Highlights from the POWER FORUM – a live discussion held during the 2011 meeting of the American Academy of Ophthalmology

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Optimizing Surgical Outcomes with Refractive Wavefront Technology

The OPD-Scan III gives you the data you need to deliver the exceptional outcomes your patients expect.

Larry Patterson, MD: We all want to achieve excellent, perfect refractive outcomes in our patients. In your experience, what problems or obstacles do you see interfering with your ability to reach those outcomes?

Kerry D. Solomon, MD: Well, I think there are a few things. There are limits to technology, and many of our offices don't have the processes in place that we need to "walk the walk."

Refractive cataract surgery is a reality. We've got femtosecond lasers, multifocal lenses, toric lenses and accommodative lenses. However, in LASIK practices, we're at 90 to 95% 20/20, or a very high percentage of plus or minus a half a diopter. In contrast, cataract surgery and lens replacement, for many practices, is at about 60 to 70% plus or minus half a diopter. Refractive cataract surgery is not in the same place as LASIK surgery. It will help us to pay attention to our data, follow our outcomes and optimize things as much as possible. We've got some fun, new technology to help with that, and I think with time, these numbers are going to get better.

Damien Gatinel, MD: We need to have more comprehensive diagnostic capacity. In the areas of cataract and refractive surgery, we must be able to distinguish the cornea from the internal optics. This is very important because I think the quality of the diagnosis helps determine the outcome. The diagnosis helps me make better decisions and choose the right strategies for treatment. So, I think that today, it's very important to improve the diagnostic capabilities in our practice. We have a large armamentarium to work with, but we still need to raise our expectations on the diagnostic side.

Farrell "Toby" Tyson, MD: I think cataract surgery is being held to a much higher standard today than it was decades ago. Our patients expect almost perfect vision, so we must have the right equipment to obtain top-notch results. There's a transition happening in our practices — we're trying to get the equipment that will give us the information we need. The effort to change our outcomes is changing equipment, the surgeon's process, workflow and the physical aspects of our practices. We're not just looking at axial length and keratometry. We're evaluating wavefront patterns, and considering which type of IOL best matches each individual. All of this consumes time and space in a clinic. As a result, we're finding that we have to learn a whole new method of taking care of our patients in a way that provides an excellent standard of care but is also efficient.

Mitchell A. Jackson, MD: I agree that patients have high expectations. To ensure that they're satisfied with the outcomes, our job begins with managing their expectations. That's the first thing I always try to do, because we really aren't there yet to perfectly nail the result. I manage patient expectations with refractive cataract surgery as a first step, and then go into managing the pre-op evaluation.

Paolo Vinciguerra, MD: This is challenging for the ophthalmologist. The most demanding part is not so much the surgery, but the planning and the decisions in integrating all of the technology that we have and understanding all of the possibilities that those technologies provide. That is the hidden work — the patient doesn't see it, but it is perhaps the most important part of our jobs.

Arturo Chayet, MD: We were used to measuring the eye from the surface, but what about the internal parts of the eye — the posterior cornea, the lens itself and the IOL once it's in place? I think evaluating the internal

aspects of the eye is very important and that's something this type of technology can provide.

Treating Patients with Past LASIK

Dr. Patterson: We've all seen enough cataract surgery patients who have had LASIK or RK refractive surgery, so we know that refractive outcomes can be all over the place. Do you have a quick, simple and accurate way to calculate IOL power for these patients?

Dr. Kerry Solomon: There are a few things we can do. First, ground your patients' expectations. We tell everyone, “If you hadn't undergone previous refractive surgery, your likelihood of getting where you want to be — 20/20, for example — is maybe 80 to 85%. Your past surgery puts you in the 60 to 65% realm, but there are some things we can do to improve that.”

I think the ideal diagnostic technology for all of us would be a device where we could take a measurement, make an adjustment based on the patient's history, including past surgery, and come up with an answer that's close. It's too early for us to tell in previous refractive patients, but I'm very excited about what the OPD-Scan III (Marco/Nidek) technology brings to the table.

Dr. Tyson: Our knowledge of the patient's surgical history is another issue. Many practices are inundated with people who come in and say, “I've had laser surgery.” They don't have any background. We ask, “Was it myopic or hyperopic?” They don't know. I think we need a device that can show us what we're dealing with quickly. Was it a mild myopic treatment? Was it a high myopic treatment? With a device that can answer your questions, you'll know how much variability you're likely to have.

Dr. Kerry Solomon: The OPD III has the ability to take the information and plug it into the ASCRS website, exactly as you're saying. That doesn't require much information. I think it's very exciting.

Dr. Jackson: The OPD III gives you the spherical aberration. If you're not sure what type of procedure a patient had in the past, or he can't remember and you can't get the records, and you've done your topography with the OPD III (or whatever device you're using), you still get the spherical aberration number for all patients, including those with past LASIK. You can take the spherical aberration data and treat the patient with a customized monofocal lens based on that information.

Determining the Axis for Toric IOLs

Dr. Patterson: Many of us are using torics now. How do you determine if your toric IOL is at the correct axis, and how does the OPD III technology help with that?

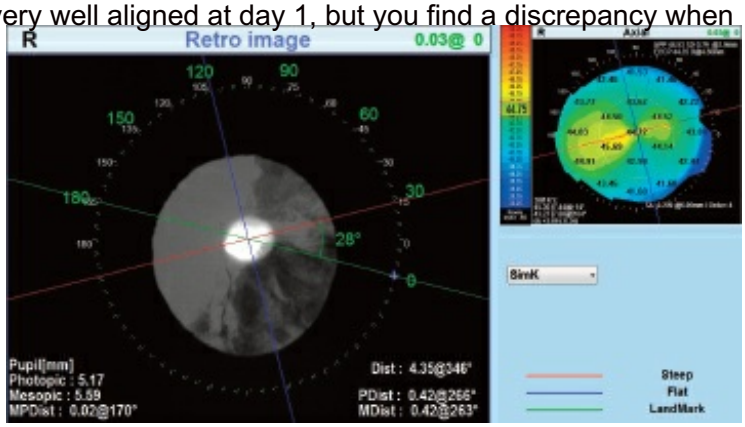
Dr. Gatinel: It's a very interesting question. Pre-operatively, you can assess the orientation of the corneal cylinder, because what you want to correct is not astigmatism, it's corneal astigmatism. And because the instrument has a Placido topography system, it shows you the orientation of the corneal cylinder at the time of acquisition. If you go to the toric IOL menu, a map (**Figure 1**) shows you the main meridians — the steepest and the flattest. You can know the precise location of the steepest meridian. Pre-op, you perform a retro-illumination acquisition, which might show you some iris details or even limbal details, which can be useful for marking the axis where you're going to align the IOL.

Figure 1. The toric IOL menu on the OPD III provides the key meridians, the steepest and the flattest.

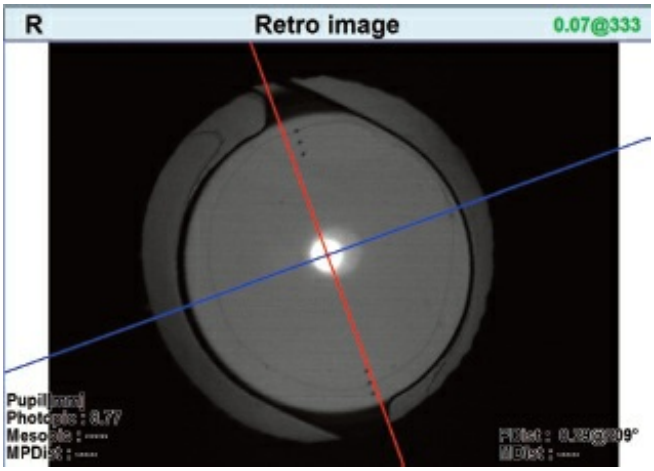
Post-operatively, as early as day 1, you can make another retro-illumination acquisition with the IOL and check objectively if you're on axis or if you're, say, two, three, or four degrees off (**Figure 2**). Once you get this retro-illumination acquisition, you can use a reticle to view the marks that usually come on the IOL — like the arc on the three points of one IOL — to see how accurate or misaligned you are.

Figure 2. You can use a retical to view the marks that usually come on the IOL

This is very important because sometimes the IOL is very well aligned at day 1, but you find a discrepancy when you perform an examination a month later. At that point, you don't know if you were wrong to start with or if the IOL shifted or rotated over time. I've noticed some rotation, particularly in myopes, who usually have larger bags. By looking early, we can show to the patient that we did the proper job initially. If there is rotation later, I can fix it because I know exactly how many degrees I have to rotate the IOL. By knowing how many degrees I'm off, I can do a better job realigning the IOL by rotating it in the proper range, and the checking it.



Dr. Kerry Solomon: I had a case this morning where the topographer showed 2 diopters of astigmatism, the IOL Master (Zeiss) showed two diopters of astigmatism, and the OPD III showed a diopter and a half. That's the difference between a T4 and a T5 lens.



More than half of our patients are eligible for astigmatism surgery, whether it's toric or presbyopia-correcting lenses, but those with half a diopter residual astigmatism? We wouldn't operate on them in our LASIK practice.

In fact, on the toric calculator, it was 0.2 diopters residual astigmatism. If I'd implanted a T5, I probably would have flipped the patient by about 0.7 diopters. I wound up getting manual Ks, which were 1.5 diopters. We went with the OPD measurement, and that told us where the patient was. I think it's very impressive and exciting to see that the OPD III has proven to measure the absolute amount of astigmatism. In helping me choose toric lenses, it has been accurate — close to my manual Ks.

Dr. Gatinel: I think it's also important that you can detect keratoconus or pellucid marginal degeneration. When you're using toric IOLs, it's important to distinguish regular astigmatism from irregular astigmatism, and performing topography systematically helps in this way.

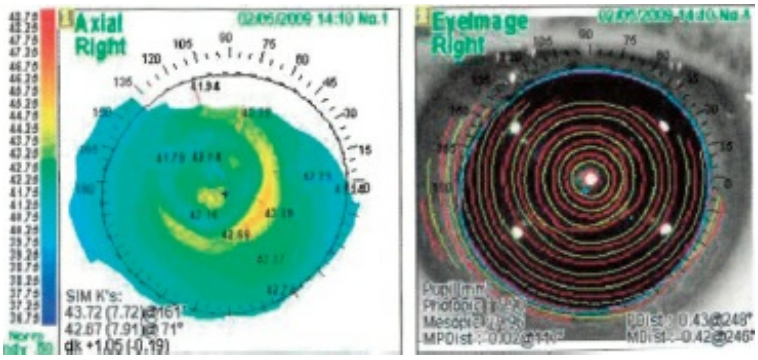
Dr. Jackson: When you have a patient in your chair and you're discussing whether you're going to use a toric IOL or an upgraded lens implant, I think it's best if you can show the patient the maps, especially if you have an EHR with screens in the exam rooms. I can show a patient her corneal astigmatism, her lenticular internal OPD III reading, and say, “This is what I'm going to remove.” This helps patients see why there may be residual astigmatism afterward unless we treat it. It's a great device for patient education (**Figure 3**).

Figure 3. The OPD III is great tool for patient education.

Dr. Tyson: It also keeps you from making errors. One of my patients had IOL calculations that reflected a lot of cylinder. This would have been a toric patient, but as soon as I saw my OPD III printout (**Figure 4**), the top showed me this very interesting asymmetric astigmatism. It looked like a “C” right in the middle of the cornea. It happened to be the perfect size for a Goldmann tonometer, so the OPD III was able to pick it up. If I hadn't seen that, I would have operated on this patient and put in the wrong lens. Luckily, the

OPD III showed me what was going on, so I was able to bring the patient back on a later date, get the right IOL Master measurements, and perform the correct surgical procedure.

Figure 4. OPD III maps shows mark by an applanation tonometer.



Dr. Vinciguerra: It's important that we can measure the pupil, since some corneas show different astigmatism at different pupil sizes. We need to explain to those patients what we're aiming to optimize — day or night vision — to avoid unexpected results and patient disappointment.

Addressing “Night-and-Day” Vision

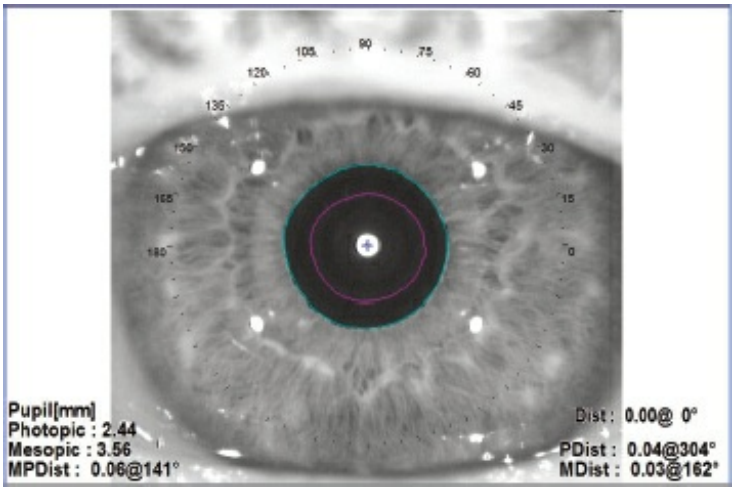
Dr. Patterson: Patients' prescriptions can change as the pupil changes from day to night. As a result, patients sometimes tell us after surgery, “I'm fine in the daytime, but I'm having trouble at night,” or vice-versa. Of course, we also hear this complaint from people who never had surgery, so how do we measure that, and how do we prescribe for people who see differently at different times of day?

Dr. Tyson: The OPD III allows you to take measurements and refractions with different pupil sizes. It will actually tell you the pupil size and what the refraction is over that. You can see a mesopic pupil and a photopic pupil and get the refraction for each one. You can see if there's a big spread.

We also hear a great deal about night vision issues, and we can adjust the prescription to improve things like nighttime driving. We see it primarily with patients who are not happy driving at night in their multifocal lenses. Some patients are even unhappy driving with multifocals during the day, and we usually find that those patients' pupils are a bit larger in the daylight than we would hope. They've got a partially diffractive optic functioning like a distance-dominant lens, and it's making it difficult for them to have the daytime vision they want.

So, I look for mesopic and the photopic pupils preoperatively. And that's the nice thing about the OPD III system: In 30 seconds, I get my corneal topography, my auto-refraction, and my wavefront. At the bottom, I get my corneal spherical aberration. And I get my light and dark pupillometry, which really lets me know which lens is right for this patient (**Figure 5**). I'm not concerned about getting myself into trouble by going down the wrong path.

Figure 5. With the OPD III, practitioners obtain corneal topography, autorefraction and wavefront images in just 30 seconds. Corneal spherical aberration is also displayed. Here, light and dark pupillometry is shown.



Dr. Jackson: Many of the lens implants we're using are pupil-dependent, or pupil-independent. To have the data on the mesopic and photopic pupil, with all this other data, helps you make a proper decision on the IOL you're about to implant on a patient so you don't get into trouble post-operatively.

Uncovering Angle Kappa

Dr. Patterson: Let's say that you implant multifocal IOLs in a patient, and the outcome is 20/20 distance and Jaeger-1 at near. The implant looks fantastic. However, the patient is unhappy. What's the problem?

Dr. Jackson: I'm discovering that it's often the angle kappa, and I recommend that everybody start looking at angle kappa with their patients pre-operatively. When we're measuring angle kappa post-operatively, we're learning that if a patient has 0.4 mm or greater angle kappa in a multifocal IOL, that patient is more likely to complain. It's not wavefront or the ocular surface — we've handled those properly — but it's angle kappa. We know that's the difference between the optical axis and the visual axis.

Now, when I look at this pre-operatively and see that a patient has an angle kappa of 0.4 mm or greater, I try to avoid a multifocal lens. I don't want to get into trouble with the patient going forward. And that's really a great thing about the OPD III. It enables me to help patients post-operatively, and also gives me a number to look at with all these other variables preoperatively. I evaluate a great deal of information very quickly, so I don't make that mistake again.

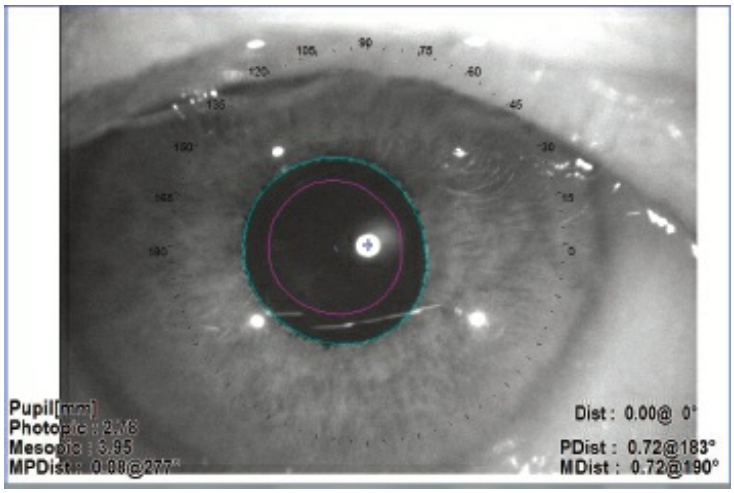
Dr. Vinciguerra: We actually published on this after we had a patient who was totally unsatisfied the day after implantation of an IOL.[1] When we measured the patient, we discovered a high amount of coma in the same direction of the displacement of the angle kappa. We went back in, moved the lens and the patient gained two lines the following day. He was totally satisfied. It's a very easy procedure to check the angle kappa with the OPD III, and it's very useful. We were able to fix the problem because we knew exactly how much to move the lens. If you see the two images, the change in the internal wavefront is impressive.

Dr. Jackson: We found the same thing. Many unhappy patients had significantly more coma than the happy patients. This at least helps us understand why they're not happy.

Jonathan Solomon, MD: I think this also applies to our aspheric toric lenses. In large part, if you're off the visual axis by as little as 0.5 mm, you can induce coma. I believe that if you pay attention to that, and more importantly, if you're aware of preexisting exaggerations in angle kappa before you walk into the operating room, you can avoid having dissatisfied patients.

Dr. Gatinel: With the OPD III scan, it's interesting that the wavefront is centered not on the center of the pupil, but on the first Purkinje image. This is probably closer to the visual axis, especially in patients with large angle kappa (**Figure 6**).

Figure 6. With the OPD III scan, the wavefront is centered on the first Purkinje image, which is probably closer to the visual axis, especially in patients with large angle kappa.



Dr. Jackson: I highly recommend that people use the OPD III to evaluate the data in any patients who are unhappy with their outcomes; you'll probably find that those patients have a fairly large angle kappa.

Selecting an Aspheric IOL

Dr. Patterson: We've got a range of variably aspheric IOLs to choose from, like plus-asphericity, minus-asphericity, and no asphericity. How do you determine which one will get your patient closest to zero spherical aberration? And does getting patients to zero really make a practical, day-to-day difference in their vision anyway?

Dr. Chayet: Oh yes, definitely, it makes a huge difference — even more so in patients who have undergone previous refractive surgery. It's not easy to tell exactly which lens a patient needs, so it's a very nice thing that the OPD III and IOL station software automatically chooses the best lens for the patient. There's no one particular lens that's good for all patients, but the software helps you choose the right one so you can address the spherical aberration and achieve what you want to achieve.

Dr. Jonathan Solomon: About a year and a half ago, we did a study [2] in our office looking at just those capabilities with the OPD-III. We wanted to see how well it could help us line up an aspheric lens, addressing issues with angle kappa and more importantly angle-alpha and making sure it's an appropriate alignment. Not only is the machine unbelievably accurate at identifying corneal spheric aberration, but it's also accurate in quantifying the total ocular spherical aberrations, and that's the bigger issue.

The wealth of information you collect in just 20 seconds with the OPD-III is critically important to help guide your ability to identify the right lens for the right patient. Sure, we understand that a toric lens and a presbyopia-correcting lens is a premium package, but when you can offer a monofocal aspheric implant as a premium package to a patient, you really improve the level of care across the board. That speaks volumes in the community. Doing an aspheric optimized platform says a great deal about your work.

Dr. Vinciguerra: And remember that you're getting this in a single instrument, not multiple instruments. Without the OPD III, you have to use a topographer, moving the patient to the aberrometer, and then moving the patient again to do pupillometry. With the OPD III, you get everything in one shot with perfect registration, so you see exactly what the curve is, and you see the interior-internal-posterior dimensions in the same location. When you have many instruments taking data separately, registration becomes a major issue. The head moves, and they never match.

Dr. Gatinel: For the diagnosis of cataracts, we know that the crystalline lens usually balances the corneal spherical aberration a little bit. But sometimes I have unhappy patients who are 20/20. They have no ophthalmic history, so I suspect a cataract. If I look at the internal wavefront, especially the spherical aberration value, and see that it's minus 0.3 or minus 0.4, then I've got a very good early sign of nuclear sclerosis. The refractive index of the lens increases because there is an early cataract, so this helps me confirm that the patient has cataract and should benefit from surgery. Even if the patient is currently 20/20, knowing what's causing the dissatisfaction is a good thing. The OPD III then helps to measure the corneal spherical aberration, so we select the proper IOL to match the aberration.

Dr. Jackson: The critical thing is we're getting all the data from one instrument. Office efficiency is crucial, but the accuracy of the data is key. Using multiple devices, the eye is dessicated completely and by the third test the data is highly inaccurate. So, you're not only able to interpret data more accurately, you're actually getting more accurate data by getting it all at one time.

Dr. Tyson: Well, I think one of the whispers in the room here is does spherical aberration matter? I think many people believe it that if we can't hit plano perfectly every single time, why do we worry about a couple of microns of spherical aberration? We know we can only achieve so much accuracy in hitting that plano target, but if we can reduce the spherical aberration, that gives us more wiggle room to make happier patients. If you can get that spherical aberration reduced, they're still able to hit the 20/20.

When you go to a multifocal optic that is inherently contrast reducing, you want every advantage you can get. So once again, you want to perform spherical aberration matching, so you can maximize that image, because you know it's compromised to begin with. You're trying to get as close to zero as possible. It's not like we're going to have this precision. We only have about three or four lens choices. So we're talking ballpark figures. We're trying to get as close to zero as possible. We know we're not going to hit perfect zero microns left over.

When you talk about multifocal lenses, you're only dealing with two choices, and there's a decent spread between them. I think the spherical aberration matching does make sense, and in several practices, including my own, we have a separate package for our wavefront-optimized vision.

Dr. Jackson: Trattler and colleagues[3] did a prospective study called the PHACO study, which showed that before cataract surgery, many patients with few or no symptoms had ocular surface problems. About 50% had central corneal staining, more than 60% had abnormal tear breakup time, and over 21% scored less than 5 in Schirmer's testing.

That's a lot of patients with ocular surface condition problems coming in for cataract surgery. We're trying to capture data to get the best outcomes, but if many of those ocular surfaces are bad, we'll get the wrong data.

That means we'll have abnormal keratometry or axial length readings, and we'll be off by a diopter or a diopter and a half with the IOL — all thanks to a poor ocular surface. Even if we get lucky and hit it right, patients will still have poor outcomes because of post-operative vision variability.

The nice thing about the OPD III is that there's just so much information, and you can customize it any way you want. With the 33 Placido rings, I've gone almost to evaluating the mires to evaluate dryness. It gives you a lot of information about the ocular surface very quickly, on a patient who very well may already have a compromised ocular surface.

Dr. Tyson: The critical thing is not only the speed, but also the accuracy. You get all of this data in 10 seconds, so the time efficiency for the office is huge. But the time saved pales next to the fact that the eye is desiccated completely by the third test. And we know with an ocular surface that's dry, the capture and the data are highly inaccurate. Besides helping us to interpret data more accurately, we're getting more accurate data by capturing it all at once.

Marking Without Error

Dr. Patterson: When I put in a T9, the width of my ink mark alone is about a diopter to a diopter and a quarter off. How can I mark it better? I've seen some complicated, expensive techniques. Is there an easier way to do it?

Dr. Jonathan Solomon: With these markers, no matter how fine the tip, it will account for about five degrees. But with the retro-illuminated image with the OPD III instrument, you're able to actually triangulate an orientation for your toric lens that is unbelievably precise. Ninety-eight percent of the toric lenses, if you look at most studies, are within 10º. We've been able to cut our absolute error from an astigmatic component in half, just by looking at lenticular landmarks on the toric summary from the OPD III. With the OPD, we've been able to reduce astigmatism by 50% — and it's such an easy method to apply.

Dr. Tyson: When the OPD III takes the image, you can look at it and put up your landmarks, whether it's a blood vessel, lenticular marks, or iris crypts. You can line up and overlay your treatment pattern. When you go into the OR, it doesn't matter if that eye has toric or not, you're looking down there and you know where the IOL is supposed to line up, so you can line up your lens marks with the marks that you've already pre-planned.

The OPD III helps you with workflow, too. You want to be able to go from room to room with your plan already in hand.

Aspiring to Perfection

Dr. Patterson: What is the ultimate patient response that you want to hear after surgery? What are you really looking for in most cases?

Dr. Chayet: I think you should aim for emmetropia. Emmetropia is a very important component of happiness. Also important is our ability to match the right lens to the visual system of the patient.

So we have to take into consideration all of the aberrations.

Dr. Jackson: I want to be able to do my diagnostic testing, feel highly confident with the lens implant I put in based on my interpretation of the data, and end up with emmetropia or whatever result I want — a 20/happy patient. I want to have the proper data pre-operatively to help make the decision. The OPD III is definitely a significant jump in technology from what we had previously. It's showing us a lot of new factors to improve our ability to share my expectations with a patient and then achieve that final outcome. I'm confident because I've seen the pupil's size, the spherical aberration, the angle kappa, and internal OPD III versus corneal topography, all in 20 seconds.

Dr. Vinciguerra: The OPD III also helps us see more in the periphery. It has given us the capability to measure the internal wavefront and it can project more rings onto the cornea than we had seen in the past. We have

much more resolution, so we can understand much more. With the additional data about the periphery, we can see that patients with perfect periphery have better quality vision than those who do not. That can affect patients' satisfaction.

Dr. Tyson: We've always been taught that the enemy of good is perfect. That's all changed. If you're not aiming for perfection, you're never going to hit it. Some people might see us looking at angle kappa and corneal spherical aberration and wonder if it's overkill. Well, how do you want your eyes evaluated? We're aiming for perfection, and if we're not trying to find every data point that can help us get there, we're never going to reach it. Plus, when you do achieve perfection, it's a wonderful thing. Those patients come out and you know that you've hit a home run. And it's really nice when your day is mostly home runs and very few strikes.

Dr. Jonathan Solomon: I agree completely. I think in large part, there is some inherent, absolute error that we're not able to overcome at this point. Looking at a medical record before you walk into the exam lane, you're able to gather a lot of information. It's not uncommon to see that your patient has a residual spherical equivalent that isn't necessarily emmetropia, yet you walk in the door and find that the patient is just beaming. These patients are unbelievably thrilled with the results you've been able to achieve.

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