

# Using Corneal Topographic Indices

The proper interpretation of corneal maps is necessary for an accurate diagnosis of certain ocular abnormalities.

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Considerable advances have been made in the last decade in anterior segment diagnostic tools. Corneal topographers, for one, are now common in clinical practice, because the devices provide information that is essential for the detection of corneal abnormalities such as keratoconus. The color-coded contour map that shows the distribution of powers across the cornea's front surface is the first step in differentiating a normal from an abnormal condition. Like a fingerprint, however, individual corneal topographies are unique. Knowing when these variations fall outside of the norm and how they impact vision depends on quantitative indices derived from corneal topographic data.

## CLINICAL PERSPECTIVE

Although corneal topography greatly facilitates the clinical diagnosis of keratoconus, it is important to remember that some patients who have a genetic predisposition to keratoconus will not have detectable disease at the time of refractive surgery. Even a careful examination of their family history may not reveal their propensity for the condition. In a recent study, several patients without any known risk factors for ectasia developed the pathologic condition after LASIK.<sup>1</sup> Clearly, there is more to learn.

The diagnosis of forme fruste keratoconus (FFKC) relies almost entirely on an interpretation of corneal topographic analysis. Clinicians may use several other terms for FFKC such as *keratoconus suspect* or *subclinical keratoconus*, but their meaning is the same: except for corneal topographic findings and possibly some scissoring of the light reflex on retinoscopy, there are no other detectable, traditional signs that are present with true clinical keratoconus.

Topographic patterns to help diagnose keratoconus suspects that have been described in the literature include abnormal localized steepening (usually inferior, but it can be

central or superior as well), asymmetric bowties, and bowties with skewed radial axes.<sup>2</sup> Many ophthalmologists feel that there is little conclusive scientific evidence that using several available corneal topographic indices will lead to a firm diagnosis. Indices such as the steepest K reading, central and peripheral preoperative pachymetry, and the Rabinowitz inferior-superior value, however, are supported in the literature<sup>3</sup> and should be considered within the clinical picture. Nevertheless, it is important to realize that there are no magic numbers; each case must be considered on its own merit and with an integrative evaluation of all the available clinical data.

## USING THE INDICES

Of real benefit would be a computerized indication of the variation of a given value from the mean in a normal popu-

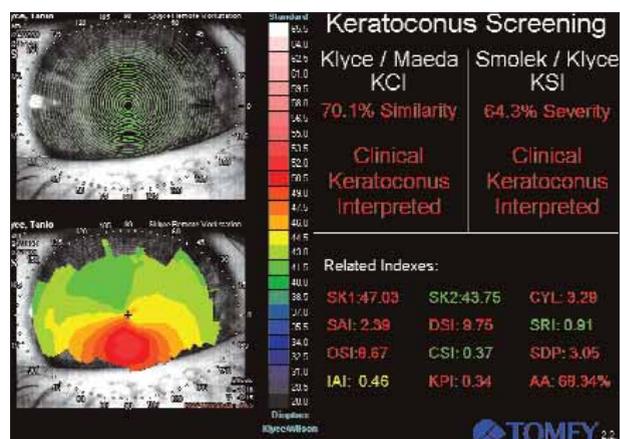


Figure 1. The Tomey Keratoconus Screening display uses color coding to differentiate normal (green), suspicious (yellow), and abnormal (red) indices. Pictured are two independent classification schemes that interpret the corneal topography consistently as keratoconus.

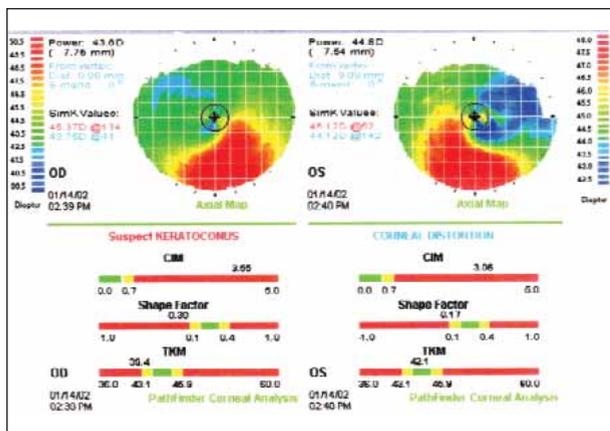


Figure 2. In the Humphrey Pathfinder's display, the three indices presented are the Central Irregularity Measure; the Shape Factor, which is a measure of corneal asphericity; and the Mean Toric K, which is derived from the best fit of a toric surface to the elevation data. In this examination, the right cornea is interpreted to be suspicious for keratoconus, and the left eye presents with abnormal corneal distortion.

lation and the statistical significance of that deviation based on published scientific data from a controlled clinical trial. Prospective studies are lacking on the detection of keratoconus and other abnormalities. Such research would provide guidelines that could be updated based on clinical experience.

Some corneal topographers provide color-coded indices to alert the physician when a particular variable is abnormal. The Humphrey Pathfinder (Carl Zeiss Meditec, Inc., Dublin, CA), Corneal Navigator (Nidek, Inc., Fremont, CA), and Tomey Keratoconus Screening (Tomey Corporation, Nagoya, Japan) corneal topographers use *green* to signify normalcy, *yellow* (caution) if the variable is two-to-three standard deviations from the normal mean, and red (clearly abnormal) if an index is more than three standard deviations from the normal mean (Figures 1 to 3).

Individual indices derived from corneal topography have specific purposes. For example, the averages of the central corneal power over the apparent entrance pupil are available on the Eyesys (Eyesys Technologies, Inc., Houston, TX), Nidek, and Tomey topographers. Clinicians may use this information to obtain accurate central keratometric (K) readings for IOL calculations. Most corneal topographers provide simulated K readings. Normal corneas should have simulated K reading of around  $42.75 \pm 1.60D$  (standard deviation); K readings that are lower than  $38.00D$  or greater than  $47.50D$  would be more than three standard deviations from the mean. By itself, a K reading higher than this range is not diagnostic of keratoconus or another disease, and clinicians must take into account pachymetry and topographic pat-

terns. Corneas with K readings of  $48.00D$  to  $50.00D$ , which are otherwise normal, have been associated with eyes that also have shorter axial lengths.

If clinicians note asymmetry on the topography, they can estimate manually the gradient in power, a rough estimate of the Rabinowitz inferior/superior gradient. For example, if the dioptric value along a 3-mm superior arc less the dioptric value along a 3-mm inferior arc is  $> 1.40D$  and  $\leq 1.90D$ , then the cornea may be suspicious for keratoconus. If the gradient is  $> 1.90D$ , then it may qualify as clinical keratoconus. Although this test is not very specific, it can provide some guidance on distinguishing between normal and abnormal topography. Alternatively, the inferior/superior index is calculated by a number of different corneal topographers that include the Eyesys and the Nidek systems.

More sophisticated methods combine the use of many topographically derived indices and artificial intelligence approaches to screen for keratoconus suspects. Several classification schemes are available on corneal topographers to assist in differentiating keratoconus suspects from patients with normal variations in corneal topography. In general, these methods rely on techniques of discrimination in conjunction with examples of normal corneal topographies as well as corneal topographies classified as *keratoconus suspects*. These techniques include the original Rabinowitz criteria with indices such as inferior/superior index, maximum K readings, and skewed radial axes that are intended to capture the essential features of keratoconus.<sup>4</sup> Other examples

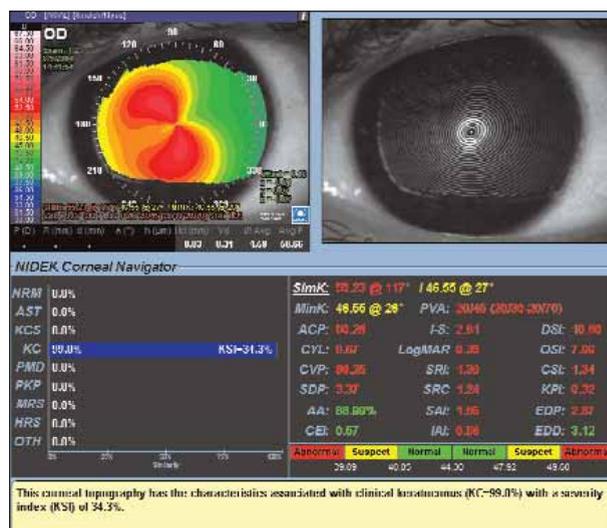


Figure 3. The Nidek Navigator's display shows a cornea with keratoconus. Noteworthy are the skewed radial axes and the abnormal amount of cylinder. This neural network-based system also classifies normals, astigmats, keratoconus suspects, pellucid marginal degeneration, penetrating keratoplasty, myopic refractive surgery, and hyperopic refractive surgery. Unknown variations are classified as *other*.

include the Tomey Keratoconus Screening software (Figure 1), the Humphrey Pathfinder (Figure 2), and the Nidek Corneal Navigator (Figure 3).<sup>5-7</sup> Although each of these tests is capable of estimating the likelihood of a given topography's being consistent with keratoconus suspects (or another corneal condition), it is essential for clinicians to realize that none is 100% specific, sensitive, or accurate. Practitioners must interpret the diagnostic information provided by the corneal topographer within the context of all the available clinical information.

## CONCLUSION

Clinicians should use the indices for diagnosing keratoconic patients or keratoconus suspects only after the patients have discontinued wearing contact lenses for long enough to reverse or at least stabilize all corneal molding. The corneal topography of the average soft contact lens wearer with spectacle blurring can require several weeks to stabilize completely.<sup>8</sup> Physicians may need to repeat the measurements of visual acuity, manifest refraction, and topography every 2 to 3 weeks until these values have stabilized before using topographic indices for planning laser vision correction or cataract surgery. ■

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