Excimer Laser Surgery Planning

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Cataract and refractive surgeons are accustomed to considering corneal shape as the primary determinant in planning the type and placement of their cataract or keratotomy incisions to achieve a spherical cornea. However, when these surgeons introduce laser technology into refractive practices, they may be uncomfortable in the knowledge that, despite an unchanged surgical goal of eliminating the need for glasses by changing the corneal shape, their underlying surgical paradigm now disregards the corneal shape and their treatment is determined by refractive astigmatism.

Variance between spectacle and corneal astigmatism both in magnitude and axis is widely prevalent, and the consequences of this variance is that an inevitable amount of astigmatism remains. I am frequently asked the question, "If our goal is get rid of glasses, why not use the refraction as the only treatment parameter for both cylinder and sphere?" The answer is not difficult to find, by targeting a zero spherical equivalent for the correction of spherical myopia, the goal of eliminating spectacles is largely taken care of. However, by sculpting the spectacle astigmatism onto the cornea, residual astigmatism is maximized, which is contrary to the established and conventional principles of corneal surgery.

We can determine the optimum result in each eye by employing two generally accepted principles: that less corneal astigmatism is preferable to more; and that if residual astigmatism is unavoidable, a with-the-rule orientation is preferable to against-the-rule. By using the targeted residual corneal astigmatism as the guiding surgical paradigm, rather than the two preoperative astigmatisms, then all astigmatism surgeons, whether they use blade or laser technology, will be operating on the same axis, attempting to correct the same amount of astigmatism.

All forms of refractive surgery would then come under one common principle of treatment — to assess the effect of proposed change in astigmatism on both refraction and corneal shape.

Practical Astigmatism Analysis for the PRK and AK Surgeon

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The principle underlying the planning and analysis of astigmatism surgery is simple. The intended path of the surgery is the Targeted Induced Astigmatism (TIA) vector. The actual path taken is the Surgically Induced Astigmatism (SIA) vector. The difference vector measures the force and its orientation still required to achieve the initial goal. It is the various relationships between the SIA, TIA and difference vectors that tell us whether the treatment was on or off axis, or whether too much or too little force was applied and how to adjust for it.

The TIA is the key that provides the essential link enabling an analysis to be performed both at the corneal and spectacle plane. While astigmatism analysis is adequate for determining what has happened (SIA), whether or not a particular astigmatic change was intended, until now our analysis systems have not compared how what has happened differs from what we wanted to happen. Comparing pre-operative and post-operative astigmatism values ignores any change in the astigmatism's axis and consequently is misleading, because it inevitably renders all imperfect corrections to be "undercorrections." It does not identify the separate "errors" of magnitude and axis.

Analyzing astigmatism results by topography as well as refraction is an essential step in monitoring the changes at the surface where they arise. By using the TIA, our topographical targets are now calculable. This has not been possible until now because where the goal has been to treat solely by refraction, we have not been targeting spherical cornea. The trend now emerging when performing laser astigmatism surgery is that significant differences exist in our results when comparing those achieved by refraction with the changes measured on the cornea, where they are actually occurring.