EPITHELIAL MAPPING IN THE ERA OF CUSTOMIZED SURGERY

This auxiliary method for diagnosing keratoconus can provide greater precision in patient selection for keratorefractive surgery and improve outcomes.

BY EDWARD MANCHE, MD

As a corneal surgeon, one of the greatest thrills is the front-row view of the constant evolution of technology that refines our care for patients. A relatively new tool in our refractive surgery armamentarium is corneal epithelial mapping. In the latest installment of our Fundamentals in Five *column, Edward Manche, MD, focuses on this important diagnostic tool and its potential for enhancing the accuracy of refractive surgery screenings, among its various other applications.*

KAVITHA R. SIVARAMAN, MD

The field of ophthalmology has advanced significantly, with cutting-edge technologies driving the evolution of diagnosis and treatment options. First explored in the early 1990s, epithelial mapping has become a crucial tool for identifying subclinical keratoconus and enhancing surgical decision-making.[1]

FUNDAMENTAL 1 PURPOSE AND EVOLUTION

Epithelial mapping techniques have evolved from using very high-frequency digital ultrasound to more widely available OCT devices. Central to the diagnostic utility of epithelial mapping is the corneal epithelium's primary function as a smoothing agent. In eyes with pathologies such as keratoconus, the epithelium compensates for the uneven corneal surface by thickening around the cone and thinning at its apex.

FUNDAMENTAL 2 DIAGNOSTIC UTILITY

Epithelial mapping has become increasingly important in refractive surgery. By assisting with patient selection, epithelial mapping can improve outcomes.

Traditional methods of measuring corneal topography, including corneal curvature analysis and Scheimpflug imaging, help identify patients at risk of corneal ectasia. These methods, however, often leave clinicians uncertain about the candidacy of certain patients for keratorefractive surgery. This can leave some suitable patients without access to these procedures.

FUNDAMENTAL 3 APPLICATIONS IN REFRACTIVE SURGERY

Epithelial mapping provides a more accurate and sensitive assessment of the corneal epithelium than traditional methods of measuring corneal topography. As a highly sensitive indicator of early corneal changes, the epithelium can help identify subclinical keratoconus—a key factor in determining the safety and appropriateness of refractive surgery.

A completely normal epithelial profile may suggest candidacy for refractive surgery. Conversely, epithelial thinning surrounded by a thick ring is suspicious for keratoconus and a contraindication for keratorefractive surgery.

Increased precision in the patient evaluation enhances the overall safety and efficacy of refractive surgery by helping ensure that only the most appropriate candidates undergo a given procedure.

FUNDAMENTAL 4 IMPACT ON REFRACTIVE OUTCOMES

Changes in the corneal epithelium can affect refractive outcomes in several ways. In FDA clinical trials, patients' UCVA improved over a 12-month period after topography-guided LASIK.[1] Recent studies have found correlations between these improvements and changes in epithelial thickness.[2] Corneal remodeling can improve patients' visual acuity after other keratorefractive surgical procedures as well.

Epithelial mapping can also be useful when considering a LASIK enhancement. Some patients develop significant epithelial hyperplasia. Abnormal thickening of the central epithelium can lead to postoperative hyperopic surprises if the epithelium is removed during PRK enhancement surgery. A preoperative assessment of epithelial thickness can help surgeons

identify the most suitable enhancement strategy, whether that be reducing the programmed correction or performing a LASIK versus PRK enhancement.

FUNDAMENTAL 5 FUTURE DEVELOPMENTS AND EMERGING TECHNOLOGIES

As epithelial mapping technology evolves, I expect its use in ophthalmology to become more routine, especially among refractive surgeons. The current gold standard in high-resolution imaging is very high-frequency ultrasound. Its accuracy is 1 µm versus 3 µm with OCT-based epithelial mapping. The latter, however, is noncontact, fast, and user-friendly. Its ongoing refinement will likely lead to wider adoption in the field.

Other technologies shaping the future of refractive surgery include Brillouin microscopy, such as with a Brillouin Optical Scanner System (Intelon). This noncontact laser system measures ocular biomechanics and holds promise as a patient screening tool in keratorefractive surgery. Identifying corneas that appear to be normal but are actually weak can help ophthalmologists decide whether to proceed with surgery and which specific procedures to perform.

CONCLUSION

Epithelial mapping offers benefits for surgeons and patients. The technique may not be necessary in every situation, but it can be invaluable when the decision whether to proceed with surgery is not clear-cut. Epithelial mapping can increase the safety of keratorefractive surgery, improve patient selection, and assist with the customization of treatment. The technique is poised to play a significant role in the future of refractive surgery. ■

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2. Saleh S, Epp LJ, Manche EE. Effect of corneal epithelial remodeling on visual outcomes of topography-guided femtosecond LASIK. *J Cataract Refract Surg*. 2022;48(10):1155-1161.

SECTION EDITOR **KAVITHA R. SIVARAMAN, MD**
- Partner, Cincinnati Eye Institute, Ohio
- ksivaraman@cvphealth.com
- Financial disclosure: None

EDWARD MANCHE, MD
- Director of Cornea and Refractive Surgery, Stanford University School of Medicine, California
- Professor of Ophthalmology, Stanford University School of Medicine, California
- edward.manche@stanford.edu
- Financial disclosure: Consultant (Glaukos, Johnson and Johnson Vision); Equity owner (RxSight, PlacidO, VacuSite); Research funding (Alcon, Allergan/AbbVie, Carl Zeiss Meditec, Johnson & Johnson Vision, Novartis, Recordati Rare Diseases)