric IOL. Our goal is to reduce corneal residual astigmatism to a slight undercorrection with no shift in axis. Clinical follow-up is performed

1 day, 1 week, and 1 month after surgery. We typically consider follow-up to be complete if the patient is satisfied with his or her postoperative visual acuity and astigmatism.

Vector analysis is essential to any advanced investigation. Stable measurements can be obtained no earlier than 1 month after surgery. We compare the measured and calculated mathematical parameters using Optimeyes and the iAssort software (Assort Surgical Management Systems, a vector analysis program developed by Dr. Alpins).

As for terminology, the difference is that our chosen wording, *postoperative astigmatism*, adds a subjective component to refractive astigmatism. Variables that were present at the time of surgery (eg, corneal markings, surgical adjustment errors, and variations in tunnel length, depth, and incision) or incidental events after surgery such as wound healing can be measured, are a part of the induced corneal astigmatism, and result in prediction errors. Other parameters such as irregular areas and adaptation to higher-order aberrations can also influence outcomes.

Corneal residual astigmatism can be displayed only to a limited extent using wavefront technology, but total astigmatism can differ. One may find astigmatic aberrations in addition to measured refractive astigmatism. Such aberrations may necessitate a secondary adjustment, even when objective markers show a successful result.

BRYAN S. LEE, MD, JD

Postoperative corneal astigmatism combines preoperative corneal astigmatism (including posterior corneal astigmatism) and astigmatism induced by surgical incisions. By definition, it does not include lenticular effects, which can arise from implantation of a toric IOL or from additional factors such as IOL tilt.

If *refractive astigmatism* is defined as the manifest refraction after surgery, then the difference between refractive and corneal astigmatism will come from the lenticular astigmatic component. In contrast, I view *residual astigmatism* as a holistic term that takes into account the target. Refractive astigmatism after surgery may be 0, for instance, but if the target left the patient with 0.25 D of with-the-rule cylinder, then there is some residual astigmatism. ■

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PROFESSOR ALPINS REPLIES

The term *postoperative astigmatism*, as used by Prof. Reitsamer, is certainly clear in its meaning, as are *remaining* or *resultant astigmatism*. Dr. Lee correctly stated that, when there is plano cylinder but 0.25 D of corneal astigmatism, then some astigmatism is left—a common situation—and this is termed *ocular residual astigmatism*.

Looking narrowly at only corneal or refractive cylinder can be misleading when assessing the overall situation, which makes Prof. Reitsamer's point in his final paragraph pertinent. That is, when corneal astigmatism remains after a refractive procedure, as it usually does when LASIK is performed using 100% refractive parameters (the traditional and most common approach), then corneal cylinder can be excessive. It is greater than 1.00 D in more than 30% of eyes[1,2] and exceeds preoperative corneal astigmatism in 7% of eyes[2] because ocular residual astigmatism is neutralized on the cornea.[3]

When this excess is measurable postoperatively with wavefront aberrometry, the patient likely sees glare and halos at night as well as occasional image doubling. This situation is likely the origin of the patient dissatisfaction occasionally reported in the lay press. When high ocular residual astigmatism exists preoperatively and is displayed with the iAssort software, excessive corneal astigmatism can be avoided with vector planning. This treatment mode will be discussed in more detail in a future installment of this series.

Incisional keratotomy, whether by laser intrastromal techniques or manual incisions made with a diamond blade, has a useful place in the refractive armamentarium. When there is less than 2.00 D of corneal astigmatism, a strong argument can be made for creating a spherical cornea (ie, via keratotomy) and implanting a spherical IOL rather than leaving the corneal astigmatism and implanting a toric IOL.

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