Excimer Laser Correction of Astigmatism: Consistent Terminology for Better Outcomes

The performance of laser vision correction with the refractive laser has become a routine practice for the refractive surgeon and an established procedure in mainstream ophthalmology. The safety and effectiveness of the technology have promoted the approval of the procedure by regulatory agencies and acceptance by most of the general public. However, patients' opinion of this discretionary surgical intervention is not always positive.[1-3] The impact on the overall demand for the surgery may be disproportionately reduced because dissatisfied patients (4.6% in a study by Solomon et al.[3]) may discourage many eligible candidates.

The elements that cause persistent postoperative visual difficulties are multifactorial[1] and difficult to predict prior to surgery. However, inadequate astigmatism correction is a frequent reason for reoperation and may influence the quality of vision obtained from the initial surgery.[4] Fortunately, the risk of remaining postoperative astigmatism is one of few issues that can be properly addressed preoperatively. In our opinion, if astigmatism and its modes of treatment were properly addressed using the most up-to-date treatment paradigms, the near 5%[3] rate of "less-than-satisfied" patients could be substantially reduced.

Laser refractive treatments are mostly based on refractive parameters such as manifest refraction or aberometrically derived wavefront astigmatism. Corneal astigmatism parameters, whether derived from computer-assisted video keratography or manual or automated keratometry, normally play no part in the spherocylindrical ablation plan. This would appear paradoxically to disregard corneal surgical principles that apply when an incisional surgical treatment is planned for the cornea. The modes to evaluate and measure astigmatism by corneal and refractive values fundamentally differ. Therefore, their gauging by magnitude and orientation will inevitably differ from one another, no matter how accurate the measurements are or how closely their acquisitions are aligned. Furthermore, the refractive cylinder includes the visual cortex component and the optical system of the eye, whereas corneal astigmatism is confined to the cornea alone. Any treatment that is based on one element of measurement, such as refractive, to the exclusion of the other (corneal) by definition cannot negate the discrepancy, and either approach performed without consideration of the other by definition cannot result in zero astigmatism.

Corneal refractive differences have been evident for a long time and were termed "residual astigmatism" by Duke-Elder.[5] The parameter was first described vectorially with a magnitude and axis orientation by Alpins,[6] who introduced the term ocular residual astigmatism (ORA) to differentiate the traditional term from the commonly used term "residual" astigmatism or astigmatism remaining after surgery. There have been several terms used to describe the differences between corneal and refractive astigmatism values, most of which attribute them entirely to ocular phenomena and are referred to as "intraocular," "lenticular," "noncorneal," or "internal" astigmatism. In fact, not only do their origins lie in optical contributions from the various refracting surfaces within the eye, but there are also non-optical perceptual components of the phenomena that contribute to the resultant cylinder.[6-8] The impact of this often unrecognized component is important. The ORA parameter encompasses all factors contributing to corneal refractive differences. It quantifies the amount and orientation of astigmatism to be neutralized on the cornea when treatment is performed entirely by refractive parameters.[6]

In healthy astigmatic populations, the average amount of ORA in patients undergoing spherocylindrical treatment for laser vision correction ranges from 0.81[6] to 0.73[8] diopters. The mean ORA was 1.34 diopters[9] in eyes with form fruste and mild keratoconus and even higher in eyes with keratoconus of a more severe degree.[10,11] Recent studies demonstrated that eyes with high ORA have poorer visual outcomes, a higher amount of corneal astigmatism remaining, and an increase of lower and higher astigmatic aberrations[12] after laser vision correction than those with low ORAs.[13,14] Furthermore, the consequence of high ORA is its association with greater corneal irregularity.[10,11]

Calculating the ORA prior to surgery thus is crucial in counseling patients to expect realistic outcomes when pretreatment ORA exceeds average levels. This knowledge helps to reduce or avoid dissatisfaction posttreatment.

We should also recognize that terminology in the astigmatism arena is confusing and ambiguous. The astigmatism left after a surgical procedure in common practice is often termed "residual astigmatism" and this occasionally spills over into published material. This use conflicts with the term in use for more than 50 years since Duke-Elder's description of a different phenomenon. Alternative terms for astigmatism left after surgery such as "remaining," "resultant," or "surgical residual astigmatism"[6] should be considered. Furthermore, to avoid confusion in the terms, new devices such as the Ocular Response Analyzer (Reichert Technologies, Depew, NY) are best referred to in their full description without resorting to abbreviations (the style manual of the American Medical Association discourages the use of acronyms of any terms in which there might be misinterpretation).

There is a compelling need to further study potential adverse effects of astigmatism when neutralizing all of the ORA on the cornea. There appear to be improved visual outcomes in both healthy[12] and keratoconic[9] eyes when excess corneal astigmatism is reduced by the use of vector planning.[6,9,12-14]

The process of preoperative vector planning developed by Alpins[6,9,12-14] addresses these issues in an optimized manner: it includes corneal astigmatism parameters in combination with the refractive cylinder value. This process provides the benefit of substantially reducing the corneal astigmatism remaining after surgery (by 40% to 50% or more), with potential visual and refractive cylinder improvement. Preoperative vector planning deserves further study to assess its ability to avert adverse outcomes in patients at risk with higher than normal ORAs.

Accurate astigmatism management is likely to be one of the final frontiers in astigmatism treatment with photoablative techniques. We need to reduce the percentage of dissatisfied patients to a more acceptable level of 1% or less. In both astigmatism treatment and terminology, there are critical issues of systematized treatment planning and professional communication that need to be addressed.

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