Next Generation Retinal Imaging: cSLO Combined With Spectral Domain OCT

Highlights of a Breakfast Symposium held during The Retina Society meeting, Boston, Mass.

PANELISTS: David M. Brown, MD, FACS, Scott W. Cousins, MD, Jeffrey S. Heier, MD, Peter K. Kaiser, MD, Quan Dong Nguyen, MD, MSc

Simultaneous ICGA and SD-OCT of RAP Lesion
Exploring How New Imaging Modalities Can Change Patient Care

We are in the midst of a retinal revolution, a time in which our approach to virtually every common retinal disease we treat is undergoing change. Advances have occurred in all aspects of disease management, including diagnosis, surgical technique and instrumentation, and pharmacologic treatments. We have 23-gauge and 25-gauge sutureless surgery with new instrumentation and light sources. We have new pharmacotherapeutics, such as agents that target vascular endothelial growth factor (anti-VEGF agents) and steroid implants.

Optical coherence tomography (OCT) has led to significant changes in our management of AMD and retinal diseases associated with edema. Some of these advances are being led by improvements in diagnostic imaging, and some of these advances are leading to improvements in diagnostic imaging. For example, OCT was predominantly a research tool until the success of treatment advances such as anti-VEGF and triamcinolone injections led to a realization of its benefits as a treatment-monitoring tool.

Now there is a new world of diagnostic imaging unfolding before us. Lasers and superluminescent diodes are changing the way we look at the eye, revealing new information and new ways of understanding the disease process.

What we knew as OCT is now changing into spectral domain OCT (also known as Fourier domain OCT). With this advancement, we are now able to resolve most of the layers of the eye, and debate has already begun on how these high resolution images correlate with histology.

**IMPROVED FLUORESCEIN AND ICG ANGIOGRAPHY**

Confocal scanning laser technology (cSLO) is providing us with a multitude of new imaging modalities. The cSLO enables us to excite fluorescein dye at its peak wavelength, returning images with finer detail than traditional photography, and providing movies of blood flow which tell a dif-

![CNV NOT DETECTED ON FA](image1)

![CNV DETECTED ON VOLUME SCAN, NOT ON FA](image2)

![IS THERE A ROLE FOR ICG?](image3)

**Fig. 1.** CNV that is missed by fluorescein is detected with a SD-OCT volume scan as well as with ICG angiography.
ferent story than intermittent still images.

The improvement in angiographic image quality is most dramatic when applying cSLO to indocyanine green (ICG) imaging. While Yannuzzi and others showed us the first signs of RAP through cloudy images of the choroid, ICG imaging using cSLO provides clear views of the choroidal vasculature. In one of our cases, we used simultaneous ICGA with spectral domain OCT to find CNV that was not apparent on fluorescein angiography. We picked it up as a little blip on an OCT scan and confirmed it with ICG (Figure 1).

**AUTOFLUORESCENCE: IMAGING WITHOUT DYE**

Another coming innovation is autofluorescence. This is the concept of using laser wavelengths to excite naturally occurring fluorophores in the retinal pigment epithelium (RPE) cells to obtain images without using any invasive dye. While autofluorescence is not a new imaging modality, it is one in which we are only beginning to understand and appreciate its potential.

Giovanni Staurenghi, MD, who has as much experience as anyone with autofluorescence, recently showed us early and late phase frames from angiograms in 6 different cases of age-related macular degeneration. In at least 2 (and most likely 3 or 4) of the cases, I would have treated what I thought was choroidal neovascularization (CNV). However, autofluorescence showed the lesions were not due to CNV, but were consistent with patterns of vitelliform disease.

In another case, I had been following a patient with a
history of central serous chorioretinopathy for about 5 years (Figure 2). Fundus photography and fluorescein angiography both showed diffuse RPE changes, but the patient’s acuity in the left eye was still less than that expected on these tests alone. However, using autofluorescence we could see that the RPE was extensively damaged.

**COMBINING CAPABILITIES**

Combining fundus camera capabilities with laser imaging enables wide field images (Figure 3). We can obtain limited fields with all of our instruments and identify areas of pathology, but we can get a better feel for the case with a wider field. With wide field images, we can add important information to our findings, such as peripheral dropout.

Three dimensional volume scans allow us to evaluate the entire macula, and then mark the area in question with a baseline scan using any of 5 different modalities, in order to follow this exact area over time (Figure 4). Using eye tracking technology, both the fundus image and the selected cross-sectional scan can be followed automatically on a repeat exam, greatly enhancing our ability to detect and analyze abnormalities.

**DOES NEW TECHNOLOGY ADD VALUE?**

So now that we have the next generation of high resolution imaging, the real question is: what are the real benefits? Do these beautiful new images really affect what we do in daily life and will they have an impact on our patients?

We have invited a group of panelists, experienced with the new imaging modalities to address these questions.

Jeffrey S. Heier, MD, is a vitreoretinal surgeon at Ophthalmic Consultants of Boston and president of the Center for Eye Research and Education in Boston, Mass. He can be reached at jheier@eye-boston.com or (617) 314-2611.
The Next Step in OCT Technology

Spectral domain provides unprecedented views of the retina.

It is an exciting time for retinal imaging. Optical coherence tomography (OCT), a technology that has become an invaluable part of practice, is undergoing a transformation. The newest instruments employ spectral domain technology, a more powerful way to create images than the current gold standard time domain technology.

Higher image resolution and acquisition speeds are what sets the new instruments apart from their predecessors. In the following text, I will explain how that higher resolution and speed is accomplished and illustrate their potential benefits.

ATTAINING HIGHER RESOLUTION

The overall resolution of an OCT instrument is determined by two independent directions of resolution: transverse and axial. Transverse resolution is based on the spacing of the A-scans performed and is limited by the optics of the eye. Therefore, it cannot be improved upon. In contrast, axial resolution depends on the wavelength and bandwidth of the instrument’s light source, which can be improved. Both spectral domain and time domain OCT systems use superluminescent diode light sources, but those in the spectral domain systems have a slightly broader bandwidth, improving axial resolution over time domain. Research facilities use systems with even higher resolution because they have employed expensive titanium sapphire lasers as the light source.

Increasing the speed of an OCT system is another way to increase its resolution. To understand how spectral domain and time domain systems differ in this regard, it helps to review how OCT works. First, the light source is split 50/50 by a beam splitter. Half of the light goes into the sample, ie, what is being imaged. The other half goes into a reference arm, typically a mirror. The two streams of light are then reflected back. The time it takes each stream of light to return is measured and compared to the reference light to create a reflectivity profile and resulting image of the sample.

In time domain systems, for this process to work, the reference mirror has to move back and forth with sequential scans. Because it depends on this mechanical moving part to perform its A-scans, time domain is a slower imaging modality. Approximately 400 A-scans per second is the maximum that can be achieved reliably. Because patient eye motion is also occurring, it is not feasible to use time domain OCT to precisely map retinal tissue.

In contrast, in spectral domain OCT, the reference arm does not move. Instead, when the light is reflected back, the entire signal (at all wavelengths) is recorded in parallel by a spectrometer. All of the wavelengths are then converted by Fourier transform into time delay signals to produce the image. Because all of the echoes are measured simultaneously as opposed to sequentially with the reference mirror, the process is 50 to 100 times faster than time domain OCT.

When the speed of OCT is increased, motion artifacts are reduced and digital processing is not required to align adjacent A-scans, resulting in more accurate retina scans.

To further enhance resolution, multiple spectral domain
Several companies now offer, or will soon offer, spectral domain OCT instruments. They all have B-scan and 3-D capabilities and similar axial resolution, but we can point to differences among them as well. Scanning speed, which has an impact on motion artifacts and scan accuracy, varies among the available instruments. For example, the 3D OCT-1000 from Topcon includes a color fundus camera, and the Spectral OCT/SLO from OTI can be used to perform microperimetry. In addition to spectral domain OCT, the Spectralis HRA+OCT can also be used for fluorescein angiography, indocyanine green angiography and autofluorescence.

### New OCT Instruments Have Varying Capabilities

<table>
<thead>
<tr>
<th>Device</th>
<th>Eye Tracking</th>
<th>3D-OCT</th>
<th>Axial Resolution</th>
<th>A-scans/sec</th>
<th>Imaging</th>
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<td>Heidelberg Spectralis HRA+OCT</td>
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<td>7 µm Optical</td>
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<td>cSLO, IR, RF, FA, ICGA, Autofluorescence</td>
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<td>Heidelberg Spectralis IR+OCT</td>
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<td>Yes</td>
<td>7 µm Optical</td>
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<td>Opko/OTI Spectral OCT/SLO</td>
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<td>6 µm</td>
<td>18,000</td>
<td>Near IR, Color Fundus</td>
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1. 510(k) FDA approved; 2. 510(k) pending

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**Healthy Macula on TD-OCT**

**Healthy Macula on SD-OCT**

**Figs. 2 and 3.** Spectral domain OCT allows better delineation and visualization of retinal structures.

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**IMPROVED RETINAL BOUNDARY DELINEATION**

Since the data are obtained so slowly in time domain, motion artifacts often occur. To compensate for this motion, digital processing, i.e., interpolated data, must be used with time domain OCT. To image the macula, 6 scans of the macula are obtained, and the rest of the retinal thickness is interpolated from these 6 scans. These 6 radial line scans of the same location can be combined to reduce noise. Noise is inevitable in image capture, but when multiple scans are taken, the instrument can identify differences between them as noise and remove it as shown in Figure 1 on the previous page. The result is a much sharper image. In general, spectral domain systems allow better visualization of the retinal structures (**Figures 2–6**).
measure less than 5% of the mapped area. Therefore, errors can be propagated over a large area, and small abnormalities between scan lines may not be detected. Moreover, the software assumes the radial line scans are straight and intersecting at the center point. It relies on this assumption to reconstruct the data. However, as the eye moves, so does the scan location. As a result, the clinician has no way of knowing if he or she is ever imaging the same spot on the retina (Figure 6).

In contrast, spectral domain systems do not need to interpolate data points because their high speed provides a much greater coverage of the macula (Figure 7). That means, for example, when a clinician is deciding whether a patient needs another age-related macular degeneration (AMD) treatment, he or she will not miss a pocket of fluid because a scan line did not pass through it.

In addition, the improved resolution of the spectral domain OCT can improve the machine’s ability to accurately detect retinal boundaries. In general, time domain systems accurately detect the retinal boundaries in eyes with macular edema, but not as consistently in eyes with AMD. Sadda and colleagues showed that retinal thickness boundaries in these cases frequently are identified incorrectly.1 This is especially problematic for clinical trial reading centers and physicians treating glaucoma. With improved resolution, the spectral domain software is more successful at automatically detecting retinal boundaries resulting in more accurate retinal thickness maps.
EYE TRACKING AND REGISTRATION IMPROVE PATIENT MONITORING

Time domain images are obtained slowly, so patient movement can occur, leading to motion artifacts. To reduce this problem, the Spectralis uses eye tracking technology. The device takes a continuous reference scan of the retina. When the eye moves during scanning, so does the location where the scan is performed. The scanner takes images only when the reference laser is tracking the retina. This eliminates motion artifact caused by patient movement. The Spectralis can then combine multiple scans taken from the exact same position to eliminate noise. The difference in noise level and improvement in resolution when this eye tracking feature is enabled is notable.

An ongoing challenge with the use of time domain OCT systems is that they do not register images visit to visit. The scans obtained between visits are not registered with time domain systems. Using the eye tracking feature and the reference image from the previous visit, the Spectralis can capture data at the next visit in the exact same position. This precise registration is a boon for reading centers, but also important for any clinician following a treatment over time to see how the OCT changes between visits (Figure 8).

CHANGE PRESENTS CHALLENGES

Along with the benefits of spectral domain OCT come a few challenges that are currently being addressed. The capabilities of these systems are derived from the vast amount of data they capture. The resultant files are very large, which is not a problem for viewing on-screen or with patients in the photography area. However, sending such large files to the clinical exam room or reading station is too much for most practice infrastructures to handle in a timely manner.

Also, the software for the new spectral domain systems is still relatively immature and is continuing to evolve. The lack of a validated normative database is an issue, especially in the management of glaucoma. Finally, clinicians will want to have access to their time domain data after they upgrade to a spectral domain system. How that can be accomplished is still unknown. For example, will every manufacturer’s spectral domain unit allow viewing of the time domain data?

LEARNING MORE EACH DAY

As these issues are resolved, there is little doubt that spectral domain OCT is the technology for the future. As clinicians learn more about the significance of its capabilities, they will allow better diagnosis, monitoring and treatment for patients with retinal diseases.

Peter K. Kaiser, MD, is director of the Digital OCT Reading Center at the Cleveland Clinic Cole Eye Institute. He can be reached at pkkaiser@aol.com or (216) 444-6702.

REFERENCE

Combination Instrument Enhances Patient Care

A Duke University physician describes his experience with multi-modality imaging.

As Dr. Kaiser explained in the previous article, spectral domain optical coherence tomography (OCT) is the future of this technology. All of the newest instruments are based on spectral domain, rather than time domain, processes. Therefore, they all collect more data faster and, as a result, produce higher resolution images. Some of the instruments combine other imaging modalities with spectral domain OCT.

In our practice, we have been using the Spectralis HRA+OCT from Heidelberg Engineering, which combines high resolution cross-sectional images of the retina with 4 imaging modalities: infrared, fluorescein angiography, indocyanine green (ICG) angiography or autofluorescence. Having all of these modalities in one device allows us to apply them in new ways and improve patient care.

INFRARED

Infrared imaging is, of course, a good modality for visualizing surface abnormalities such as epiretinal membranes. With the use of a pseudo-color component with the Spectralis HRA+OCT the infrared images are almost good enough to project as fundus photos.

FLUORESCEIN ANGIOGRAPHY

Spectralis HRA+OCT is also an outstanding fluorescein angiography unit. It uses laser excitation to provide dynamic high-speed movies with sharp resolution. I find it useful to be able to register the OCT scans with angiography. For example, simply moving the cursor over diabetic microaneurysms shows their location in relation to the fovea for the purpose of delivering focal laser treatment.

The device has wide field capability as well. A 55-degree field of view can be obtained without contact, and a contact Staurenghi lens (Figure 1) provides a complete wide field view. We have clinical evidence to suggest that diabetic macular edema patients with severe peripheral nonperfusion may be most susceptible to treatment with anti-vascular endothelial growth factor (VEGF) therapy, so that wide field imaging of patients with DME will be increasingly useful.

ICG ANGIOGRAPHY

ICG angiography with the Spectralis HRA+OCT is fundamentally different than with standard flash technology. As it does with fluorescein angiography, the Spectralis acquires dynamic, high-speed movies (up to 16 frames per second) for ICG imaging.

Most of the important information occurs in the first 15 or 20 seconds of these videos. Essentially, we have to learn to read these dynamic ICG angiograms just like we learned to read fluoresceins in our fellowships. The studies image choroidal neovascularization (CNV) through three phases: an arterial phase, a capillary phase and a venous phase.

What we have learned with this instrument contradicts the
conventional wisdom of CNV morphology that we surmised from fluorescein angiography. The conventional wisdom suggests that CNV are capillaries derived from capillaries. In reality, most CNV lesions are a vascular complex with a feeding artery, a capillary unit and a draining vein. This is important knowledge because it allows us to classify lesions into categories based on whether they are perfused by tiny thread-like feeder vessels or large branching arteries. Those CNV perfused by small feeders with low flow capillaries appear to respond well to anti-VEGF therapy. On the other hand, CNV perfused by large feeders with many branching arteriolar vascular complexes are high flow and respond well to photodynamic therapy (PDT).

I have used ICG angiography with the Spectralis HRA+OCT in many cases to enhance patient care. For example, since my fellowship, I had always been fascinated by a comment made by J. Donald M. Gass, MD. He said that all serous pigment epithelial detachments (PEDs) are vascularized. Others disagreed, maintaining that serous PEDs are manifestations of dry age-related macular degeneration, caused from fluid that cannot pass through the lipid filled Bruch’s membrane. Recently one of my patients presented with acute vision loss after carotid artery surgery associated with a notched PED and subretinal fluid. Fluorescein angiography showed nothing in the PED notch. However, high-speed ICG angiography showed a prominent feeder artery and a capillary complex. The patient actually had a vascularized PED. We have imaged a series of 55 consecutive PEDs with ICG and found about half of them to have neovascularization that was not evident with fluorescein. We are now treating those patients.

As I mentioned, it appears the degree of arteriolar vascularization in CNV is indicative of which patients will respond to anti-VEGF therapy. In my hands 15% to 20% of CNV cases fail to respond anatomically to anti-VEGF therapy, and some lesions enlarge or bleed while on therapy. I have found that in patients who are doing well on anti-VEGF therapy, ICG angiography with the Spectralis shows the capillary portion of the CNV decreases or disappears over time. Conversely, in someone who is not doing well or fails to respond, ICG angiography usually shows an arteriolarized CNV with large branching arterioles and enlargement of the capillary portion. In one of my patients, who was needing monthly therapy, ICG angiography revealed a large feeder vessel. The leakage was not only VEGF-driven but flow-driven as well.

In a similar case, one of my patients was not responding
to treatment with bevacizumab (Avastin, Genentech). Based on ICG imaging, I treated the feeder complex, not the entire capillary complex. His retinal thickness normalized and the eye remained dry for 9 months. Cases like these leave no doubt in my mind ICG-directed PDT is a very useful aspect of this instrument.

**AUTOFLUORESCENCE**

I have been using fundus autofluorescence for the past two years and have concluded it is an underappreciated technology. With other instruments, fundus autofluorescence requires acquisition of a single image with bright flash illumination and a specific filter set. The problem with this approach is that the images have low contrast. With the Spectralis HRA+OCT, however, the unit uses laser illumination and can average 15 images to enhance the contrast.

Similar to other autofluorescence instruments, the Spectralis measures retinal lipofuscin, which is the byproduct of retinal pigment epithelium phagocytosis that accumulates as particles within cells. It appears to be derived from vitamin A metabolism. In fact, Sirion Therapeutics is currently evaluating the drug fenretinide as a way to block vitamin A transport to prevent lipofuscin buildup and therefore prevent geographic atrophy (GA) progression. Several other drugs are on their way to clinical trials for GA, so this is a condition that will become a high priority for research and clinical care. Most pharmaceutical companies setting up GA clinical trials are choosing the Spectralis HRA+OCT as their standard instrument.

Autofluorescence also will be useful in unusual maculopathies. I recently obtained a fluorescein angiogram using the Spectralis HRA+OCT in a patient with Stargardt’s disease. In addition, lypofuscin and A2E hyperfluoresced in autofluorescence mode. What I found very informative is that I also was able to align the cursor at the margins of the area of atrophy and scrutinize the structure of the retina (Figure 4). In this case, disruption of the outer segments was evident. Suspecting that progressive vision loss would occur in this case, we began counseling the patient about low vision services and occupational planning.

I believe the images we can obtain and correlate using the Spectralis HRA+OCT also will teach us more about how to interpret structure/function relationships. For example, one of our hypotheses, put forth by Alan C. Bird, MD, is that intact autofluorescence in the retina overlying CNV indicates eyes that have good visual potential, and absent autofluorescence over CNV suggests poor vision potential.

**FIVE WAYS TO IMAGE ARE BETTER THAN ONE**

Now that we have been using the Spectralis HRA+OCT in practice, we have experienced many cases to illustrate that we cannot appreciate what we cannot see. For example, in one patient, we had been using time domain OCT to follow a tiny amount of fluid in one eye of a patient who had a disciform scar in the other eye. He was not sure whether he wanted to consent to anti-VEGF therapy, so we imaged the retina with the Spectralis HRA+OCT. This gave us the advantage of scanning the entire macula rather than only six cuts through the fovea. What we found was extensive fluid outside of the fovea, including along the superior and juxtafoveal zones. Zones of his contained fluid that had not been detected with time domain technology. Because this new instrument allows us to look at a volumetric OCT scan and also evaluate a dynamic video of the same area, we get a better appreciation for the extent and severity of pathology.

Based on my experience so far, the multiple imaging modalities of the Spectralis HRA+OCT give us the ability to learn more about the pathology of each individual eye. That ability adds a great deal more value for our practices than the spectral domain OCT component alone.
Utilizing a Multi-Modality Imaging Instrument

A panel of experts discusses capabilities, efficiency and applications.

Jeffrey S. Heier, MD: Panel members, now that we have the ability to combine spectral domain optical coherence tomography (OCT) with infrared imaging, fluorescein and indocyanine green (ICG) angiography and autofluorescence in the same instrument, how do you think it will affect how you take care of patients?

David M. Brown, MD, FACS: The eye tracking feature, which compensates for eye movement, really makes the Spectralis HRA+OCT stand out. It is difficult to find a talented photographer for private practice and even harder for clinical trials. Less experienced photographers tend not to be able to capture good images when the patient’s eye is moving around. However, this instrument’s eye tracker and image stabilization makes patient cooperation much less of an issue. It really levels the playing field both for photography and OCT imaging.

Whereas the ICG angiograms and autofluorescence imaging from almost every other imaging systems look fuzzy, the Spectralis ICGs look as crisp as a film fluorescein angiogram. The choroidal vessels are visible in both the early and late images. Because of the eye tracking, this instrument has far less noise to clean up as it is constructing images, and I think this is the reason for the better resolution. Personally, I never found autofluorescence or ICG imaging useful at all until we started using a laser imaging system. Now we use it every day.

With the spectral domain OCT imaging, the specific histopathologic bands between the different retinal layers are visible in most patients. It’s like getting a noninvasive retinal biopsy. With spectral domain OCT, I actually had to review my ophthalmic pathology notes to first identify what I was seeing.

“Personally, I never found autofluorescence or ICG imaging useful at all until we started using a laser imaging system. Now we use it every day.”

—David M. Brown, MD, FACS

Quan Dong Nguyen, MD, MSc: One of the spectacular properties of the Spectralis HRA+OCT is the eye tracking system. It can fill a major need in today’s practices now that many retina specialists rely on noninvasive OCT technology in making decisions, such as in deciding whether patients with neovascular AMD need re-treatment. It is crucial to know precisely what retinal area is being evaluated from visit to visit, and the eye tracking/image alignment provides that.

Another special feature is the ability to perform autofluorescence and fluorescein angiography simultaneously with spectral domain OCT. Autofluorescence may help us to understand what is occurring in patients whose eyes appear within normal limits on fluorescein angiography.

*The views expressed by Dr. Nguyen in this article do not constitute or imply any endorsement by the Johns Hopkins University, the Johns Hopkins Hospital or the Johns Hopkins Health System.
but who have suboptimal vision. There is a lot for us to learn about the capabilities of the Spectralis, and I am sure many of us will have a lot of information to report within a year from now.

**Dr. Heier:** Everyone on the panel participates in clinical trials, a situation where OCT reproducibility is crucial for measuring treatment effect. How will multi-modality imaging impact this?

**Dr. Nguyen:** For certain diseases like diabetic macular edema, it may not be too difficult to see changes from visit to visit because we may be interested only in assessing large areas of intraretinal fluid. However, in other processes such as choroidal neovascularization (CNV) from age-related macular degeneration, we may have a difficult time identifying and detecting changes at different time points within the study, given the complexity of the disease manifestations (eg, subretinal fluid, intraretinal fluid, RPE detachments). I believe a system that allows us to take point-to-point measurements is invaluable in clinical trials. Trial investigators will appreciate it, as we will be at our Retinal Imaging Research and Reading Center in Baltimore, where we always strive to achieve the highest level of detecting changes within a clinical trial, as well as assessing and comparing different measurement systems available for standard clinical care and clinical research.

“Without the tracking system, one just does not know whether one is getting accurate measurements at different visits in a clinical study. On OCT measurements, when one moves the cursor just a few microns back and forth, one can change the retinal thickness value drastically. If the investigators rely on just the thickness value generated without a precise point-to-point correspondence among visits, they may not have truly valid measurements, and hence, may not be able to fully assess the study questions. Therefore, any system that allows true tracking with precise measurements at specific points will be invaluable in data collection and analysis for any clinical trial, in my opinion.”

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**“It is crucial to know precisely what retinal area is being evaluated from visit to visit, and the eye tracking/image alignment provides that.”**

—Quan Dong Nguyen, MD, MSc

**Dr. Brown:** We certainly benefit from the acquisition of higher quality, more accurate images in practice, but I hope obtaining them and evaluating them will not slow down the clinic. We would like to be able to figure out where the pathology is located fairly quickly.

**Dr. Heier:** We have certainly seen cases in which additional imaging has enabled us to make the diagnosis. For example, a young boy referred to us a month after having commotio retinae from being hit in the eye with a paint ball had 20/200 visual acuity. No one had been able to figure out why. He had been previously evaluated using fluorescein angiography, without a clear-cut explanation for the decreased vision. Multi-modality imaging with autofluorescence and spectral domain OCT revealed extensive RPE damage in the region of the commotio, but the macula was not involved. However, the SD-OCT revealed subtle photoreceptor damage that the Stratus couldn’t pick up.

“Adding efficiency to imaging

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One question many practices have is how they would handle an upgrade to spectral domain OCT. Right now, everyone has a time domain OCT system in the office along with other instruments with other capabilities. How will they transition?
Scott W. Cousins, MD: We are finding that combining fundus imaging and SD-OCT on one platform does not slow us down at all. To keep the day moving, we have our photographers perform specific studies of certain types of lesions. For example, when they see a pigment epithelial detachment they know to perform the ICG angiography. Also, in one-doctor offices, a combination device can be the single instrument, so all of the testing can be done in one place. You can perform the ICG angiography in 20 to 30 seconds because you are interested only in the transit phase. You are not tying up your photography unit for 15 to 30 minutes like you do with the bright flash technique where you are looking at the late frames 15 to 30 minutes later.

I have busy clinics like most of the panel members, but I have to look at the videos myself in a few cases each day. Most of the time, the photographer can point out where the pathology is and bring up that image for me on the digital viewing station. Using the Spectralis HRA+OCT as a workhorse instrument does not slow down my efficiency, but it increases my ability to diagnose and treat patients who fall outside the standard way that we approach common cases.

Dr. Heier: SD-OCT does appear to have significant potential to impact our management of patients today, and its value is likely to grow as we learn more. Imagine, when a patient comes into the clinic, we do a volume scan and find a subtle area of pathology. Now, we can reference that point every time; we absolutely know what effect our treatment is having. We are unlikely to miss anything. If we have an area that we want to keep checking, we know we will be able to check it repeated.

Spectral domain technology will allow us to better diagnose different types of lesions, such as polypoidal and retinal angiomatosus proliferation, and monitor treatment effect. A recent case of mine comes to mind. A patient was referred to us as a high myope with a little hemorrhage. On time domain OCT we weren’t convinced we had localized the hemorrhage. We were able to image the exact point of the hemorrhage and isolate it with confidence since the fundus image was obtained simultaneously with the SD-OCT. That allowed us to determine the hemorrhage was intraretinal; there was no underlying CNV. Also, now we can come back to that exact spot every time.

**TRANSITIONING TO NEW TECHNOLOGIES**

Dr. Heier: A number of different spectral domain OCT instruments are available now. What are the important points we should be looking for?

Dr. Kaiser: Look carefully at the software. Software is what differentiates these systems. The hardware for most of them is similar, with the exception of the Spectralis spectral cSLO/OCT and the Opko/Ophthalmic Technologies Inc. Spectral SLO/OCT. These two stand out in terms of hardware. When you are evaluating the systems, find out how easy the software is to use. Does it include reader software? Reader software is vital because you do not want to keep running over to the photography area. Some of the companies have reader software and some do not. Also, much of the software for the various instruments is immature right now and constantly improving. Therefore, find out what costs are involved with upgrading as new versions are released. Are software upgrades free? Are you locked in? Do you need to buy a one-year service contract to get those? That is a big issue.

The question I always ask the manufacturers is what they are going to do with my time domain OCT data. You are likely not going to want to keep your time domain equipment, so some sort of trade-in should be available. Whatever we are going to do with all of our old data, it is an important issue.

When you are considering purchasing one of the new spectral domain OCT devices, another aspect to check on is whether the camera and light source are fixed. When they are fixed, it may be difficult to get all patients, especially larger patients, into the device. With the Spectralis HRA+OCT you can kind of move in any direction, which is an advantage. We do not always consider these types of things when we are focused on the images, but sit down and see how each of these instruments is for patients and the flow in your room. They are all different in these respects.

Dr. Heier: Where is this technology going in the future? I heard a recent talk refer to intraocular OCT. We would have an intraocular probe to follow right where we wanted to go inside the eye and know exactly where we were.

Dr. Brown: The more we can see, the more we can do, and the more we can detect subtle differences. I think the best way to compare the different spectral domain machines is to compare details in the outer retina. In other words, how often can you identify the external limiting
membrane and define the band between the outer and inner photoreceptors? Whereas these bands are hardly ever imaged with the time domain units, the Spectralis demonstrates these layers routinely even in challenging patients.

In AMD, we have some pretty amazing therapeutics right now, but we really don’t know if any of our combination therapies are additive or not. In other words, are the add-ons giving us any incremental improvements? As we won’t have any randomized trials to determine this, we have to rely on anatomic markers. Therefore, we need great imaging to really know whether they are helping or hurting. I think with spectral domain technology, we are “off to the moon” in this area, so to speak.

**Audience Member:** Can anyone comment about the differences between the instruments in regard to imaging the vitreoretinal interface?

**Dr. Brown:** Spectral domain OCT imaging is clearly superior to the time domain system when it comes to imaging the vitreoretinal interface. I have cases of traction that were not visible with time domain technology, but I could see very well with spectral domain OCT. The motion video is much better at demonstrating vitreoretinal separation and traction prior to surgical intervention than the individual cuts of a time domain unit.

“**This technology likely will play a role in driving our advances over the next several years.**”

―Jeffrey S. Heier, MD

**Dr. Kaiser:** Most of the spectral domain OCTs are similar in their ability to pick up the vitreoretinal interface. Some of the 3-D volume views are very interesting in how they show the vitreous actually coming down into the retina. They provide a good idea of how to manage these problems.

**Dr. Heier:** At this point, many physicians are wondering exactly what impact the capabilities of spectral domain OCT will have on practice. Having seen what we have from OCT, I do not think it is a stretch to imagine that the capabilities are going to have a significant impact on how we treat patients going forward. It is up to us to determine what the impact will be and apply it to our pharmacological and surgical interventions. This technology likely will play a role in driving our advances over the next several years.
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