Corneal versus refractive astigmatism: integrated analysis

by Noel A. Alpins, FRACO, FRCSoph, FACS
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Editor’s note: This article, by Noel A. Alpins, FRACO, FRCSoph, FACS, is the third in a series of articles that Ocular SURGERY NEWS plans to publish in its specialty surgery series.

The genesis of my approach to astigmatism treatment stems from the premise that the anatomic condition that existed in the way I was taught to approach astigmatism surgery - Spencer Thornton and other early investors in laser surgery - did not sufficiently reflect our use of astigmatic keratotomy (AK) incisions on the steepened corneal meridians. Later, the laser manufacturers and their medical investigators recommended placement of the astigmatic correction on the axis of refractive astigmatism, which in many patients differs significantly from corneal astigmatism. Some AK surgeons also advocate this approach. Should treatment be based on corneal or refractive astigmatism? I wondered.

Answering that question led me to a realization of the importance of comparing corneal and refractive measurements separately - and described a link between them - utilizing vector planning.

With AK, the pendulum swung in favor of corneal astigmatism. With laser procedures, the pendulum swung to refractive astigmatism. Manufacturers now appear ready to link corneal topography to excimer excimer laser, which can contribute prior wisdom and ignores valuable information provided by refractive astigmatism values.

With my approach, the pendulum need not swing all the way back to a reliance solely on corneal shape as a determinant of treatment. My method provides a way to merge diagnostic (topography), therapeutic (laser) and analytic (vector analysis) functions into an integrated refractive surgical approach.

Basic concepts

The mathematics of my method are described in previous papers (see references at end of article), therefore, I will not go into detail here. Some basic concepts, however, must be understood.

Figures 1, 2, and 3 demonstrate how my approach can be used in treating a patient who has a discrepancy between topographic astigmatism (T) and refractive astigmatism (R). If the surgeon treats with 100% emphasis on eliminating the refractive astigmatism, obviously some corneal astigmatism will remain. I have described the separation (vector) between T and R as ocular residual astigmatism (ORA) - the least astigmatism remaining that can be achieved in any individual eye. This quantity has, in the past, been termed "residual astigmatism." But using this term might not compare with the same term often used to describe the amount of astigmatism remaining after surgery. Of course, corneal astigmatism can be measured with keratometry or topography. For purposes of this discussion, I refer to the simulated keratometry value of the topography only.

The ORA is equivalent to magnitudes due to the refractive (Figure 1) and topographic (Figure 2) targets when treating by topography and refractive values, respectively. The maximum correction of astigmatism is achieved when the remaining astigmatism is at its minimum (the minimum target astigmatism) and it is equal to the ORA. This remaining astigmatism will be refractive, topographic or a combination. My method enables one to calculate the ORA as well as the parameters (laser setting) to emphasize the elimination of 100% of T, 100% of R or any combination of T and R equaling 100%, while leaving the absolute minimal amount of astigmatism in a patient’s refractive system and its optical correction.

I also have described "optical treatment," which is the treatment based on calculations that put more surgical emphasis on the elimination of topographic astigmatism the more "unfavorable" the astigmatism falls on the cornea. Using this approach, the surgeon can choose which orientation he or she believes is "in Favorable." Current thinking would suggest favoring with-the-rule (WTR) astigmatism, putting more surgical emphasis on eliminating corneal astigmatism that is calculated in advance to fall against the rule (ATR).

Widespread issues

I believe it is common for people to demonstrate disparities between their corneal and refractive astigmatism in magnitude or axis or both, which lends importance to an integrated approach. In my paper "New method of targeting vectors to treat astigmatism" (J Cataract Refract Surg. 1997;23(1):43-50), I report proscriptive readings from 100 consecutive patients on whom I subsequently performed photoablation refractive keratectomy. Computing careful manifest refraction calculated at the corneal plane to simulate keratometry values taken with the TMS corneal topography system (Computed Anatomy Inc, New York), the mean magnitude of topographic astigmatism exceeded refractive astigmatism in 59 patients; in the remaining 41, refractive astigmatism was greater.

Third, as one would expect, the ORA increased directly in proportion to increasing differences for both T and R magnitude and axis. As long as there are two fundamentally different ways of measuring astigmatism, then current treatment modalities must address the most effective way to deal with these differences adequately.

Some people attribute the differences between corneal and refractive astigmatism to measurement errors, others refer to it as an "anatomical astigmatism." In my opinion, these explanations do not explain or address the means to deal with the differences adequately. Astigmatism can be introduced at any or all of the optical interfaces - from the lens to the cornea, the back of the cornea, the front surface of the lens, the lens itself, the back of the lens, the vitreous and iridescent stimulus as well as the visual cortex of the brain which is often overlooked as having an overriding conscious control over the fine-tuning of any final vision of the eye.

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References: