THE HUNT FOR PERFECTION


Topography- and wavefront-guided refractive surgery each have strong points.

BY EDWARD E. MANCHE, MD; AND JOSHUA ROE, MD

On the hunt for perfection with keratorefractive procedures, surgeons are increasingly performing wavefront- and topography-guided ablations. Continued evolution of laser technology has improved results and limited some of the vision-related changes encountered with previous ablation algorithms.[1-7]

Wavefront-guided ablation profiles are generated from preoperative aberrometry measurements of the patient's higher-order aberrations (HOAs). These profiles aim to treat preexisting HOAs and minimize the induction of new HOAs. Topography-guided ablation profiles are generated based on an elevation profile of the corneal surface; the corneal HOAs, as measured by corneal aberrometry; and the refraction. The actual corneal surface map is compared with the desired or ideal corneal surface, and the difference becomes the ablation profile.[8]

Is one approach better than the other? This article addresses some of the nuances in making a choice between topography- or wavefront-guided modalities.

ABLATIONS

Wavefront-guided. Recent publications on wavefront-guided ablation document improved results with a high-resolution aberrometer (iDesign Advanced WaveScan Studio System, Johnson & Johnson Vision). These publications report superior results with this latest platform in comparison with those of earlier wavefront-guided platforms, conventional and wavefront-optimized platforms, and small-incision lenticule extraction.[9-14] Early studies show better astigmatism control,[12,15,16] superior low-contrast vision,[17] improved distance UCVA, and better aberrometric outcomes with the high-resolution device.[10]

Topography-guided. Much of the literature on topography-guided ablation focuses on treating highly aberrated and ectactic corneas, cases for which this technology has been shown to outperform other modalities. Topography-guided treatments can be successful in cases in which obtaining wavefront data is difficult if not impossible (eg, eyes with corneal scars, eyes with highly irregular corneas, and eyes that have undergone PKP).[18-21] That said, recent articles on the primary treatment of normal eyes have shown excellent and, in some regard, superior results with this modality compared with others.[22,23] Notably, the US FDA clinical trial data for the Contoura Vision system (Alcon) are impressive: At 12 months, 34% of eyes had 20/12.5 or better distance UCVA, and 65% of eyes had 20/16 or better distance UCVA.[23]

An area of growing interest is combining topography-guided ablations with CXL to prevent keratoconus progression or ectasia after refractive surgery and simultaneously improve vision. The evidence to date is promising but largely limited to case series.[24-26]

COMPARISONS

Prospective. Few publications have documented direct comparisons of the outcomes of topography- and wavefront-guided ablations. Our review of the literature identified one prospective comparison of the two modalities by Toda et al.[27] These investigators compared wavefront-guided results obtained with the iDesign Advanced WaveScan Studio System and Star S4 IR Excimer Laser System (both from Johnson & Johnson Vision) to topography-guided results attained with the OPD-Scan III and EC-5000 CXII excimer laser system (both from Nidek). Both modalities achieved excellent results, but the researchers reported that subjective quality of vision might have been better in the wavefront-guided cohort.[27]

Retrospective. Moshirfar and colleagues compared the iDesign Advanced WaveScan Studio System with the Star S4 IR Excimer Laser System, the topography-guided Contoura Vision system, and the topography-guided Customized Aspheric Treatment Zone software (CATz, Nidek). This is the largest comparison of wavefront- and topography-guided LASIK that we found in our review of the literature.[17] In that study, a significantly higher percentage of eyes treated with the Contoura achieved distance UCVA better than 20/20. Notably, the Contoura eyes also had significantly lower sphere, cylinder, and spherical equivalent than the eyes treated with the other laser platforms.

When results were stratified by spherical equivalent, the Contoura system achieved significantly better results with higher myopic treatments, as had been seen in earlier studies.[28] However, patients treated with the iDesign had significantly greater average preoperative sphere, cylinder, and spherical equivalent when compared with those treated with the other platforms. The analysis confirmed previous reports that topography-guided ablations may outperform alternatives in highly aberrated corneas. Treatment with the iDesign produced the largest improvement in mesopic

(Continued on page 20)

(Continued from page 16)

contrast sensitivity, and the Contoura produced the largest improvement in photopic contrast sensitivity.

CONCLUSION

Both wavefront- and topography-guided ablation profiles can achieve excellent results. Some differences in outcomes remain, and certain clinical scenarios may be better suited to one platform than another. Future studies will define the role each has in laser vision correction. ■

1. Schallhorn SC, Farjo AA, Huang D, et al. Wavefront-guided LASIK for the correction of primary myopia and astigmatism: a report by the American Academy of Ophthalmology. *Ophthalmology.* 2008;115(7):1249-1261.
2. Yamane N, Miyata K, Samejima T, et al. Ocular higher-order aberrations and contrast sensitivity after conventional laser in situ keratomileusis. *Invest Ophthalmol Vis Sci*. 2004;45(11):3986-3990.
3. Buzzonetti L, Iarossi G, Valente P, et al. Comparison of wavefront aberration changes in the anterior corneal surface after laser-assisted subepithelial keratectomy and laser in situ keratomileusis: preliminary study. *J Cataract Refract Surg*. 2004;30(0):1929-1933.
4. Chalita MR, Xu M, Krueger RR. Correlation of aberrations with visual symptoms using wavefront analysis in eyes after laser in situ keratomileusis. *J Refract Surg.* 2003;19(6):S682-686.
5. Mysore N, Krueger R. Advances in refractive surgery: May 2013 to June 2014. *Asia Pac J Ophthalmol (Phila).* 2015;4(2):112-120.
6. Lin DT, Holland S, Tan JC, Moloney G. Clinical results of topography-based customized ablations in highly aberrated eyes and keratoconus/ectasia with cross-linking. *J Refract Surg*. 2012;28(11):S841-848.
7. Holland S, Lin DT, Tan JC. Topography-guided laser refractive surgery. *Curr Opin Ophthalmol*. 2013;24(4):302-309.
8. Kohnen T. Classification of excimer laser profiles. *J Cataract Refract Surg.* 2006;32(4):543-544.
9. Schallhorn SC, Venter JA, Hannan SJ, Hettinger KA. Outcomes of wavefront-guided laser in situ keratomileusis using a new-generation Hartmann-Shack aberrometer in patients with high myopia. *J Cataract Refract Surg*. 2015;41(9):1810-1819.
10. Moussa S, Dexl AK, Krall EM, et al. Visual, aberrometric, photic phenomena, and patient satisfaction after myopic wavefront-guided LASIK using a high-resolution aberrometer. *Clin Ophthalmol*. 2016;10:2489-2496.
11. Chen X, Wang Y, Zhang J, et al. Comparison of ocular higher-order aberrations after SMILE and wavefront-guided femtosecond LASIK for myopia. *BMC Ophthalmol.* 2017;17(1):42.
12. Schallhorn S, Brown M, Venter J, et al. Early clinical outcomes of wavefront-guided myopic LASIK treatments using a new-generation Hartmann-Shack aberrometer. *J Refract Surg*. 2014;30(1):14-21.
13. Prakash G, Srivastava D, Suhail M. Femtosecond laser-assisted wavefront-guided LASIK using a newer generation aberrometer: 1-year results. *J Refract Surg*. 2015;31(9):600-606.
14. Smadja D, De Castro T, Tellouck L, et al. Wavefront analysis after wavefront-guided myopic LASIK using a new generation aberrometer. *J Refract Surg*. 2014;30(9):610-615.
15. Khalifa MA, Ghoneim AM, Shaheen MS, Piñero DP. Vector analysis of astigmatic changes after small-incision lenticule extraction and wavefront-guided laser in situ keratomileusis. *J Cataract Refract Surg*. 2017;43(6):819-824.
16. Khalifa MA, Alsahn MF, Shaheen MS, Pinero DP. Comparative analysis of the efficacy of astigmatic correction after wavefront-guided and wavefront-optimized LASIK in low and moderate myopic eyes. *Int J Ophthalmol*. 2017;10(2):285-292.
17. Moshirfar M, Shah TJ, Skanchy DF, et al. Comparison and analysis of FDA reported visual outcomes of the three latest platforms for LASIK: wavefront guided Visx iDesign, topography guided WaveLight Allegro Contoura, and topography guided Nidek EC-5000 CATz. *Clin Ophthalmol*. 2017;11:135-147.
18. Krueger RR. Corneal topography vs ocular wavefront sensing in the retreatment of highly aberrated post surgical eyes. *J Refract Surg*. 2006;22(4):328-330.
19. Kanellopoulos AJ. Topography-guided custom retreatments in 27 symptomatic eyes. *J Refract Surg*. 2005;21(5):S513-518.
20. Gatinel D, Bains HS. Treatment of highly aberrated eyes using the NIDEK CXIII excimer laser. *J Refract Surg.* 2010;26(6):453-457.
21. Ohno K. Customized photorefractive keratectomy for the correction of regular and irregular astigmatism after penetrating keratoplasty. *Cornea*. 2011;30(suppl 1):S41-44.
22. Jain AK, Malhotra C, Pasari A, et al. Outcomes of topography-guided versus wavefront-optimized laser in situ keratomileusis for myopia in virgin eyes. *J Cataract Refract Surg*. 2016;42(9):1302-1311.
23. Stulting RD, Fant BS; T-CAT Study Group, et al. Results of topography-guided laser in situ keratomileusis custom ablation treatment with a refractive excimer laser. *J Cataract Refract Surg.* 2016;42(1):11-18.
24. Kymionis GD, Portaliou DM, Kounis GA, et al. Simultaneous topography-guided photorefractive keratectomy followed by corneal collagen cross-linking for keratoconus. *Am J Ophthalmol.* 2011;152(5):748-755.
25. Kanellopoulos AJ, Binder PS. Collagen cross-linking (CCL) with sequential topography-guided PRK: a temporizing alternative for keratoconus to penetrating keratoplasty. *Cornea.* 2007;26(7):891-895.
26. Kanellopoulos AJ, Binder PS. Management of corneal ectasia after LASIK with combined, same-day, topography-guided partial transepithelial PRK and collagen cross-linking: the Athens protocol. *J Refract Surg.* 2011;27(5):323-331.
27. Toda I, Ide T, Fukumoto T, Tsubota K. Visual outcomes after LASIK using topography-guided vs wavefront-guided customized ablation systems. *J Refract Surg*. 2016;32(11):727-732.
28. Lin DT, Holland SR, Rocha KM, Krueger RR. Method for optimizing topography-guided ablation of highly aberrated eyes with the Allegretto Wave excimer laser. *J Refract Surg.* 2008;24(4):S439-445.

EDWARD E. MANCHE, MD

- Professor of Ophthalmology; Director of Cornea and Refractive Surgery; Director of Research, Cornea, and Refractive Surgery, The Byers Eye Institute, Stanford University School of Medicine, Palo Alto, California
- edward.manche@stanford.edu
- Financial disclosure: Consultant and Sponsored research (Johnson & Johnson Vision)

JOSHUA ROE, MD

- Captain, US Air Force
- Fellow, Cornea, External Disease, and Refractive Surgery, The Byers Eye Institute, Stanford University School of Medicine, Palo Alto, California
- dr.roe@me.com
- Financial disclosure: None