Ophthalmology MANAGEMENT
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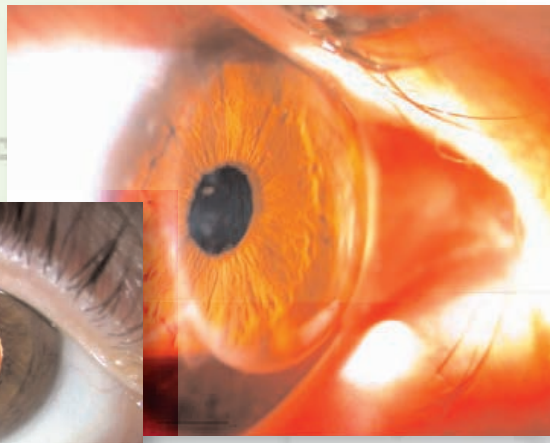
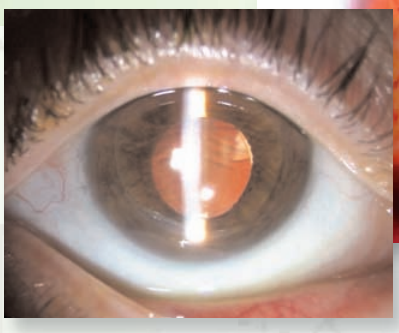
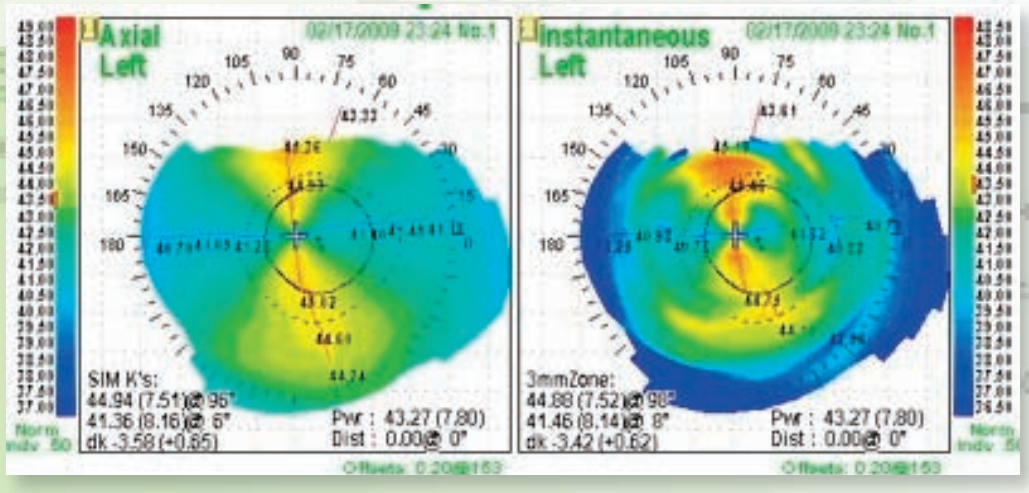
Maximizing the Use of the Marco 3-D Wave™ in Cornea and Intraocular Lens Applications





Experts discuss how this multifunctional device can help in the diagnosis and treatment of ocular disease and optimize visual outcomes.



By Jonathan D. Solomon, MD

Experience a Paradigm Shift With The Marco 3-D Wave™

Understand how this device helped streamline patient scheduling and improve patient flow.

When I completed my training in ophthalmology, the idea of premium IOLs or refractive cataract surgery was just beginning to take hold. Like many of my colleagues, I saw this as an opportunity to develop a niche for my practice. Arming myself with the appropriate tools, a reproducible surgical technique and the ability to recognize good candidates, I decided to expand my practice.

The first thing I learned was that premium IOL patients require a considerable amount of chair time. In the beginning, I compiled core measurements with several instruments, and as a result, efficiency and patient flow suffered. I rearranged the way I scheduled patients to allow more face-to-face time, but it was still necessary for cataract patients to encounter nearly every device in the office. I solved this time-constraint issue when I purchased the Marco 3-D Wave. The 3-D Wave is a combination autorefractor, keratometer, pupillometer, corneal topographer and wavefront aberrometer all in one.

In this article, I'll discuss how the Marco 3-D Wave works, how it improved practice efficiency and patient scheduling, and led to a paradigm shift in my approach to patient care.

Ins and Outs of the 3-D Wave

With the use of an infrared slit beam and photodetectors situated on a rotating wheel, the 3-D Wave moves an incident beam along a specific pupillary meridian while a reflected beam returns in the same or opposite direction.

The instrument detects the time it takes for light to peak at the photodiode and calculates the optical pathway difference (OPD). Combined with software intended to measure photopic and mesopic pupil size, the 3-D Wave enables a single user to quickly and precisely gather the refraction across different pupil diameters. The device creates a wavefront profile by compiling 1,440 individual data points in only 0.4 seconds. It also displays higher-order aberrations to the 8th order across pupils between 2 mm and 6 mm in diameter.

The 3-D Wave is considered an objective, serially automated version of the handheld retinoscope and is the only wavefront sensor using dynamic skiascopy. In addition, it further refines data collection by highlighting spherical aberration and separating corneal measurements from the total ocular spherical aberration. The 3-D Wave compiles data in a clear and concise format and offers superior map presentations.

Improved Practice Efficiency

Because the 3-D Wave provides so much information so quickly, it has reduced the time it takes to acquire patient data by 30% and cataract patient consultations by 15 minutes in my practice. I'm able to see more patients and have more meaningful discussions with them about lifestyle issues, the anatomy of the eye and which lens is most appropriate. Once I consider all of the patient information and the data from the 3-D Wave, I usually can whittle down lens selection to two choices very quickly.

What's more, since the 3-D Wave combines five instruments in one, all of the tests are performed in a small space in one room. I no longer have to shuffle patients from one exam room to the next for diagnostic testing. Another bonus: The efficiency of the 3-D Wave enabled me to switch to blocked scheduling for cataract patient consultations. I schedule these patients back to back instead of scattering them throughout the day whenever scheduling permits, which improves patient flow.

Paradigm Shift

The improvement in patient scheduling and the rapid collection of information the 3-D Wave provides has caused a very positive paradigm shift in my practice. No longer do I look at cataract patients as either individuals who pay out of pocket for premium multifocal IOLs or those who rely on medical insurance to pay for monofocal IOLs. I consider every patient a premium patient who deserves premium eye care. All patients benefit from the 3-D Wave technology, because they receive the best lens choice for them.

For instance, a 58-year-old nurse practitioner presented with bilateral posterior subcapsular cataracts and was interested in obtaining a full range of vision. The 3-D Wave enabled me to quickly review the topography and corneal spherical aberration and recognize the patient had a 6.98-mm mesopic pupil. She was concerned about the possibility of excess glare while driving at night but wanted to use the computer and read charts without her eyeglasses. She reported a great deal of difficulty wearing a trial pair of monovision contact lenses in her early 30s. After much discussion, we decided to choose the partially diffractive optic Aspheric ReSTOR D1 (Alcon Laboratories Inc.) implant (**Figure 1**). Following implantation in her nondominant eye, the uncorrected distance visual acuity was 20/20+; the uncorrected intermediate visual acuity was 20/25; and the uncorrected near visual acuity was 20/16 at

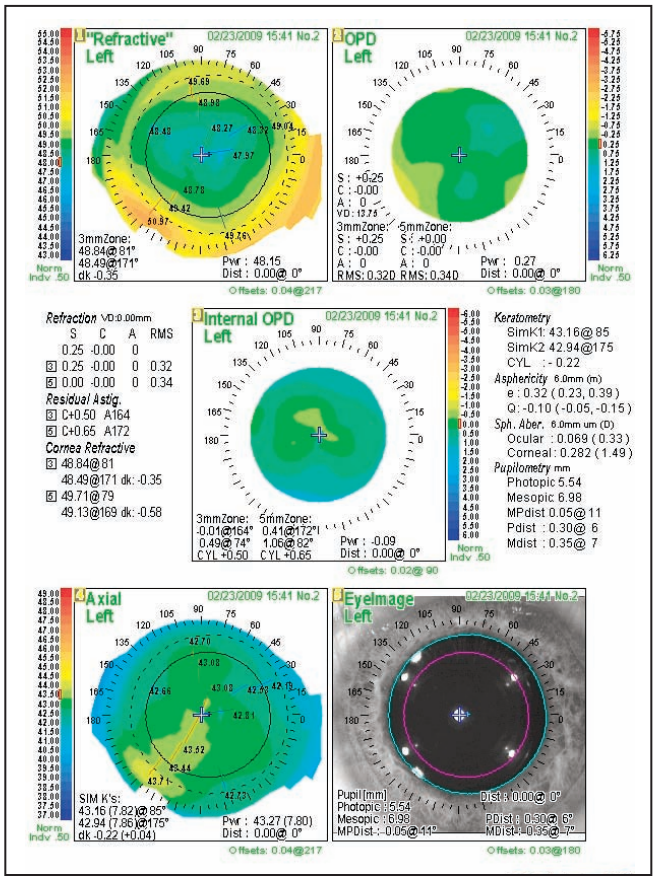


Figure 1. This image shows a 3-D Wave scan 2 weeks after implantation of the Aspheric ReSTOR D1 lens. Notice the mesopic pupil size and value of the corneal spherical aberration of 0.282 µm and the ocular spherical aberration of 0.069 µm, consistent with the intended reduction of -.20 of the AcrySof Aspheric platform.

1 week. Three weeks after bilateral implantation, the patient reported minimal halos at night and total spectacle independence.

Keratometrically Challenged Patients

The 3-D Wave is also helpful for those I call the keratometrically challenged — patients who've undergone LASIK, PRK or RK and those who have large degrees of corneal astigmatism. A single scan can differentiate between keratometric and lenticular astigmatism on the internal OPD map and total OPD map. I can cross-reference this with the wavefront refraction and verify higher-order aberrations. The refractive map can provide information about the peripheral cornea for patients who can't remember if they were nearsighted or farsighted before LASIK surgery. The Q values explain whether the cornea is prolate (negative Q-hyperopic LASIK) or oblate (positive Q-myopic LASIK).

Corneal Shape and Higher-order Aberrations

More than 10 million Americans have undergone keratorefractive surgery, and in their lifetime, all will develop cataracts. Aside from the challenge of calculating precise lens power, it's important to consider the effect corneal shape has on higher-order aberrations.

Current research has demonstrated that an optical system improves the closer it is to zero spherical aberration. Aspheric IOLs are designed to mitigate the naturally occurring positive spherical aberration of the corneal surface. Eliminating spherical aberration leads to improved contrast sensitivity during simulated night driving. The Tecnis Z9000 IOL (Abbott Medical Optics) and the AcrySof IQ SA60AT (Alcon Laboratories Inc.) are intended to induce negative spherical aberration. The SofPort LI61AOV IOL (Bausch & Lomb) is a neutral, zero aspheric lens that doesn't add or subtract spherical aberration. The question is how do you determine which IOL is the best choice?

For example, hyperopic LASIK tends to induce negative spherical aberration. A negative aspheric lens would further increase total ocular asphericity. Most would assume that a traditional monofocal IOL with positive spherical aberration would be the best lens choice, unless you measure the amount of spherical aberration before cataract surgery. This was the case concerning a patient who presented 4 years after hyperopic LASIK with a cataract in her nondominant eye, following measurable regression. Preoperatively, the 3-D Wave showed her eye had minimal, corneal spherical aberration. Therefore, I implanted the Bausch & Lomb LI61AOV to achieve the status of no spherical aberration.

Comparing Predictive Values to Post-op Results

With this example in mind, I conducted a pilot study that compared the postoperative total spherical aberration with the predicted value in the preoperative cornea in patients implanted with the Bausch & Lomb LI61AOV zero spherical aberration lens. Results showed that the total ocular spherical aberration was consistent with the inherent corneal spherical aberration. The follow-up feasibility study separated patients based on the preoperative corneal spherical aberration. Eyes with greater than 0.235 µm of spherical aberration received the Tecnis Z9000 IOL. Eyes with less than 0.1 µm received the Bausch & Lomb LI61AOV lens, while eyes between 0.1 µm and 0.235 µm received the AcrySof IQ SA60AT. With a goal of emmetropia, the desire was to nearly eliminate ocular spherical aberration. Most impressive was the power of the study's predictive value. The mean absolute error was 0.025 µm. With a well-centered IOL, the accurately measured corneal spherical aberration is combined with the correct aspheric lens, leading to a consistent reduction of higher-order aberrations.

Importance of Calculating Spherical Aberration

The vast majority of the nearly 3 million cataract surgeries performed annually involve the use of monofocal lenses, so we should always aim to precisely calculate and manage spherical aberration. The benefit of maintaining a tight control on spherical aberration is unmistakable, particularly when dealing with a population that can benefit from this the most. The 3-D Wave allows for the rapid collection of data that's necessary to achieve a high level of precision. In addition, appreciation of higher-order aberrations is quickly becoming the standard of care, and scrutiny of spherical aberration is another way to improve your patients' quality of vision and quality of life. **OM**

Dr. Solomon is in private practice in the Greater Washington, DC area. He's a clinical instructor at The Wilmer Eye Institute at The Johns Hopkins University. He also serves as chief of ophthalmology at the Dimensions Surgical Center in Bowie, Md.

By James J. Salz, MD

Making Optimal Use of the 3-D Wave™ in Refractive and Cataract Surgery Applications

Here's how this ophthalmologist maximized visual outcomes in a variety of patients.

I've had the Marco 3-D Wave for about 2 years, and it's probably the most frequently used instrument in my busy practice at the American Eye Institute in Los Angeles. The Marco 3-D Wave is a combined autorefractor, keratometer, corneal topographer, wavefront aberrometer and light and dark pupillometer, making it a multifunctional diagnostic instrument.

We perform autorefractions with the Marco 3-D Wave on all new patients who require a complete eye exam. The autorefraction takes just a couple of minutes and provides our technicians with an excellent starting point for performing refractions. The instrument has helped decrease the time it takes for the technicians to provide a complete workup, because it enables them to start with a refraction that's very close to the patient's final prescription.

In addition, the 3-D Wave helps us better evaluate potential refractive and cataract surgery patients, as well as manage astigmatism, and it enables us to generate more income. This article will explain how I use the Marco 3-D Wave and how it benefits my patients and my practice.

Evaluating Refractive Surgery Candidates

We use the 3-D Wave for all patients who come in for refractive surgery consultations. We perform refractions and obtain keratometry, corneal topography and wavefront aberrometry readings. Previously, we had to use three separate instruments in different exam rooms to obtain this information, which took about 10 minutes. Since the 3-D Wave combines the capabilities of five instruments, we can complete diagnostic tests in about 2 minutes in just one exam room. The graphic information the 3-D Wave provides makes it easy for us to explain to patients whether or not they're good candidates for refractive surgery, and if they're best suited for custom wavefront-based LASIK or conventional LASIK.

Cataract Patient Workup

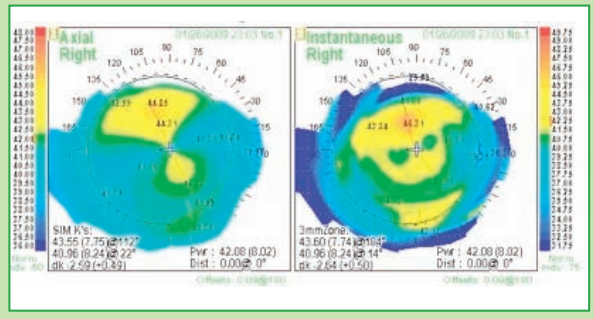
When evaluating cataract patients before surgery, we perform autorefractions and obtain keratometry, pupillometry, topography and wavefront readings. We also calculate and print out corneal spherical aberration and total spherical aberration measurements. We explain to patients that these findings enable us to give them the best possible visual outcome.

In addition, I review the results of the 3-D Wave tests with patients and the findings from the IOL Master. I explain the IOL Master readings are essential in calculating lens power. I discuss the topography results. And if they have little or no astigmatism, I explain that I can make an incision in the normal temporal location, and that additional incisions or a toric lens implant won't be necessary. If they have astigmatism, I demonstrate that I can correct the astigmatism with eyeglasses after surgery or attempt to reduce the astigmatism with LRIs or a toric lens implant. For years, I didn't charge patients for topography and LRIs, but in order to generate additional revenue for my practice, I began charging patients for both procedures.

Lastly, I show patients the results of their wavefront test and explain that the readings for spherical aberration help me choose a spherical or aspheric lens implant.

Case 1

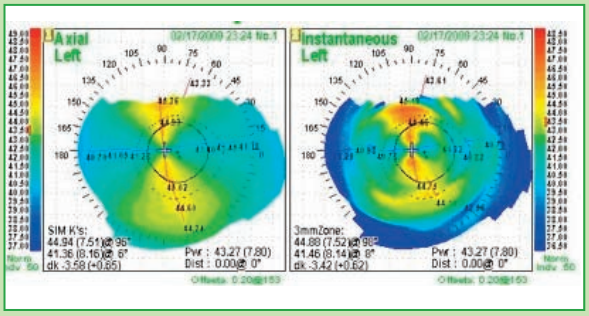
The refraction of this cataract patient was -3.50 -1.00 x 15 OD with a best-corrected visual acuity of 20/60. The topography of this patient showed asymmetrical astigmatism of 2.59D with more steepening superiorly. The superior limbal relaxing incision at 115º was 2 o'clock hours in length. The inferior incision in the same axis was 1 o'clock hour in length at a blade setting of 600 microns. Postoperative uncorrected visual acuity was 20/25 in this dominant right eye targeted for distance. The target for his post-op refraction OS was -1.50D. Topography showed a similar asymmetrical astigmatism of 2.34D. Again, I performed asymmetrical LRIs. His refraction was -1.00D post-op in his nondominant left eye targeted for monovision.



The topography of this patient shows 2.34D of asymmetrical corneal astigmatism OD, which were corrected with limbal relaxing incisions.

Case 2

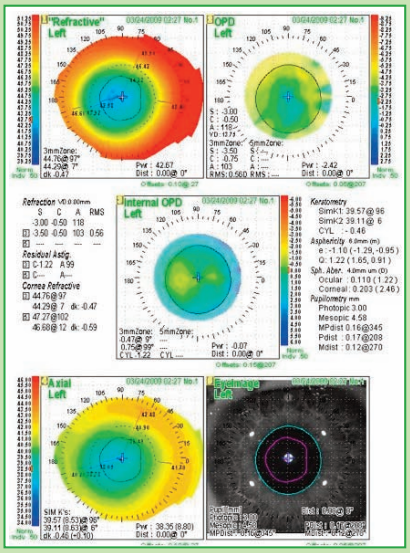
The refraction of another patient who required cataract surgery was +1.75 -5.00 x 18 OS. His best-corrected visual acuity was 20/80. The topography of this patient showed symmetrical astigmatism of 3.58D. I performed symmetrical LRIs that were 3 o'clock hours in length above and below the cornea at 95º. Postoperatively, his refraction was -1.00 -0.50 x 180.



The topography of this patient shows 3.58D of symmetrical corneal astigmatism (left). Symmetrical LRIs 3 o'clock hours in length above and below (right) improved the refraction.

Case 3

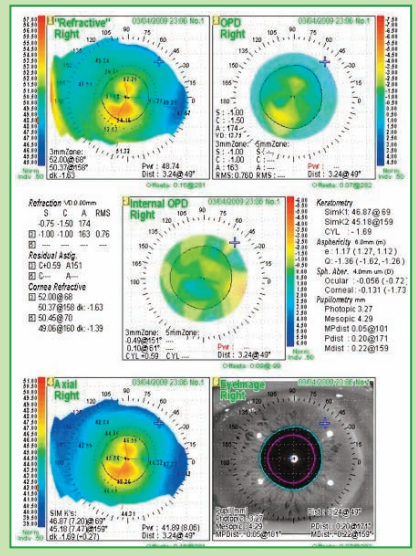
I performed PRK 8 years ago on the following patient who had -9.00D of myopia. She later developed a cataract in her left eye that caused her refraction to become more myopic at -5.00D. Her best-corrected visual acuity was 20/50. The map below shows the typical central flattening of a patient with myopic PRK. And as expected, she had positive corneal spherical aberration of 0.203. I implanted an aspheric lens (Alcon AcrySof IQ SN60WF) targeted for monovision at -1.50D in the nondominant left eye. Her postoperative refraction is now -2.00D.



This topography map shows typical central flattening of a patient who had myopic PRK. Her positive spherical aberration of 0.203 was corrected with an aspheric lens (Alcon AcrySof IQ SN60WF).

Case 4

I performed LASIK in another patient 8 years ago for hyperopia. She developed a cataract in her right eye. Her best-corrected vision was 20/70 with a plano refraction. Her topography shows the typical central steepening of hyperopic LASIK, and as expected, she has negative corneal spherical aberration of -0.131. The implant I chose was a spherical lens (Alcon AcrySof SA60AT) in this nondominant eye with a target of -1.50D. Her final refraction is -1.25D.



This topography map shows typical central steepening of hyperopic LASIK. The patient's negative corneal spherical aberration of -0.131 called for a spherical lens (Alcon AcrySof SA60AT) correction.

Valuable and Profitable Instrument

The Marco 3-D Wave has been a valuable addition to my practice. The technicians find the instrument easy to use with minimal training. It helps us to quickly evaluate our refractive surgery patients and produce additional income for cataract patient workups. For example, if we only used the Marco 3-D Wave to evaluate 10 cataract patients a month, we'd generate $900 (covering the average lease payment). If three patients choose to have LRIs, we can collect an additional $750 for a total of $1,650. Currently, my practice performs these evaluations on 350 cataract patients each year. Aside from the extra revenue, the instrument helps us produce better visual outcomes for cataract patients, manage astigmatism and select the appropriate lens implant based on topography, spherical aberration of the cornea and wavefront aberrometry readings. **OM**

Dr. Salz is clinical professor of ophthalmology at the University of Southern California. He's president of Laser Vision Medical Group in Los Angeles, and partner with the American Eye Institute in Los Angeles. He's been principal investigator in nine FDA laser vision correction studies and has published articles and lectured extensively on all aspects of refractive surgery.

By Thomas John, MD

Using the 3-D Wave™ in Cornea And IOL Applications

This surgeon used the 3-D Wave to more accurately diagnose and treat patients.

User-friendly, automated ophthalmic testing equipment that saves time and requires little space is always welcome in any ophthalmology practice. The 3-D Wave (Marco), certainly fits these criteria. I find this unit to be a useful clinical tool in evaluating the anterior segment and the entire optical system. The 3-D Wave is extremely accurate and can be coupled with the EPIC 5100 or TRS 5100 refracting systems. It provides a one-stop-shop approach to a comprehensive eye exam that most ophthalmologists will appreciate. It's an autorefractor, keratometer, corneal topographer, pupillometer and wavefront aberrometer all in one unit. These fast, complex composite measurements often can help you perform an objective evaluation of a patient's symptoms and come to a more definitive clinical diagnosis. This enables you to assess patient complaints, manage various ocular conditions and improve best-corrected visual acuity. It's an essential diagnostic tool in the office setting.

In this article, I'll share some clinical examples of cases that underscore the utility of the 3-D Wave device.

Case 1: Good Vision But Persistent Symptoms

A 47-year-old Caucasian man was referred to me by a retina specialist for evaluation of his cornea and anterior segment for unexplained ocular symptoms. The patient complained of blurred vision in his left eye for about 5 months. He had a history of repaired bilateral retinal detachments. In his left eye, he had retinal detachment surgery with the use of silicone oil in March 2008. The silicone oil was removed from his left eye about 2 months after surgery. He complained he couldn't see with his left eye in bright light but could see better with his pupil dilated in dim light.

The patient's uncorrected vision in the symptomatic left eye was 20/30-2. The uncorrected vision in the asymptomatic right eye was 20/60-2, which improved to 20/40-2, using the pinhole. The clinical exam in the left eye revealed a clear cornea, a well-centered posterior chamber IOL and an attached retina. He also had a history of blurred vision in his left eye. Normally, one would question the symptoms in the patient's left eye, because of the excellent surgical result and the uncorrected visual acuity of 20/30-2. I tested both of the patient's eyes with the 3-D Wave and examined his cornea and retina in his left eye using optical coherence tomography (OCT).

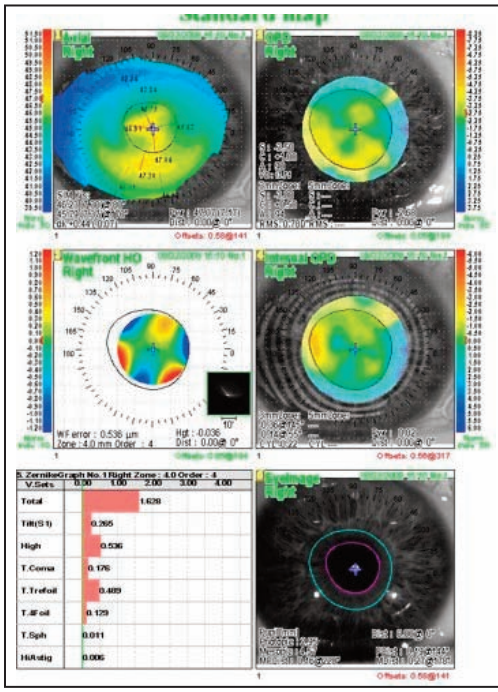


Figure 1. Wavefront analysis of the right eye, using the 3-D Wave, shows a total aberration of 1.628. The point spread function also is shown.

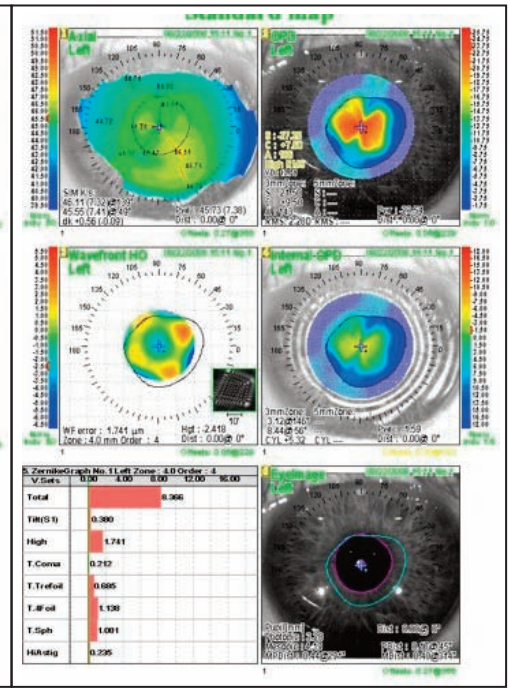


Figure 2. Wavefront analysis of the left eye shows a total aberration of 8.366 and a grossly abnormal point spread function.

Uncovering the Problem

The 3-D Wave wavefront analysis showed abnormal total aberrations and point spread function (PSF) in the left eye compared with the right eye (**Figures 1 and 2**). OCT showed macular thickening in the asymptomatic right eye and a normal macula in the symptomatic left eye. OCT showed normal corneas in both eyes. The total aberrations in the right eye were 1.628 and 8.366 in the left eye. Based on the 3-D Wave wavefront analysis, I reexamined the patient clinically after pupillary

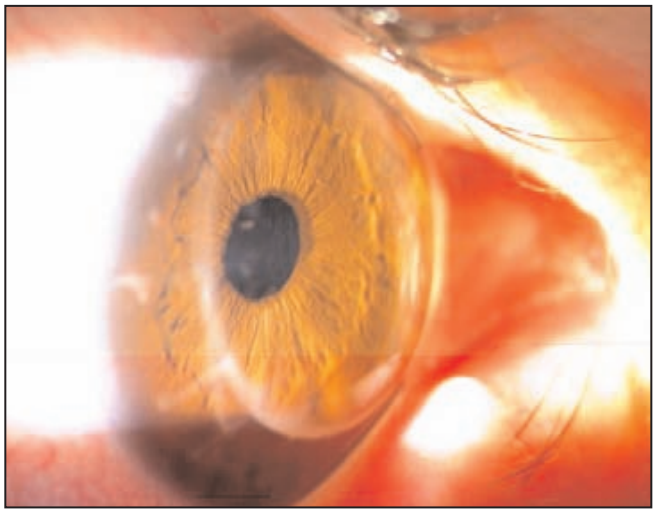


Figure 3. This image shows a clear cornea with no ectasia after total anterior lamellar keratoplasty for the correction of corneal ectasia after LASIK.

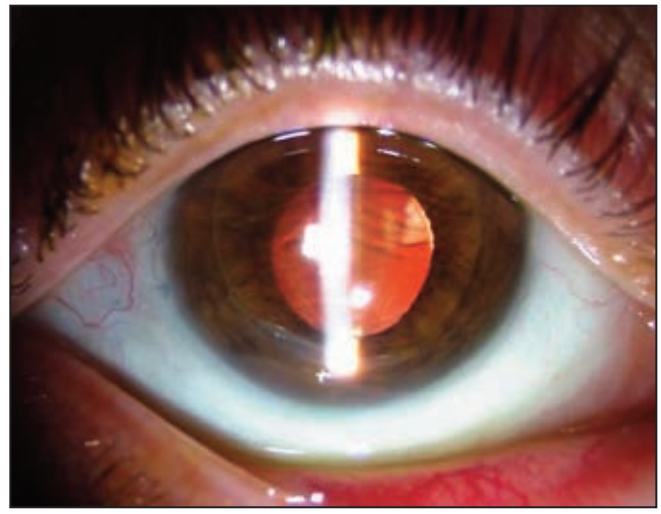


Figure 4. This image shows macro- and micro-folds in the clear, donor corneal disc following Descemet's stripping automated endothelial keratoplasty.

dilation. A red reflex exam showed a silicone oil droplet on the posterior IOL surface. This oil droplet contributed to his ocular symptoms. I sent the patient back to his retinal surgeon to correct the problem.

This case demonstrates that without the use of wavefront analysis using the 3-D Wave, I wouldn't have uncovered the true etiology of his ocular symptoms, and the patient might have gone from doctor to doctor without ever receiving the proper diagnosis and treatment. His symptoms would've been discounted because his uncorrected visual acuity was excellent after retinal detachment surgery with silicone oil.

Case 2: Confirmation of Corneal Ectasia

A 45-year-old man underwent LASIK in both eyes. He presented with a history of blurred vision in his right eye. His uncorrected vision in the symptomatic right eye was count fingers. He had numerous metallic, nonreactive, small foreign bodies in the corneal interface between the flap and the bed. The 3-D Wave corneal topography exam confirmed corneal ectasia in the right eye. The PSF was abnormal, and the total aberrations in the right eye and left eye were 6.512 and 2.378, respectively. He underwent total anterior lamellar keratoplasty in his right eye (**Figure 3**), retaining his healthy corneal endothelium, thus preventing any future endothelial graft rejection and surgical correction of the corneal ectasia.

The 3-D Wave topography confirmed the diagnosis of corneal ectasia in the patient's right eye and showed poor quality of vision with abnormal PSF and increased total aberrations.

Case 3: Preventing Surgical Intervention

A 55-year-old Caucasian woman underwent Descemet's stripping automated endothelial keratoplasty with phacoemulsification and posterior chamber IOL implantation in both eyes under topical anesthesia with monitored anesthesia care. Her uncorrected visual acuity was 20/100 in the right eye, which improved to 20/40 using the pinhole. Her uncorrected visual acuity was 20/30 in her left eye. The patient complained of blurred vision in her right eye. Biomicroscopic examination revealed macro- and micro-folds in the donor disc that was clear and well adherent to the patient's cornea (**Figure 4**). I considered a corneal disc exchange in her right eye. The 3-D Wave analysis of the cornea showed increased total aberrations in her right eye. The total aberration 8 months after surgery was 2.226 with a dK of 0.66, and the total aberration at 1 year and 6 months after surgery was 1.704. The patient's symptoms improved over time.

The 3-D Wave topography confirmed the remodeling of the donor-recipient corneal interface with decreased total corneal aberrations over time, thus improving her ocular symptoms. This test helped me decide to observe the patient instead of performing a corneal disc exchange.

Useful, Investigative Tool

The 3-D Wave certainly is a useful, clinical investigative device that can assess corneal topography, evaluate the optical system and calculate higher- and lower-order aberrations and more. Such an instrument helps in the clinical diagnosis of various corneal and anterior segment diseases. In addition, physicians can use the 3-D Wave sequentially over time to evaluate response to treatment, progression of keratoconus and iatrogenic corneal astigmatism after penetrating keratoplasty. Clinicians also can use this unit in presurgical applications to screen for keratoconus or pellucid marginal degeneration, which are contraindications to LASIK. You can use the 3-D Wave for pupillary evaluations and documentation and to evaluate the quality of vision in patients after cataract surgery. The 3-D Wave is a multifunctional unit that's an essential clinical tool in any eyecare practice. **OM**

Dr. John is clinical associate professor at Loyola University in Chicago, and he's in private practice in Tinley Park and Oak Lawn, Ill.

The OPD-Scan II (3-D Wave) is manufactured by Nidek.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