The Expanding World of OCT Applications

The growing imaging technology is redefining ophthalmology

By Tim Bennett, CRA, OCT-C, FOPS, Harrisburg Pa.

Optical Coherence Tomography (OCT) is a routine and integral part of many practice settings – so much so that it feels like it's always been available in the clinic. But it's still a relatively young imaging procedure. The technology was developed at the Massachusetts Institute of Technology in 1991, but it wasn't until 2002 that OCT instrumentation matured to the point where it became both practical and affordable for clinical use. Originally employed as a tool for imaging the retina, OCT technology continues to evolve and expand within ophthalmology and beyond.

The rapid adoption and evolution of OCT in such a short time has been astounding. Specialized anterior segment OCT machines became available in 2005 and the introduction of Spectral Domain OCT (SD-OCT) technology in 2006 dramatically improved both resolution and acquisition time. The value of this test lies in the ability to provide direct cross-sectional images of ocular tissues resulting in a "virtual biopsy." Current instruments also offer analysis and measurement tools that can identify specific anatomic layers and provide topographic and volumetric information.

Not Just for Retina Anymore

Some of the first clinical OCT uses were the identification of vitreo-retinal interface abnormalities such as posterior vitreous detachment, macular holes and epiretinal membranes. Volumetric measurement of intraretinal fluid in macular edema soon began to replace fluorescein angiography for detecting post-cataract CME and diabetic macular edema. The use of OCT to monitor treatment for AMD, DME, and RVO has exploded as anti-

VEGF treatments have become the treatment of choice for these conditions.

Beyond the initial retinal uses, OCT has expanded in other specialties in ophthalmology. Glaucoma specialists are increasingly using both anterior and posterior segment OCT to assess and monitor glaucoma and glaucoma suspects. Retinal scanners provide measurement of the retinal nerve fiber layer (RNFL) optic nerve morphology, and the macular ganglion cell complex. Progression analysis software and normative databases provide information that can track and potentially predict worsening disease. Anterior segment OCT (AS-OCT) can be used to look at the anterior chamber angle structure to examine narrow angles at risk for angle closure glaucoma. It can also be used to confirm a full thickness opening after laser iridotomy.

SD OCT is becoming an increasingly valuable tool in neuro-ophthalmology. It has been shown to be helpful in differentiating papilledema from optic disc drusen and pseudo papilledema. Observation with Spectral Domain OCT has revealed interesting changes in Parkinson's disease, Alzheimer's disease and traumatic brain injury, which may help diagnose and treat these neurodegenerative syndromes.

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Refractive Uses

Cornea and refractive surgeons use AS-OCT to document and measure the condition of the cornea, angle and anterior chamber. Early keratoconus can present as focal corneal thinning that can be detected with OCT pachymetry. Pre and postoperative images and measurements can be useful in corneal transplants and refractive procedures such as laser-assisted in situ keratomileusis (LASIK), Descemet-stripping endothelial keratoplasty (DSEK), deep lamellar endothelial keratoplasty (DLEK), and other surgical procedures. LASIK flap and bed thickness as well as postoperative structural integrity can be assessed with OCT. Corneal power can be calculated in post LASIK cataract patients based on both anterior and posterior corneal curvature with OCT.

Current State of Instrumentation

Spectral domain technology is about 50 times faster with twice the resolution of time domain OCT. The increase in speed and resolution promotes increased accuracy and repeatability. With improved resolution, physicians are better able to identify individual layers of the retina. Eye-tracking during acquisition can minimize fixation problems and movement artifacts. Superimposition of sequential scans allows for accurate serial tracking of disease progression or improvement after treatment. Enhanced Depth Imaging (EDI) is a technique that shifts the peak sensitivity of the instrument from the vitreoretinal interface to the deeper tissues of the fundus to better visualize choriodal and deep optic nerve pathology.

Today's spectral domain instruments are often combined with a second imaging system such as a scanning laser ophthalmoscope (SLO) or fundus camera. Registration of the scan location with a fundus image provides a valuable frame of reference for physicians when interpreting OCT results. Some instruments are capable of combining fluorescein angiography, ICG angiography, and fundus autofluorescence imaging with OCT. Other specialty instruments include a handheld OCT and a combination SLO and OCT that can also perform microperimetry to assess macular function and correlate it with anatomic findings.

Anterior segment OCT instruments consist of dedicated stand-alone AS-OCT units and converted retinal scanners with add-on hardware and software. Converted spectral domain retinal scanners at a wavelength of about 840 nm have higher axial resolution, but less tissue penetration than time domain

AS systems at longer wavelengths of 1300 nm. Along with deeper penetration into the iris and angle structure, TD systems can scan a wider field with greater depth up to 16 mm by 7 mm deep.

Future hardware and software upgrades to current retinal and AS instruments will expand their feature set and capabilities. We are likely to see more automation, more combined modalities, and expanded normative databases and analysis.

Photographers and Technicians

What does this mean for photographers and technicians performing OCT? With all the automated features in the current crop of instruments, there is a perception that OCT is simple and easy to perform. While it may be true that, compared to fundus photography, angiography and B-scan ultrasound, OCT imaging is easier to learn, the skill needed to obtain a good diagnosis should not be taken for granted. Even with automatic features and tools, OCT results are still dependent on the cooperation level of the patient, the condition of the eye, and the skill of the operator. It's not always as simple as pushing the button. Good patient management skills, combined with a working knowledge of ocular anatomy and common clinical findings will aid the imager in capturing consistent scans. Identifying and correcting artifacts during the scanning process is an important skill as artifacts may compromise diagnostic quality. Some of these may be corrected in the review software, but in some cases, re-imaging the patient may be necessary.

With the continued advancement in technology, features, and diagnostic applications come new opportunities to learn additional skills.

In the absence of universal training programs, certification may provide a foundation for self-study. The Ophthalmic Photographers' Society offers an OCT certification program (OCT-C). See www.opsweb.org/?page=Certification for details. This credential stresses knowledge of anatomy, physiology, common clinical findings, as well as recognition and correction of common scanning and analysis artifacts. It represents a high degree of competence in OCT imaging.

Optical Coherence Tomography is an amazing technology that continues to change ophthalmic practice. Recently, one of our regular patients referred to it as "the magic of OCT." It's easy to see why patients feel that way. It takes just a few moments to non-invasively capture important diagnostic information that guides treatment plans to preserve vision. Not a week goes by that we don't discover something unexpected or amazing while scanning patients. **OP**

Technical Tips for OCT Scans

by Sergina M. Flaherty, COMT

1. **Develop a plan of action** - Institute request forms for physicians to mark the exact scans they expect as well as any special areas of interest.

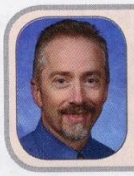
2. **Identify a Patient** - Confirming the patient's name, birth date, and chart or EMR number, prior to obtaining a scan.

3. **Prepare the Patient** - Keep in mind initial scan conditions and patient positioning.

4. **Select Scan Type** - Select the scan type the physician has requested.

5. **Acquire Scan** - There are three important parameters that can affect the interpretation of a scan: signal strength, centration, and scan alignment. All three are the responsibility of the technician performing the scan.

The tips above were excerpted from Ms. Flaherty's article, "OCT: A Technicians Point of View." The full version of this article can be found at www.ophthalmicprofessional.com



Mr. Bennett is an ophthalmic photographer in the Penn State University Department of Ophthalmology at Milton S. Hershey Medical Center. He is a nationally recognized author, lecturer and educator in the field of ophthalmic photography and has served as president of the Ophthalmic Photographers' Society.