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Advanced imaging of the anterior segment optimizes Laser Vision Correction candidate selection

Accurate preoperative screening is one of the key steps to successful laser vision correction outcomes. During the screening process, we assess corneal shape, thickness, and health. We quantify larger and smaller vision imperfections. We assess suitability for monovision in older patients. We analyze the tear film. And we discuss the patient's vision needs in depth, to help match the right procedure to the right patient.

Accurate screening helps us match the right procedure to the right patient. In some patients, we determine that no procedure is the best procedure. With the advanced imaging technology, 30% of patients who present to us for laser vision correction are determined to be non-candidates and we recommend either alternative procedures or no procedure at all. Only those patient who are determined to be excellent candidates, are recommended to proceed.

Traditional WorkUp

The screening fundamentals include: refraction, topography, pachymetry, and slit lamp examination of corneal clarity and tear film. Schirmers and wavefront exam may be added as well, depending on the clinical findings.

Although we measure pupil size with infrared pupillometry in every patient, the relevance of pupil size to laser vision correction outcomes remains unsubstantiated. Multiple studies, including those performed in the military, found pupil size irrelevant to laser vision correction outcomes, even at night. Moreover, with the LADARVision technology, we can customize the diameter of any treatment area to oversize any

Continued with WorkUp on page 2

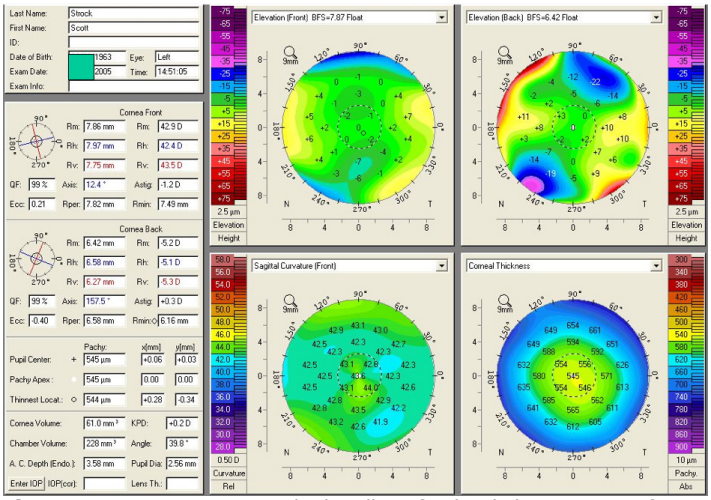

Figure 2. Four-Map Pentacam display allows for detailed assessment of anterior elevation (top left), posterior elevation (top right), sagital curvature (bottom left), and corneal thickness map (bottom right). This map is normal.

Camera orientation display

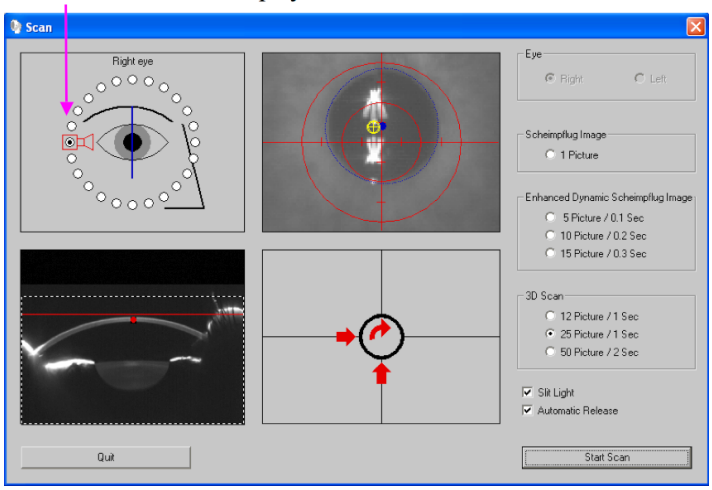

Figure 1: Oculus Pentacam camera rotates around the eye. Rotational scanning slit technology generates data on 25,000 true corneal elevation points. In contrast to all the other imaging technologies, including Orbscan, true central corneal data, rather than an estimate, is generated with Pentacam, allowing for accurate and detailed evaluation.

Advanced Imaging Studies

Rotational scanning slit systems, such as Visante OCT and Oculus Pentacam, elevated imaging accuracy to a whole new level. OCT images allow exceptional visualization of cornea and anterior segment. Pentacam is the only imaging system that positions the camera in the periphery, not in the center, of the visual axis (Figure 1). Therefore, true measurement, not an estimate, of the corneal curvature and power is performed.

Everyone, regardless of traditional workup outcomes, benefits from both advanced imaging studies during their screening process. Patients presenting for laser vision correction benefit from detailed visualization of their cornea and anterior segment and from the accurate measurement, not an estimate, of their corneal curvature (Figures 2,3,4). Patients presenting for cataract and lens surgery benefit from the accurate lens density and corneal power calculation – both anterior and posterior surface– to optimize their IOL power calculation (Figures 5 and 6).

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pupil size.

Traditional corneal imaging and pachymetry have limitations. Ultrasound pachymetry is typically hand-held. It relies on manual probe placement on the guesstimated center of the cornea. Multiple measurements in predictable and reproducible corneal locations are nearly impossible. Therefore, ultrasound pachymetry is our "best guess" rather than the accurate measurement of the true corneal thickness.

Topography is based on placedo-disc reflection from a light source positioned in the center of the visual axis. It creates a "blind spot" in the central 1.8 to 2.0 mm of the cornea overlying the visual axis. The data in the very center of the visual axis, therefore is, not real data. It is not the real measurement of the 1.8 to 2.0 mm corneal curvature overlying the visual axis. Rather, the measurements are extrapolated from the smallest reflected ring. Yet, this data is critical since it analyzes the very center of the visual axis. The very center may be abnormal, but if the paracentral curvature is normal, the very center may be erroneously interpreted as normal as well.

Corneal tomography (scanning slits) with Orbscan was the first step toward increasing accuracy of data collection. Scanning slit system allows non-contact pachymetry and visualization of both anterior and posterior cornea. The Orbscan, however, is still placedo-disc based and the camera remains in the center of the visual axis. Therefore, the center of the visual axis is not measured, it is estimated. Moreover, Orbscan images are based on vertical scanning slits only. The rest of the data is interpolated. In fact, no continuous slit data is available along the horizontal meridian at all. Therefore, the accuracy of Orbascan in assessing posterior corneal curvature remains questionable.

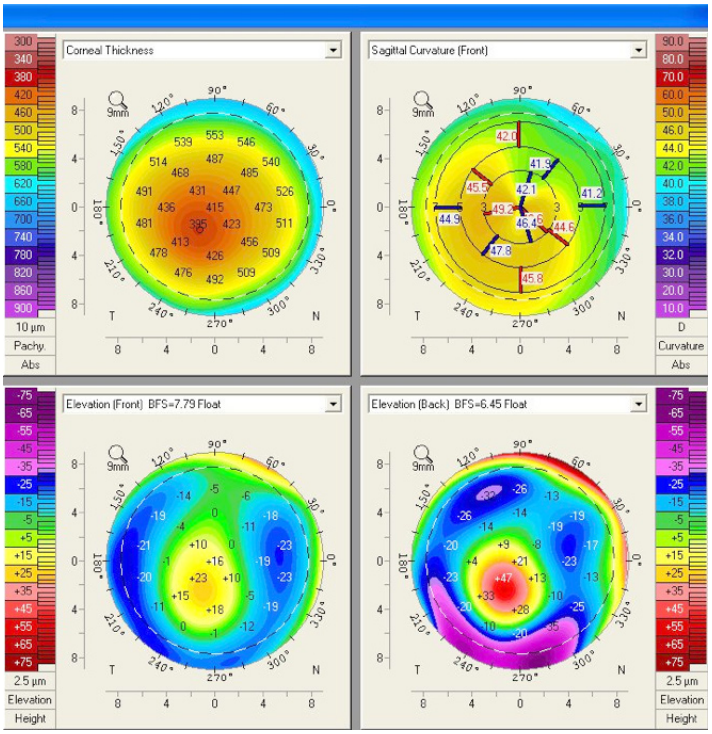

Figure 3. Four-Map display in this patient indicates keratoconus. Sagital view shows typical placedo-disc topographic appearance. Anterior elevation exceeds 15 microns and posterior elevation exceeds 20 microns – both consistent with keratoconus. Also, the thinnest cornea is inferior.

Laser Vision Correction Screening

- Refraction
- Topography
- Pachymetry
- Pupillometry
- Slit lamp evaluation
- Tear Film analysis
- Visante OCT Scan
- Oculus Pentacam Scan

	Measurement	Purpose
Visante OCT Scan	Detailed non-contact pachymetry map	• Refractive Surgery Screening • Keratoconus follow up
	Detailed imaging of corneal layers	• Epithelilal thickness assessment • Scar depth calculation
	Residual stromal bed measurement	• Determine candidacy for enhancement
	Angle depth calculation	• Glaucoma screening and follow up
	Anterior chamber depth calculation	• Phakic IOL Screening
Oculus Pentacam	Detailed non-contact pachymetry map	• Refractive Surgery Screening • Keratoconus follow up
	Anterior and posterior corneal elevation maps	• Refractive Surgery Screening • Keratoconus follow up
	Corneal wavefront map	• Refractive Surgery Screening • Aspheric IOL selection in cataract surgery
	Anterior and posterior corneal power maps	• Increased accuracy in IOL power calculation
	Lens densitometry	• Lens clarity quantification and follow up
	Anterior chamber depth calculation	• Phakic IOL Screening

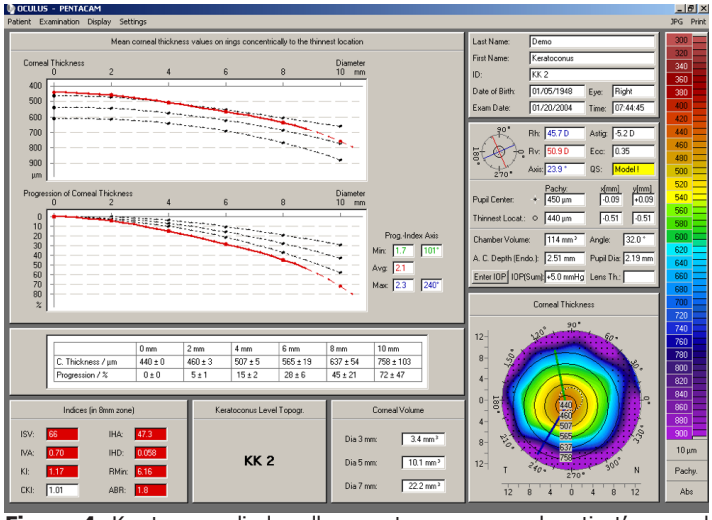

Figure 4. Keratoconus display allows us to compare each patient's corneal thickness and the progression of their thickness from the center to the periphery to the measurements in normal patients. This patient's corneal thickness (red line in the two top left graphs) is outside the normal ranges. Also, 7 out of 8 keratoconus indices (bottom left) are highlighted in red, indicating abnormality. Based on the multiple indices, this patient has keratoconus.

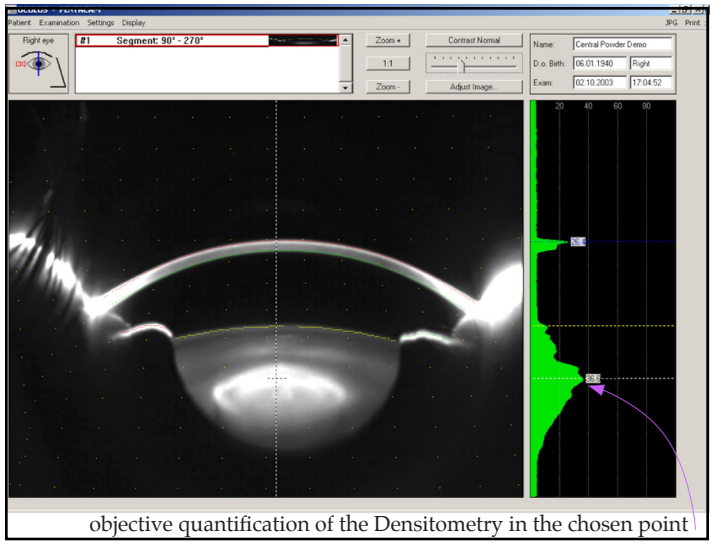

Figure 5. Lens densitometry quantification. Green graph on the right measures density of the lens at any given lens layer. Progression can be followed precisely. Top left corner image indicates camera/slit position.

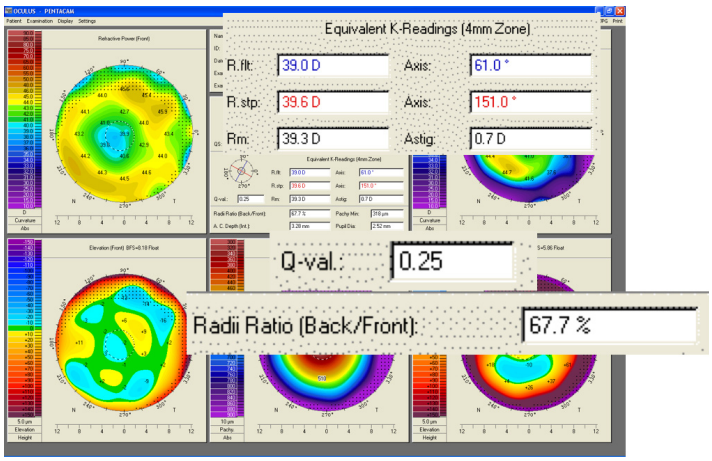

Figure 6. Pentacam Holladay report (Equivalent K-readings, asphericity Q-value, and back-to-front corneal curvature ratio) generates accurate corneal power measurements, especially after corneal refractive surgery. IOL power calculation accuracy increases, allowing for better cataract and lens replacement surgery outcomes.

Pentacam Screening Parameters

With Pentacam, we evaluate sagital corneal curvature, anterior curvature, posterior curvature, detailed pachymetry map, progression of corneal thickness from center to periphery, and corneal wavefront map with Zernicke deconstruction. Sagital corneal curvature view is similar to the placedo disc based topography. The sensitivity in keratoconus screening comes from analyzing the anterior and posterior curvature elevations (Figure 3). Anterior elevation greater than 15 microns above best fit sphere and posterior elevation greater than 20 microns are considered abnormal.

Keratoconus screening examination compares each patient's corneal thickness to the normal parameters. It also plots the progression of corneal thickness from center to the periphery, comparing this progression to normal parameters as well (Figure 4). Eight different indices of keratoconus are used to analyze the shape and thickness of each individual cornea. Two or more out of range indices are considered abnormal.

Pentacam is the only device available in the U.S. that can generate the wavefront map of the cornea alone. Traditional wavefront analyzers used in the wavefront-guided laser vision correction generate the wavefront of the entire optical system of the eye – cornea, lens, and vitreous. Certain wavefront aberrations, such as coma for example, can be consistent with keratoconus. If the lens has coma aberration in the opposite orientation than the cornea, the standard wavefront map may appear normal. The Pentacam wavefront map of the cornea, however, will identify such abnormality.

Sight Gags *by Scott Lee, O.D.*

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