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Glaucoma

Imaging study

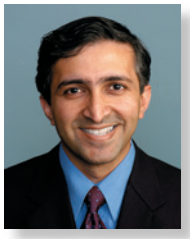
FD-OCT shows promise as advance in glaucoma diagnosis

Technology is still in infancy, but techniques for volumetric measurement are in the works

By Cheryl Guttman

Reviewed by Vikas Chopra, MD, and David Huang, MD, PhD

Las Vegas—Early results from the ongoing prospective Advanced Imaging for Glaucoma Study (AIGS; see *www.AIGStudy.net*) indicate that Fourier-domain optical coherence tomography (FD-OCT; also called spectral-domain OCT) is a valuable addition for glaucoma diagnosis, according to research presented here at the annual meeting of the American Academy of Ophthalmology.



Dr. Chopra

In the glaucoma free-paper session, Vikas Chopra, MD, assistant professor, Doheny Eye Institute, Keck School of Medicine, University of Southern California, Los Angeles, presented findings from analyses evaluating the glaucoma discrimination capabilities of time-domain OCT (TD-OCT; Stratus, Carl Zeiss Meditec) and a newly introduced FD-OCT platform (RTVue, Optovue). The study involved an AIGS subset of 30 subjects with normal eyes and 31 patients with perimetric glaucoma.

Circumpapillary and macular scanning were performed with both systems to obtain thickness measurements of the circumpapillary retinal nerve fiber layer (cpRNFL) and macula. In addition, macular inner retinal layer (IRL) thickness was determined using FD-OCT. Glaucoma discrimination capability was determined based on construction of area under receiver operating curves (AROCs) for each of the parameters.

Thinning demonstrated

Compared with the normal controls, the glaucomatous eyes showed statistically significant thinning of the cpRNFL, macular IRL, and macula. In the AROC analyses, the combination of the cpRNFL plus IRL measurement with FD-OCT had the greatest capability for glaucoma discrimination (AROC = 0.97), although the AROC for the IRL measurement alone was 0.96. Using the FD-OCT device, the AROCs for cpRNFL and macular thickness both were 0.90. As expected for the TD-OCT device, cpRNFL was a better discriminator than the macular thickness measurement (AROCs = 0.94 and 0.87, respectively), Dr. Chopra reported.

Take-Home Message

A newly available Fourier-domain optical coherence tomography (FD-OCT) platform (RTVue, Optovue) offering improved imaging speed and higher resolution relative to time-domain OCT (TD-OCT) was evaluated for glaucoma detection in a small subset of normal and glaucomatous eyes from the Advanced Glaucoma Imaging Study. All eyes also underwent imaging with TD-OCT (Stratus, Carl Zeiss Meditec). FD-OCT analyses of inner retinal layer thickness alone or combined with circumpapillary retinal nerve fiber layer thickness offered the highest sensitivity for glaucoma detection.

"Both of these OCT systems demonstrated excellent ability to differentiate glaucomatous eyes from normal controls using cpRNFL thickness measurements," said Dr. Chopra. "However, unlike the [TD-OCT device], this FD-OCT platform allows reliable retinal segmentation analysis in all eyes. By determining thickness of the macular IRL, FD-OCT can objectively measure changes to the retinal anatomy that are specifically affected by glaucoma damage for improved discrimination.

"However, based on these early results, we believe FD-OCT measurement of the macular IRL thickness should not be considered a substitute for circumpapillary anatomy measurements, but rather it might serve as an additional complementary parameter for improved detection of glaucoma," he added.

Previous studies with TD-OCT have shown that the macular retinal thickness measurement was not as sensitive as cpRNFL thickness in detecting glaucoma, Dr. Chopra noted. That finding, however, does not necessarily mean that the macula does not contain as much diagnostic information as the cpRNFL, he said.

"In fact, our own research and a study reported by Ishikawa et al. show that measurement of the inner retinal complex instead of the overall retinal thickness improves the diagnostic power of macular mapping with the [TD-OCT device] to a level equivalent to circumpapillary NFL evaluation," Dr. Chopra said. "Unfortunately, only 65% of glaucomatous eyes had a good enough signal-to-noise ratio to perform the macular segmentation using the time-domain technology. FD-OCT overcomes that obstacle."

Improved speed, resolution

David Huang, MD, PhD, associate professor, Doheny Eye Institute, is the

principal investigator in the AIGS and a co-inventor of OCT. Compared with TD technology, he said, FD-OCT offers both an exponential increase in imaging speed (65-fold) and better resolution.

Whereas TD-OCT captures a single pixel at a time and acquires 400 axial scans per second, FD-OCT can capture 2,000 pixels simultaneously and performs 26,000 axial scans per second. In addition, the FD-OCT technology offers a twofold advance in resolution compared with TD-OCT: 10 versus 5 µm, respectively.

"The slow speed of TD-OCT limits the number of axial scans that can be acquired in a reasonable amount of time and leads to a keyhole view of the fundus so that a lesion the size of the optic disc could be missed in the peripheral macula," Dr. Huang said. "In contrast, with the scan patterns that have been developed for the FD-OCT RTVue, it can acquire a detailed survey of the macula in less than 1 second, and in 2 seconds, it can acquire scans for a 3-D dataset that can be viewed in summation to provide fundus views in X or Y B-scan cross-sections or in 3-D cutaway views from any orientation," he said.

"FD-OCT also provides a sharper picture so that details such as small blood vessels and the photoreceptor inner and outer segment boundaries become clearly visible," he added. "As another advantage, because of its rapid acquisition time, FD-OCT avoids motion artifact that can confound interpretation of conventional OCT images."

Focal Point

FD-OCT can capture 2,000 pixels simultaneously and performs 26,000 axial scans per second.

Reasons unclear

Commenting on the results of the AIGS substudy, Dr. Huang noted that it is unclear why FD-OCT was not superior to TD-OCT for discriminating glaucoma based on analysis of the cpRNFL.

"We are working to refine the image processing for circumpapillary RNFL measurement with FD-OCT," he said. "I expect that when we take advantage of the capability of FD-OCT to sample RNFL over a map area rather than just a circular line, we will also find FD-OCT to perform better on cpRNFL analysis."

Dr. Huang

Dr. Huang and colleagues are working to develop techniques for volumetric measurements.

"With the increased amount of data from volumetric analysis and better sampling of the anatomy, I am certain that will result in even greater advances with FD-OCT," he said.

"Even though FD-OCT is still in its infancy and we are using relatively primitive approaches for analysis, it has already shown an advantage compared with standard TD-OCT for glaucoma diagnosis," Dr. Huang explained. "Certainly, FD-OCT is a revolution in diagnostic imaging that holds great promise for the future and will usher in clinical applications never possible before."**OT**

'FD-OCT is a revolution in diagnostic imaging that holds great promise for the future and will usher in clinical applications never possible before.'

David Huang, MD, PhD

FYI

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Dr. Chopra has no financial interest in any of the material presented.

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