

# Diagnosing Early Keratoconus

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Epithelial Thickness Mapping with the Optovue Avanti OCT is helping ophthalmologists identify the first signs of this condition.

BY A. JOHN KANELLOPOULOS, MD

It had been speculated for many years that in keratoconus, the corneal epithelium responds to the thinning and ectasia of the cornea in a vivid way. We now know that corneal thinning prompts the epithelium to grow thinner as well. But in the area adjacent to the corneal thinning the epithelium becomes thicker, as nature attempts to cover the irregularity and reduce the symptoms.

High-frequency ultrasound has been able to show these phenomena for some time. Today, the Optovue Avanti Widefield OCT can show these activities quickly and easily via its Epithelial Thickness Mapping (ETM) software, which produces a color-coded map of the epithelial thickness across the central 6 mm of the cornea.

## The Clinical Importance of ETM

In healthy eyes, epithelial thickness is universal (approximately 53  $\mu\text{m}$  in all eyes), regardless of age and other factors. A rare variation in that thickness could indicate a problem such as early keratoconus.

The early detection of keratoconus has gained importance since the advent of corneal cross-linking (CXL). Instead of prescribing glasses and corrective contact lenses or performing a transplant for keratoconic patients, we can actually help slow or halt the disease's progression.

To detect keratoconus as early as possible, we must learn more about its signs and routinely screen eyes for the condition. I use ETM to map the corneal epithelium of every patient in my practice. It is an indispensable tool for me to diagnose keratoconus and assess its progression.

To identify early epithelial changes in keratoconic eyes, we start with what we know. We know about the compensatory nature of epithelial distribution in response to anterior stromal surface irregularities. Specifically, the epithelium is thinner over the steeper, conic area in a keratoconic eye and thicker over the flatter areas. This compensation can prevent us from seeing topographical changes in the early stages of the disease.

My colleagues and I wanted to better understand this phenomenon, so we conducted a study of normal corneas, untreated ectatic corneas, and ectatic corneas previously treated with CXL to determine if their overall epithelial thickness would reveal a very early ectasia prognostic factor for keratoconus.<sup>1</sup> We found that a keratoconic condition causes an overall increase in epithelial thickness, particularly in younger patients. This "reactive" epithelial hypertrophy may precede any of the standard findings on corneal topography or tomography.

High-frequency ultrasonic biomicroscopy showed that (1)

cross-linked corneas have lower elasticity and a thinner epithelium than normal corneas; (2) keratoconic corneas have a much thicker epithelium overall; and (3) keratoconus suspects have a thicker epithelium as well.

These findings may help us develop guiding parameters to detect early, subtle cases of keratoconus. By using Optovue's ETM routinely, in addition to when we suspect keratoconus, we may find corneal epithelia that are remodeling and becoming thicker. It is an easy process—the ETM scan takes a few seconds for an undilated test, instead of 30 to 45 minutes with a water bath for high-frequency ultrasound. The ETM evaluation produces a color-coded map of the epithelium that makes it simple to identify problem areas, such as early signs of epithelial asymmetry (Figure 1).

## Additional Applications For ETM

In addition to mapping the thickness of ocular tissues, ETM also helps us detect the peculiar epithelial distribution of dry eye disease. Thus, ETM offers a uniquely definitive test for the disorder and a means to categorize cases. Additionally, the technology is crucial for evaluating corneas for their candidacy for refractive and cataract surgery.

My staff and I are currently testing ETM software that with a 9-mm zone test zone. We will also continue our efforts to determine the earliest signs of keratoconus. ■

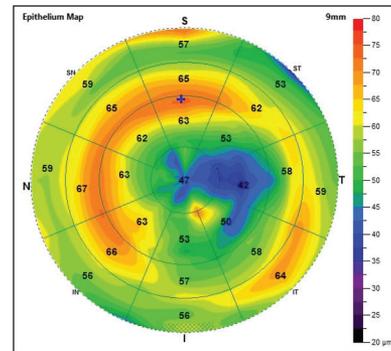


Figure 1. ETM provides an efficient way to quantify epithelial thickness and to track change between visits.

1. Kanellopoulos AJ, Aslanides IM, Asimellis G. Correlation between epithelial thickness in normal corneas, untreated ectatic corneas, and ectatic corneas previously treated with CXL; is overall epithelial thickness a very early ectasia prognostic factor? *Clin Ophthalmol.* 2012;6:789-800.

### A. John Kanellopoulos, MD

- Clinical Professor of Ophthalmology, NYU Medical School, New York
- LaserVision Clinical and Research Eye Institute, Athens, Greece
- [ajk@brilliantvision.com](mailto:ajk@brilliantvision.com)
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# Finding the Right IOL Even After LASIK

Optovue's Total Corneal Power improves the accuracy of IOL calculation for routine and challenging cases.

BY ERIK L. MERTENS, MD, FEBOPHTH

As the millions of patients who underwent refractive surgery 1 or 2 decades ago begin to develop cataracts, they often are eager to get rid of their glasses a second time with premium IOL cataract surgery. Their expectations are very high for glasses-free vision. However, because refractive surgery alters the front surface of the cornea, it can be difficult to precisely calculate the right IOL power for postrefractive surgical patients.

Keratometry, the IOLMaster (Zeiss), and topography only measure the front corneal surface; then, their algorithms assume that the posterior surface is 82% of the front. In postrefractive surgery patients, the 82% assumption may no longer be valid, which can lead to postoperative surprises. Scheimpflug devices directly capture front and back corneal measurements, but their slow capture speed, low resolution (15  $\mu\text{m}$ ), and fluctuating angle of capture make measuring postrefractive surgery eyes problematic. In my experience, the Optovue Total Cornea Power (TCP) metric with 5- $\mu\text{m}$  resolution solves this problem very well.

## Total Cornea Power

To optimize patients' visual acuity after surgery, TCP by Optovue gives us a better option.

Unique in the market, the Optovue TCP software directly quantifies corneal power by measuring both the front and back surfaces of the cornea. The software's 5- $\mu\text{m}$  resolution offers a new level of precision in calculating IOL powers for all eyes, particularly those that have undergone refractive surgery. Furthermore, using TCP to evaluate post-refractive surgery eyes eliminates the need for previous medical records, which is particularly helpful when a patient had refractive surgery decades earlier. The device acquires all of the information in less than 2 seconds with excellent repeatability.

We enter the measurements into a downloadable COOLLAB Calculator app, which calculates the appropriate IOL power. The OCT-based formula for IOL power calculation is also available on the ASRCRS online calculator.

## OCT vs Other Ways to Calculate IOL Power

In a recent study comparing ways to calculate IOL power for patients who have undergone previous myopic LASIK and PRK, the authors found that the OCT-based IOL power formula used

with Optovue's TCP was accurate and more repeatable than the Barrett True-K formula.<sup>1</sup>

In my own work, I have compared the calculations of the IOLMaster, the Barrett True-K, and OCT methods. Only the OCT method was accurate for patients with all types of previous refractive surgeries.

One of my postsurgical patients, a 55-year-old male who had undergone Epi-LASIK 6 years earlier, came to me with a diagnosis of cataracts. He wanted to get a multifocal IOL so he could be free from glasses again. Using the IOLMaster's SRK/T formula, Barrett True-K, and the OCT calculator with Optovue data, I captured a range of results seen in Table 1.

The Barrett and OCT numbers were similar, but the small difference was large enough to impact postoperative results. I chose to implant a 21.00 D IOL OD and @21.5 D IOL OS. After surgery, the patient was plano with -0.50D cylinder OD and 0.25D with -0.50D cylinder OS. He no longer needed glasses for distance, intermediate and near. Without the TCP software the outcomes were much less reliable with a retreatment rate of 21%.

In a retrospective evaluation of my own practice data, I found that when I used Optovue's TCP and the OCT formula, 79% of patients were within 0.50 D of their target refraction; and 94% of patients were within 1.00 D. TCP has enhanced my accuracy in choosing the right IOL, which is why I have made it part of my routine workup for cataract patients. ■

TABLE 1.

Results OD	
SRK/T	19.00 D
Barrett	20.57 D
OCT calc	20.92 D
Results OS	
SRK/T	19.50 D
Barrett	21.69 D
OCT calc	21.41 D

1. Wang L, Tang M, Huang D, et al. Comparison of newer IOL power calculation methods for post-corneal refractive surgery eyes. (2015). Submitted for publication.

### Erik L. Mertens, MD, FEBOPHTH

- Medical Director, Physician CEO, Medipolis, Antwerp, Belgium
- Chief Medical Editor, *CRST Europe*
- e.mertens@medipolis.be
- Financial disclosure: None