Topography-Guided Laser Surgery

A promising treatment for a variety of refractive challenges.

BY SIMON P. HOLLAND, MB, FRCSC, AND DAVID T. C. LIN, MD, FRCSC

Topography-guided laser systems have been available outside the United States for 10 years, and these products are in various stages of the FDA approval process. A major advantage of a topography-guided over a wavefront-guided laser relates to capturing images in highly aberrated corneas. The latter type of laser may not be able to obtain an image due to complications of previous refractive surgery, for example. In mildly aberrated or normal corneas, however, the two types of systems produce comparable results.[1] The topography-guided platform with which we have the most experience is the Allegretto Wave Eye-Q excimer laser system with T-CAT (topography-guided custom ablation treatment) software (Alcon Laboratories, Inc.). Some of the other units currently available outside the United States are the CRS-Master (Carl Zeiss Meditec AG), Nidek Navex Quest (Nidek Co., Ltd.), and the iVis Suite (iVis Technologies).

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Indications for topography-guided laser surgery include complications from refractive surgery, postkeratoplasty astigmatism, and highly irregular astigmatism. Corneal collagen cross-linking (CXL) has expanded the applications of topography-guided laser surgery to the correction of ectasia and keratoconus.

Topography-guided platforms use a Placido disk, Scheimpflug photography, or a combination of both methods to capture images, which the systems analyze to correct corneal shape via proprietary logarithms that use customized variables such as optical zone and tilt. Any alteration in shape will cause a change in power, which previously required a second refractive laser treatment if there were sufficient tissue. We have found customized topographical neutralization, done simultaneously, to be effective in correcting induced refractive

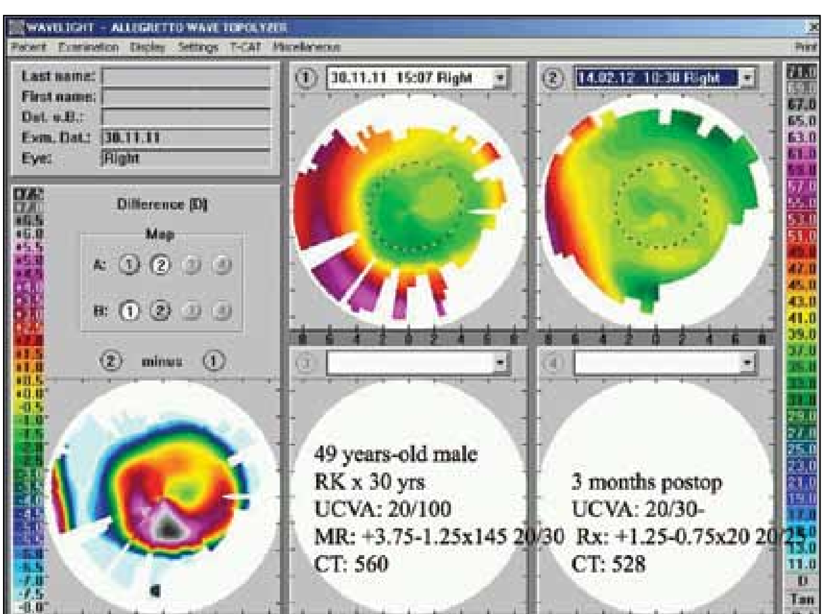

Figure 1. Topography-guided PRK on an eye with a history of RK.

error from the topography-guided treatment with added manifest refraction.[2]

COMPLICATIONS OF REFRACTIVE SURGERY

Expanding the Optical Zone and Correcting Decentered Ablations

Topography-guided laser surgery has been highly effective for improving the symptoms of glare, halos, and poor night vision by expanding the optical zone.[3,4] Compensation is predictable, because the ablation is usually symmetrical and the induced myopia can readily be treated in a combined procedure. Patients whose original laser ablation was decentered are usually highly symptomatic with high coma but can be successfully treated through a one-step procedure that corrects induced cylinder. We were able to reduce these patients' symptoms and recenter the ablation zone from a mean of 0.9 to 0.3 mm in a series of 67 eyes.[2]

After Previous RK

US surgeons are seeing an increasing number of RK patients for cataract surgery due to aging demographics often associated with decreasing contact lens tolerance and progressive irregular hyperopic astigmatism. Topography-guided laser surgery may help in these challenging cases (Figure 1), but in our experience, the procedure is probably better performed before than after cataract surgery. Any residual refractive error can then be corrected during the cataract procedure.

We usually perform PRK on these eyes to avoid flap-related problems and apply mitomycin C for longer than on virgin eyes. The role of CXL for eyes with a history of RK is controversial and requires further study.

ASTIGMATISM AFTER KERATOPLASTY

Topography-guided laser surgery may be a better choice than standard treatment for eyes with high degrees of irregular astigmatism after keratoplasty, because the former modality improves symptoms with less regression and decreases higher-order aberrations (Figure 2).[5] That said, we were not able to show a statis-

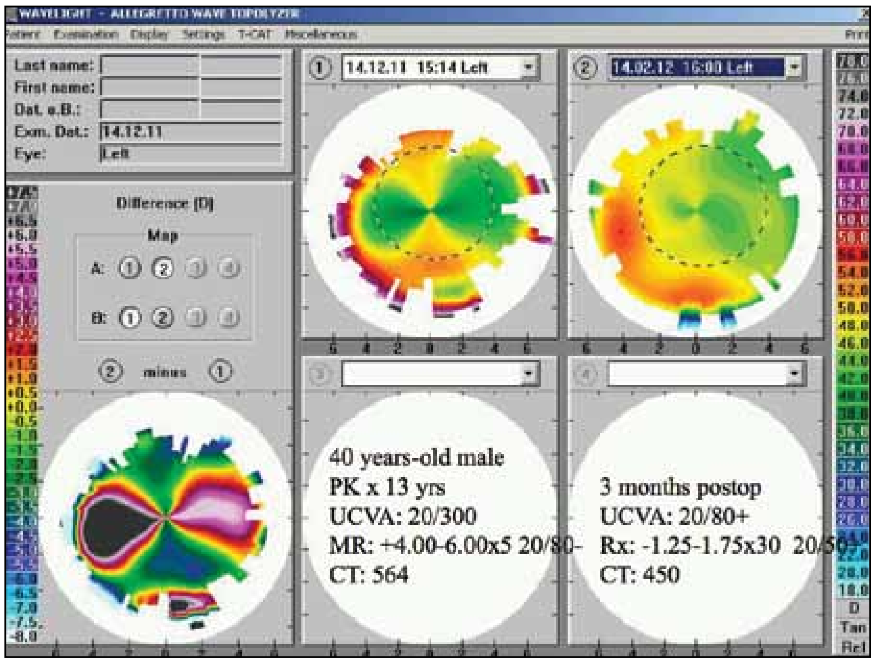

Figure 2. Topography-guided PRK to treat postkeratoplasty astigmatism.

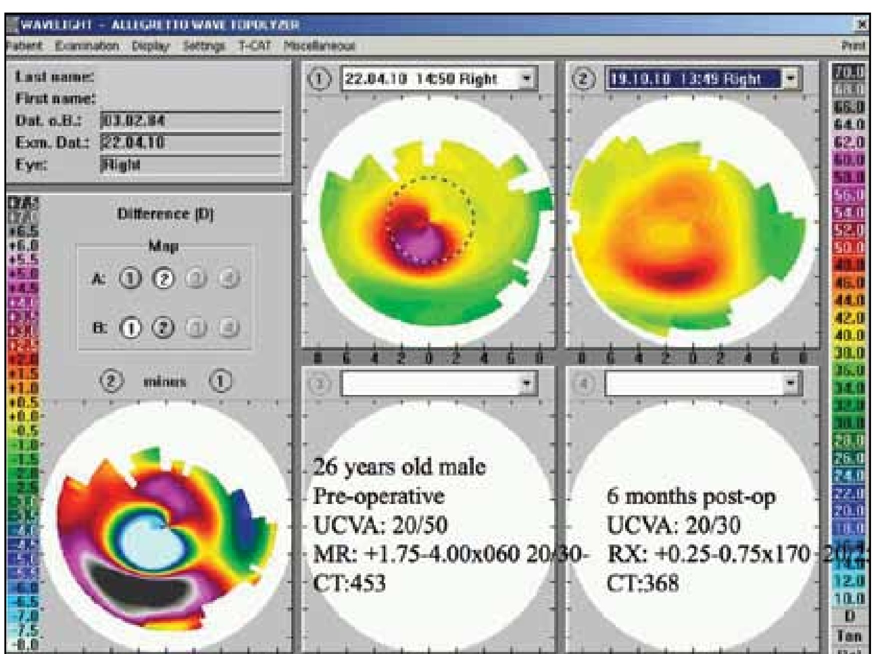

Figure 3. Topography-guided PRK for keratoconus.

tical difference between procedures in our recent series of 63 cases (34 topography guided, 29 standard treatment), but the eyes that underwent topography-guided laser surgery achieved a better UCVA and BSCVA with a greater gain of 2 lines of vision than the wavefront-optimized group.

KERATOCONUS

Although not yet available in the United States, CXL is revolutionizing the management of keratoconus abroad. Because CXL increases the cornea's tensile strength, the procedure permits topography-guided PRK to improve corneal shape and treat refractive error in a wide range of keratoconic patients. Surgeons are using both simultaneous and sequential CXL with topography-guided PRK, but interest in simultaneous treatment is rising.[6]

We have simultaneously performed CXL and topography-guided PRK on 290 patients in the past 3 years (Figure 3).[7] Our protocol was as follows. The postoperative target of topography-guided PRK using the Allegretto Wave Eye-Q excimer laser system with T-CAT software, modified by topographical neutralization was -1.25 D, with a minimal residual stromal depth of 300 µm. We removed the epithelium with transepithelial phototherapeutic keratectomy.[2] We instilled riboflavin 0.1% in dextran until aqueous staining was achieved. Irradiation with ultraviolet light (370 µm, 3 mW/cm^2/5.4 J/m^2) ensued for up to 20 minutes, with hypotonic riboflavin 0.2% in sterile water used as necessary if pachymetry measured less than 400 µm. We then placed a bandage contact lens and followed our standard regimen for post-PRK management.

One year postoperatively, 58% of patients (n = 72) had a UCVA of 20/40 or better, 92% had a BCVA of 20/40 or better, and 60% had experienced an improvement in BSCVA of 1 line or more. Two eyes lost 2 or more lines of vision. Mean astigmatism decreased from -2.87 D preoperatively to -1.40 D postoperatively. Complications were four eyes with a delay in epithelialization beyond 7 days and one eye with herpetic keratitis. Patients (n = 25) experienced a decrease in the symptoms of glare, halos, and difficulty with night driving from 3.5 to 2.0 on a 4-point scale.

Based on our results, simultaneous topography-guided PRK and CXL using a customized technique for topographical neutralization show promise for improving UCVA and BSCVA in keratoconic patients. In our experience, the combined procedure offered reasonable efficacy and safety, but longer-term studies are needed to demonstrate stability. A limiting factor in improving UCVA is corneal thickness. Even if only a partial topography-guided treatment is performed, the improved corneal contour relieves most patients of their dependence on rigid gas permeable contact lenses for daily activities.

POST-LASIK ECTASIA

Post-LASIK ectasia is one of the most difficult complications of refractive surgery to manage. Fortunately, topography-guided PRK combined with CXL is proving effective at limiting progression and restoring patients' vision.[8]

In a recent series of 17 patients, we used two laser platforms to perform the combined procedure customized by topographical neutralization.[7] Most patients (71%) attained a UCVA of 20/40 or better. Half gained 2 lines of vision or more and a mean reduction of astigmatism of 2.50 D with no ectatic progression noted as yet.

CONCLUSION

Topography-guided laser treatment plays a valuable role in managing hard-to-treat cases of severe irregular astigmatism after complications of refractive surgery as well as scarring and keratoplasty. Combined with CXL, the procedure is also demonstrating efficacy for the management of post-LASIK ectasia and keratoconus. ■

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