Energize Your Practice with Diagnostics that Streamline Patient Care

Based on a live event held during the 2012 meeting of the American Academy of Ophthalmology.

SPONSORED BY

ZEISS
Peering into the Future of OCT

A review of this technology’s storied past and a forecast of the great promise ahead.

BY CARMEN PULIAFITO, MD

It has been 20 years since OCT began to revolutionize the treatment of eye disease. An estimated 50,000 OCT systems, based on varying technologies, are used around the world today, influencing clinical decisions on the management of AMD, diabetic retinopathy, glaucoma and other conditions.

But we’re only getting started. The future will involve the use of swept-source laser systems, resulting in much higher scan speeds, longer wavelengths that image the eye and larger scan areas. We’ll be creating panoramic OCT and we’ll soon see the introduction of OCT angiography.

Evolution of OCT

Time domain OCT has evolved from 400 axial scans per second to a spectral-domain OCT (SD-OCT) that emits light at a wavelength of about 840 nm, providing 25,000 to 70,000 scans per second. We’re moving to even faster models, such as the CIRRUS 5000 HD-OCT from Carl Zeiss Meditec, with a rate of 68,000 scans per second. Swept source lasers, now in prototype form, will generate a light wavelength of 1,050 nm and perform up to 500,000 scans per second.

The primary advantage of swept source is that it’s 100 to 500 times faster than traditional OCT, generating more scans at higher resolution, providing a much more detailed view of the retina anatomy. Swept source lasers also have a simpler design, which utilizes a detector instead of a camera and spectrometer. Currently, SD-OCT is a relatively large laser. Soon, lasers will be available on a chip like the cavity-emitting laser.

Advantages of 800 nm

Despite the advantage of higher speeds, the 800 nm wavelength of some existing technologies still provides a slightly better axial resolution and better retinal contrast than higher scan technology. But if we move up to 1,000 nm, we can achieve improved image penetration, even through ocular opacity.

For example, in an eye with advanced AMD, you can see the choroid within 1 micron of resolution. Choroidal imaging will likely become more important in characterizing some forms of AMD, requiring the longer wavelength scans of swept-source OCT.

Today’s CIRRUS HD-OCT provides five high resolution sections of the macula. By coupling this high resolution and scan density with tracking, we’ll be able to sample and re-sample the same region of the macula. With the new systems, we’ll essentially achieve 700 sections.

Re-analysis of OCT data can also be used to create 12x12 fundus images, which we’ll be able to acquire in 6 seconds. Prototypes with a 1-micron spectral source OCT, demonstrate a very effective fundus recreation.

Widefield View

I’m also interested in the wide-field OCT, which will virtually eliminate the need for the ophthalmoscope. For

Birth of OCT

From the beginning, OCT represented a trend-setting collaboration between engineering and medicine that dramatically improved patient care. The first publication on this innovative imaging technology appeared in Science in November 1991, following 10 years of work by Carmen A. Puliafito, MD, MBA, at Harvard Medical School, and James G. Fujimoto, professor of electrical engineering at the Massachusetts Institute of Technology. The goal of their work was to use short pulse lasers to measure ocular structures.

Eric A. Swanson, MS, an expert on optical communications at MIT Lincoln Laboratories, established compact and low-cost methods of measurement, instead of relying on expensive femtosecond laser technology. David Huang, MD, PhD, now a professor of ophthalmology and biomedical engineering at the University of Oregon, conceived of OCT while he was a student at Harvard Medical School.

Swanson was primarily responsible for applying the technology to the clinic. Dr. Puliafito, now the dean and a professor of ophthalmology at the Keck School of Medicine at the University of Southern California, and Joel S. Schuman, MD, FASC, now chairman of the Department of Ophthalmology at the University of Pittsburgh School of Medicine, led clinical studies and validation of applications of the technology to the human eye. Carl Zeiss Meditec later commercialized OCT. The result has been a paradigm shift in the diagnosis and care of patients.

Reference

example, I scanned a patient with retinoschisis. One ophthalmologist thought the schisis cavity would affect the patient’s fovea, requiring surgery. But after carefully stitching together traditional CIRRUS HD-OCT scans, I could see the elevated edge of the schisis cavity, revealing a small epiretinal membrane. The patient was spared surgery. With swept-source OCT, we’ll be able to characterize a great deal of this peripheral disease because of its ability to completely analyze the retinal anatomy.

Finally, by using phase-resolve OCT, which reanalyzes existing data, we can view images of retinal vessels that compare well with vessels revealed by fluorescein angiographs. This may make it possible for OCT to help in the earlier diagnosis of a choroidal neovascular membrane.

The future is exciting. All of these features combined will provide clinically valuable information to help guide the care of patients with retinal disease.

Tracking Retinal Changes

New software helps you discern more details and better evaluate anatomy over time.

By Srinivas Sadda, MD

Two new tools are being used in OCT to increase efficiency and improve precision. New retinal tracking technology called FastTrac, offered with the new CIRRUS HD-OCT 5000, helps to monitor disease progression by aligning scans over time. Retinal pigment epithelium (RPE) analysis assists with the management of AMD. Here I’ll discuss how these features can benefit your practice.

Why New Retina Tracking?

When we use OCT to measure gross retinal thickness for use in standard clinical practice, poor fixation associated with eye movement typically isn’t a major problem for many patients. Even with these patients, tracking and aligning scans correctly can offer a significant benefit, however, facilitating extensive averaging of images. A high degree of repeatability of measurements is also very important when looking for subtle differences over time. Correlating your OCT findings with past studies or examination findings also requires precision.

One of the limitations of some existing tracking approaches is that they aren’t very fast, resulting in timeouts, failed acquisitions or limited scan density. For example, you can acquire 50 or so B-scans for the typical patient. However, for advanced analyses, such as RPE elevation assessments that quantify drusen, scanning only 50 lines will miss lesions between scan lines. In addition, one reason spectral domain OCT instruments appear to have better segmentation and more accurate retinal thickness maps than time domain OCT is that they use information from adjacent scans. The more closely spaced the scans, the more the segmentation improves. A CIRRUS HD-OCT 5000 software update decreases spacing significantly, resulting in a very accurate, real-time tracking approach. Besides a substantial increase in speed, this innovation permits dense volume scanning with tracking. Unlike previous point-scanning strategies, the CIRRUS HD-OCT uses a faster line scanning approach.

You will see a significant difference when you average the same images with tracking turned on or off. Most blurring effects are eliminated with tracking, as if you’ve dialed in better focus. This can be important when you’re looking for subtle findings in the ellipsoid zone, for example. More clarity is achieved because the images have been averaged properly.

Freeing yourself of motion artifacts also offers other advantages. In an OCT fundus image from an untracked acquisition, for example, you can find discontinuities in vessels due to motion. These gaps are eliminated with tracking and can significantly help with retinal nerve fiber layer analyses.

Retinal Thickness Measurement

To assess the impact of the FastTrac algorithm on retinal thickness measurement, we scanned patients in our clinic with the typical 512x120 protocol — once with the tracking on and again with the tracking off. Variation was evident when the tracking was off. With the tracking on, across all diseases, we saw superb performance with an impressive repeatability measurement of 1.5 microns.

We were also interested to determine what type of speed benefit could be obtained with the line scanning tracking strategy employed in the CIRRUS HD-OCT, and thus we conducted a small tracking speed study, accumulating data associated in approximately 20 patients. The patients underwent macular volume scans with CIRRUS FastTrac and the tracking tool in the Spectralis OCT (Heidelberg Engineering), and the time to acquire the scan was measured with a stopwatch. There was an unequal number of B-scans in the volume cubes for the two

---
agreement when quantifying atrophy. We've started to utilize fluorescence to the new CIRRUS HD-OCT and found excellent new functionality we haven't had in the past. This is a great way to track patients, creating a tool relatively easy to segment lesions and provide accurate software can be used to identify atrophy automatically, making contrast between the atrophic and adjacent non-atrophic areas. With this function, the 6.0 and 6.5 versions of the CIRRUS software can be used to identify atrophy automatically, making it relatively easy to segment lesions and provide accurate measurements. This is a great way to track patients, creating a new functionality we haven’t had in the past.

RPE Analysis Tools
Retinal pigment epithelium analysis tools also benefit from the implementation of tracking. This portfolio of tools was added to the CIRRUS 6.0 software update. Many ophthalmologists have become familiar with subretinal pigment epithelium illumination, which basically refers to the transmission of light into the choroid where RPE is absent. Loss of the RPE and increased reflectivity in the choroid helps us define the margins of geographic atrophy. We can even increase contrast by taking a partial projection image and further enhancing the contrast between the atrophic and adjacent non-atrophic areas.

With this function, the 6.0 and 6.5 versions of the CIRRUS software can be used to identify atrophy automatically, making it relatively easy to segment lesions and provide accurate measurements. This is a great way to track patients, creating a new functionality we haven’t had in the past.

Autofluorescence Versus OCT
The Bascom Palmer Eye Institute recently compared auto-fluorescence to the new CIRRUS HD-OCT and found excellent agreement when quantifying atrophy.1 We’ve started to utilize these findings to track geographic atrophy progression in reading center trials. The CIRRUS HD-OCT unit automatically provides values, indicating exactly how fast the atrophy is growing. We believe OCT-based atrophy measurements will be a critical component of clinical trials moving forward.

The Advanced RPE analysis package provides additional capabilities. Besides mapping the retina, it can map areas below the pigment epithelium. One of the benefits of spectral domain OCT is that it allows you to see the retinal substructures in the outer retina. We can now see them with fantastic detail, recognizing areas of early photoreceptor injury, for example. This will help in the investigation of dry AMD therapeutics.

Another use will be the detection of little dark spaces of vascular channels within a very shallow fibrovascular epithelial detachment or early Type 1 CNV, long before pathology is visible on an angiogram. We’ll also see increasing value in identifying a variety of drusen morphologies in the sub-RPE space.

Q&A on FastTrac
Q: Which patients should be targeted for Fast Tracking?
A: There is no reason it can’t be used on every patient.

Q: Does the system turn off or reset after 1 minute?
A: In the prototype version of the software, it would reset after 1 minute, but not in the commercial version. The mean scan takes about 12 seconds to complete.

Q: How does repeatability between tracking and non-tracking OCT compare?
A: The repeatability standard is 1.5 microns for the newer OCT. This is unprecedented and faster than the predecessor technology. It’s easy to use, based essentially on a toggle switch that doesn’t add any complexity to the procedure.

Another innovation is the creation of a fit line, which will help us estimate where the RPE should be. Now you can quantify the area between the RPE inner surface and the floor, as determined by the algorithm that will help create drusen maps.

Drusen Volume
With these innovations, we can produce RPE elevation maps, allowing us to evaluate drusen volume. These maps provide a much better method of quantifying drusen burden. Under the direction of Giovanni Gregori, PhD, and Phillip J. Rosenfeld, MD, PhD, the Bascom Palmer team has demonstrated that this is a highly reproducible and accurate method. The volume measurements have excellent agreement with a standardized expert human grader. There is less agreement on area, which is inherently unstable. (Even leaving out a small area at the edges can create significant variation.)

Drusen volume might not seem significant until a therapy requiring drusen quantification for monitoring becomes available. Some researchers however, have demonstrated that quantification of RPE elevations may be of immediate value. Dr. Rosenfeld’s group, for example, has demonstrated that a decrease in drusen volume in patients with AMD often heralds an impending negative development, such as a geographic atrophy. In addition, there are potential applications in neovascular AMD. We have largely been relying on measurements of retinal thickness when treating patients with anti-VEGF therapy. However, you might see an increase in pigment epithelial detachments (PEDs) without subretinal fluid or thickening of the retina, and this may be the only sign of activity. If you continue to watch the patient, he or she will develop fluid and other overt features of disease. Tracking PED volume over time might be useful in detecting disease activity requiring treatment.

As a next step, we have been developing software tools to automatically classify PEDs, distinguishing drusenoid PEDs from those with fibrovascular infiltration. In the future, we can envision performing risk profiling of PEDs, based on their internal characteristics.
Relevance to Practice

We’re excited about these developments, especially in reading centers. These advances and the new software package are very relevant to clinical practice now. The FastTrac is fast enough to help us with dense volume scanning and achieving great reproducibility. Dense scanning is critical for these advanced analyses.

Reference

Images of Success

How to tie your data – not your practice – in a knot.

BY RISHI SINGH, MD

Because of the Health Care Information Portability Accountability Act (HIPAA), patients will expect images of their pathologies when they walk out your door in the years ahead. I’ll discuss how our practice has transitioned to a system that archives images for this purpose, in addition to improving efficiency with the use of EMR.

Why Upgrade?

We upgraded our health records system with a new image management system to reduce the time we spent waiting for visual field printouts and OCT scans. We also wanted to minimize the effects of lost documents, studies buried in paper charts and incomplete image management software in our satellite facilities. The potential for errors was high because of our inability to see progression when baseline images weren’t available. Patient review required logging in and out among multiple databases, which was very inefficient.

With many patients coming in monthly for injections, we accumulated nearly a terabyte of data on our CIRRUS HD-OCT, causing it to operate very slowly. We needed to offload that information — but where? We decided on the FORUM® Eye Care Data Management system (Carl Zeiss), which stores images for multiple instruments and effectively links those images to EMR systems. With FORUM, we can export a full image that can be manipulated. We use two servers for FORUM, fewer than we had for our old system.

Improving Efficiency

Our new system allows us to create an easier workflow, which saves time. We benefit from one point of demographic data entry and, therefore, eliminate spelling or charting errors. A standardized integration interface also makes a difference. FORUM sends demographic information to each machine you plan to use. It will then send the images to the image management program in the central storage area, where they’ll be available for review. With FORUM, our photographers no longer need to focus on specific areas of concern or zoom in on cysts. This saves significant time.

Q&A on Image Management

Q: How is the service support for FORUM®?
Dr. Singh: Responsive. For example, people were leaving the system logged in at dozens of workstations in our practice. The vendor solved the problem by creating an auto log-off feature.

Q: Would this system help a smaller group practice?
Dr. Singh: Even a single office can benefit because the system is able to store a large amount of data over time. Also, tying all of your instrumentation together in this way is very useful. You can look at your raw CIRRUS HD-OCT data images in FORUM, clicking on an image and accessing review software. It allows you to perform any desired manipulations within the FORUM system.

Q: Was it difficult to incorporate the Zeiss FORUM into your practice?
Dr. Singh: The learning curve was simple. The company started day one in the clinic. After 10 to 15 minutes of assistance, we were able to work on our own.

Q: Can you use data from your old system?
Dr. Singh: Yes. We’re importing all of the data from our old image management system into FORUM. We’ll have nearly 10 years of data for patients logged into our system.
Transforming Glaucoma Care

How subjective and objective data are being used to provide better care for patients.

BY STEVEN D. VOLD, MD

So many factors challenge us in glaucoma care, including disease progression before vision loss, gradual visual field changes, lack of visual field reliability, the confounding influences of cataract and other diseases and lack of clinical correlation. In our practice, we respond with Carl Zeiss Meditec's Guided Progress Analysis (GPA), which allows us to use the qualitative findings of perimetry and high-definition OCT (HD-OCT) to develop quantitative reports, including event and rate of progression analyses (Figure 1).

We also use the FORUM Eye Care Data Management system to integrate our data into a central system that stores, retrieves and archives data. Because of FORUM’s bi-directional communication capability, it enhances our clinical flow, including the activity associated with 15 to 20 trials per year. Here are some of the highlights of our approach.

Using Visual Fields Effectively

When evaluating visual fields, we try to establish clinical correlation, a critical consideration. Among the key visual field
indices are mean deviation, pattern standard deviation and pattern deviation probability plots. Combined, these findings can help determine the degree of aggressiveness, whether medical or surgical, to be taken with each patient.

Efficiency is also a key factor. The software update from Carl Zeiss Meditec streamlines clinical workflow, simplifying GPA. Instead of 10 pages of paper, we can focus on progression in a 1-page printout. The criteria for identifying point progression (event analysis) with perimetry are as follows:

- Minimum of three tests required, including two baseline and one follow-up exam
- Each follow-up is compared to averaged thresholds of two baseline exams

Additional follow-ups are compared to baseline and to the two most recent follow-up exams. The baseline also affects the type of tests you should order going forward.

**CIRRUS GPA Analysis**

We establish a baseline exam configuration and identify progression in retinal nerve fiber layer (RNFL) loss through event analysis and trend analysis. Up to eight exams — two baseline and six follow-up exams — are included in the analysis, which can utilize data that was acquired before installation of the new GPA software. The average RNFL thickness shows the superior and inferior regions of the optic nerve. The thickness map provides a topography display of the RNFL for each exam. Up to six progression maps are compared to the baseline. We assess possible progression as well. A summary graph looks at each aspect of this progression analysis, allowing us to compare likely changes.

**Correlating Data**

The ability to view the OCT scan and visual field at the same time — a key feature of this system — is very important for correlating changes (Figure 2). Associating changes with the optic nerve is also very important. In addition, raw quantitative data helps. When I’m concerned about questionable progression, I may be making a surgical decision. The raw data ensures that the progression is real, not the result of an artifact or a poor test.

If OCT and visual fields data don’t match up, we need to find out why. Is the patient a poor visual field taker? Did we perform good scans and repeat the tests? As the software
Event Speakers

Carmen A. Puliafito, MD, MBA, a co-inventor of OCT, was the first ophthalmologist to use the technology to study the human macula in health and disease while at Harvard Medical School. He later introduced expanded use of the technology at the New England Eye Center at Tufts University School of Medicine and then at the Bascom Palmer Eye Institute. He is currently dean of the Keck School of Medicine of the University of Southern California.

SriniVas R. Sadda, MD, is professor of ophthalmology and director of medical retinal service at the Doheny Eye Institute at the University of Southern California. He has given more than 70 visiting professorships or invited lectures and more than 200 scientific presentations. He has published more than 120 peer-reviewed scientific articles.

Rishi Singh, MD, an assistant professor at the Cleveland Clinic Lerner College of Medicine, is a leader in electronic medical record adoption. His specialty interests include medical and surgical retina and diabetic retinopathy.

Steven D. Vold, MD is founder and CEO of VoldVision, Fayetteville, Ark. His special interests include glaucoma and cataract surgery innovation, management of complex glaucoma and cataract cases and secondary intraocular lens surgery. Dr. Vold has published extensively in medical journals and lectures internationally.