Topography-guided LASIK: A paradigm shift in refractive laser treatment

by Doyle Stulting, MD, PhD

Refractive surgery has advanced significantly in the past 2 decades. When it was first introduced, we were able to reduce or eliminate patients’ dependence on glasses or contact lenses. In exchange for spectacle independence, however, patients sometimes had to accept less than 20/20 uncorrected visual acuity (UCVA) and induced visual aberrations. Today, topography-guided treatment LASIK, with the WaveLight Allegretto Wave Eye-Q Laser (Alcon, Fort Worth, Texas) can provide not only freedom from glasses and contact lenses, but also improved quality of vision.

There are several differences between topography-guided customized LASIK and wavefront-guided customized LASIK. Wavefront-guided customized LASIK has traditionally been based on wavefront measurements obtained by projecting multiple light beams into the eye and measuring the location of the corresponding light reflected from the retina. With topographers, we can measure many more points of curvature on the cornea over a wider area than is possible with wavefront measurement devices. For example, the Topolyzer (Alcon), used in conjunction with the WaveLight Laser, measures corneal curvature at approximately 22,000 locations on the cornea, while the WaveLight wavefront analyzer (Alcon) measures only 168 sites, and the WaveScan (Abbott Medical Optics, Santa Ana, Calif.) measures only 240 points per WaveScan technology specifications.

Another benefit of topography is that measurements are not limited by the pupil. Wavefront measurements require light to reach the retina through the pupil, so the size and location of the pupil limits the area that can be measured. In contrast, corneal topographic measurements can be applied to the entire cornea.

Additionally, highly aberrated eyes and those with corneal opacities can produce inaccurate aberrometer measurements because aberrometers cannot always identify the source of light leaving the eye and because light may be scattered by the corneal opacities. In contrast, topography-guided treatment can be used successfully to evaluate highly aberrated eyes.

Aberrometer measurements are also affected by the state of accommodation (which can induce higher-order aberrations in addition to spherical refractive changes), early cataract, and vitreous opacities. Surgical correction of lenticular high-order aberrations can be problematic because they tend to change with time. Additionally, wavefront-guided treatments do not necessarily compensate for off-axis rays of light passing through lenticular opacities from different locations on the cornea.

Because corneal topography does not provide information about low-order optical abnormalities of the eye—spherical error and regular astigmatism—topography-guided refractive treatments cannot be based on corneal topography alone. For topography-guided treatment, refractive measurements of the eye’s optical system must be obtained independently of topographic measurements. Topography-guided treatment software combines both refractive and topographic information to generate the pattern of laser shots that will improve vision.

Study summary
The Topography-guided Treatment Study Group recently investigated the visual outcomes of topography-guided LASIK. This prospective, non-randomized study was performed at 9 clinical sites in the United States and included 249 eyes of 212 patients with myopia or myopic astigmatism treated with topography-guided LASIK using the WaveLight Allegretto Wave Eye-Q Laser. Outcome measures included manifest refraction, UCVA, best spectacle-corrected visual acuity (BSCVA), visual complaints, adverse events, responses to questionnaires, and complete ophthalmologic examinations.

Patients included in this study were between the ages of 18 and 65 years (mean: 34 years) and had up to –9.0 D of spherical equivalent myopia at the spectacle plane with up to 6.0 D of astigmatism, correctable to at least 20/25 in each eye.
Forty-four percent were men, and 56% were women. Eyes with prior refractive surgery, significant lenticular astigmatism, abnormal topographies, a calculated residual stromal bed thickness less than 250 µm, or other ocular pathology that might affect the results of LASIK were excluded.

Postoperative examinations were performed at day 1, week 1, and months 1, 3, 6, 9, and 12. Visual acuities and refractive errors were measured with the Early Treatment Diabetic Retinopathy (ETDRS) charts and protocol.

The study found that topography-guided treatment resulted in a significant reduction in manifest refraction spherical equivalent (MRSE) and cylinder, reaching stability at 3 months after treatment. Mean MRSE was 0.06±0.33 D at 3 months and 0.00±0.27 D at 1 year. Mean cylinder was 0.19±0.32 D at 3 months and 0.19±0.30 D at 1 year. Three months postoperatively, 91.9% of eyes were within 0.50 D of plano, and at 1 year, 94.8% of eyes were within 0.50 D of plano.

At 3 months postoperatively, 7.7% of eyes saw 20/10 or better without correction; 31.6% of eyes saw 20/12.5 or better; 68.8% of eyes saw 20/16 or better; 92.7% of eyes saw 20/20 or better; and 97.2% of eyes saw 20/25 or better. At 1 year, 15.7% of eyes saw 20/10 or better without correction; 34.4% of eyes saw 20/12.5 or better; 64.8% of eyes saw 20/16 or better; 92.6% of eyes saw 20/20 or better; and 96.5% of eyes saw 20/25 or better. Eyes treated with topography-guided treatment achieved an improvement in UCVA compared to preoperative UCVA, with 29.6% of eyes gaining 1 or more lines of UCVA, and 89.9% of eyes achieving an improvement in UCVA. I feel that topography-guided treatment LASIK treatment again.

The results of this study exceeded our expectations. We thought that we would see good outcomes but did not think that topography-guided treatment on “normal” eyes without significant topographic abnormalities would exceed the outcomes we are accustomed to seeing with currently available treatments. To our surprise, we found excellent UCVA, significant improvements in BCVA, and a reduction in visual symptoms. In fact, a majority of eyes had better postoperative UCVA than preoperative BCVA. I feel that topography-guided treatment should be considered as a first-line treatment for the reduction of myopia and astigmatism within the approved FDA ranges.

We have come a long way with corneal refractive surgery in the past 2 decades. The days when we had to warn patients that loss of BCVA and visual aberrations might be the price they would have to pay for spectacle independence have passed. With topography-guided treatment, we should tell our patients there is an excellent likelihood that they will have better vision without correction than they had preoperatively with correction and that the quality of their vision is likely to improve.

We can now be confident that topography-guided treatment is likely to have a positive impact on quality of life of our patients.

Reference
1. Summary of Safety and Effectiveness Data PMA P020050/S12

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