SS-OCT: Clinical Applications for Diagnosing and Following Ocular Pathology



Faster scanning speed provides clear images that aid in identifying pathology while greater penetrance allows the ability to understand changes in deeper tissues, such as the choroid and lamina cribrosa.

BY RUBENS BELFORT, MD, PHD; PEARSE KEANE, MD; AND KI HO PARK, MD, PHD

Swept-source OCT (SS-OCT) represents a variation on a technology that has become indispensable for imaging the anterior and posterior segments—one with technological advances that confer distinct benefits for identifying pathology and monitoring ocular tissues.

At the 3rd International Swept-Source OCT & Angiography Conference, three ophthalmologists discussed how they are using this technology in clinical practice. Following is a summary of their lectures, focusing on how SS-OCT improves diagnostic accuracy and facilitates clinical decision-making in a broad range of clinical settings.

ABOUT SS-OCT

Similar to spectral-domain OCT (SD-OCT), SS-OCT imaging relies on backscattered light that is compared to a reference beam that, when superimposed, creates an interference pattern—a principle known as low-coherence interferometry. Each technology employs principles of Fourier transformation to measure simultaneous sources of backscattered light. However, there are some important differences in how these technologies work, with implications for the types of images they produce.

The Topcon DRI OCT Triton is one of the most advanced SS-OCT devices to become available for clinical use. The DRI OCT Triton, which also includes a non-mydriatic color fundus camera and a monochrome camera for fluorescein angiography and fundus autofluorescence, achieves a scanning speed of 100,000 A Scans/sec to provide superior visualization of the vitreous and choroid in the same scan. Meanwhile, the intuitive IMAGEnet 6 software enables dynamic viewing of OCT data—providing 3D, 2D, and fundus images simultaneously—and Pin-Point Registration identifies an exact pathological location across all imaging modalities available within the Triton.

SS-OCT IS MORE SENSITIVE FOR DETECTING MYOPIC GLAUCOMA

The faster scan speed, wider scan area, and higher penetration associated with SS-OCT relative to SD-OCT would seem to allow for more accurate depiction of retinal nerve fiber layer (RNFL) defects in myopic glaucoma.

Ki Ho Park, MD, PhD, performed a prospective observation study in 150 eyes with myopic glaucoma (n = 104 perimetric and 46 pre-perimetric) and 50 healthy eyes with myopia to understand the diagnostic accuracy of SS-OCT vs SD-OCT.[1] Glaucoma was defined as neuroretinal rim change and/or RNFL defect by photography. For all eyes, a 6 x 6 mm optic disc cube scan and a 6 x 6 mm macular cube scan were performed with SD-OCT, and a 12 x 9 mm widefield scan was performed with SS-OCT. Detection of RNFL defect from thickness and deviation maps was assessed by three independent glaucoma specialists. Diagnostic power for detecting glaucoma was also compared using circumpapillary RNFL thickness at 3.4 mm; GCIPL map on SD-OCT versus Macular GCL+ map on SS-OCT; and GCIPL on SD-OCT versus Macular GCL ++ thickness on SS-OCT.

For the diagnostic accuracy of myopic glaucoma, wide GCL ++ and GCL+ thickness maps showed higher accuracy compared to GCIPL thickness for both inferotemporal and superotemporal defects. Additionally, the wide GCL+ superpixel map showed significantly higher accuracy compared to the GCIPL deviation map for inferotemporal defects, with borderline significance for superotemporal defects. In the comparison analysis of area under the receiver operating characteristic curve (AUROC) for glaucoma between SS-OCT and SD-OCT, SS-OCT showed significantly larger AUROC in the superior and 11-o'clock sectors of RNFL thickness compared to SD-OCT. In addition, the AUROC for glaucoma was significantly larger for GCL+ thickness from SS-OCT compared to GCIPL thickness from SD-OCT in average, superior temporal, inferonasal, and inferior sectors.

Based on the results, Dr. Park concluded that SS-OCT showed better accuracy for detection of RNFL defects in myopic eyes, which corresponded with better diagnostic accuracy for detection of glaucoma in myopic eyes. He also emphasized that the wide scan

SD-OCT	SS-OCT
Broadband light source	Narrow bandwidth laser that rapidly sweeps over a broad range of wavelengths—provides greater penetrance to choroidal layers
Uses a spectrometer to detect returning wavelengths	Uses a point photodetector, allowing faster scanning speeds and reduced signal-to-noise ratio degradation over imaging depth

range of SS-OCT has an advantage in detecting RNFL defects that may have been missed in the conventional SD-OCT scan range.

A POTENTIAL ROLE FOR SS-OCTA IN MANAGEMENT OF DR

The treatment paradigm for diabetic retinopathy (DR) is changing in light of data from recently completed clinical trials showing the benefit of anti-VEGF therapy for proliferative DR (PDR), and perhaps in some cases of nonproliferative DR (NPDR) as well. Analogous to how the PrONTO study impacted the use of OCT for disease monitoring in age-related macular degeneration (AMD), widefield OCT and OCT angiography (OCTA) are poised to be similarly integral mechanisms for objective quantitative analysis of PDR, monitoring the status of the retina structure and function, and ultimately, for making decisions about treatment and determining its effect.

In his presentation, Pearse Keane, MD, said that he performs a line scan, a 3D volume scan (which he compared to macular OCT on SD-OCT), and a 6 x 6 mm angio disc scan centered on the optic disc for all patients entering with DR.[2] In situations where there is concern over peripheral regions, additional scans may be ordered.

How's this approach making an impact in the clinic? A 62-year-old woman with type 2 diabetes and a history of prior panretinal photocoagulation presented for a consultation. Line scan OCT revealed diabetic macular edema. In addition, areas of preretinal hyper-reflectance were visible, suggesting neovascularization in that region. Superimposing the structural OCT over the angio disc scan in this case helped to confirm the presence of neovascularization, with red dots in the preretinal hyper-reflected material suggesting perfusion within that tissue. According to Dr. Keane, such findings are often missed during clinical examination or on SD-OCT imaging. Additional use of *en face* imaging may be additive in discovering neovascularization at the disc, he said. In this case, fibrous tissue was apparent on the disc despite the history of previous laser. Following anti-VEGF treatment, repeat imaging did not show the same preretinal hyper-reflective material, while OCTA showed no presence of blood flow in the corresponding region, thereby providing insight on the activity of the disease.

Dr. Keane emphasized that such an approach is an emerging paradigm for following DR, and until more data are available, clinicians should be cautious in interpreting the kinds of findings he described. Nevertheless, the combined use of OCT and OCTA, particularly with SS-OCT technology, appears to be a promising approach for monitoring neovascularization at the disc.

CHOROIDAL CHANGES MAY HELP DISTINGUISH UVEITIC SUBTYPES

There is increasing evidence that the extent and degree of choroidal involvement seen on SS-OCT may help distinguish uveitic etiologies. According to Rubens Belfort, MD, PhD, several forms of uveitis have similar retinal findings, which may lead to them being classified as idiopathic, if additional testing and diagnostics do not reveal an obvious cause.[3] This may delay the initiation of appropriate treatment, with potential to lead to incomplete resolution of inflammation. On the other hand, the deeper penetration capability of SS-OCT is improving the ability to appreciate subtle choroidal changes associated with uveitic subtypes that provide insight on the diagnosis, prognosis, and response to treatment.

Dr. Belfort highlighted a number of cases from his clinic that demonstrate the potential role of SS-OCT imaging in managing uveitis. A 29-year-old woman with toxoplasmosis that was confirmed with IgM testing with decreased vision of 20/40 in the right eye was successfully treated with anti-toxoplasmic drugs, with visual acuity resolving to 20/20. However, the patient discontinued therapy on her own and returned to the clinic 9 months later with recurrence and visual acuity of 20/160. SS-OCT imaging performed during this visit showed an apparent artifact above the sclero-choroidal junction. After reviewing other imaging, Dr. Belfort said it became clear that there was choroidal involvement, which was confirmed by the choroidal thickening over the site of the pathology.

In another example, a 17-year-old patient with HM vision was referred to Dr. Belfort's clinic for suspected toxoplasmosis. The patient was initially started on anti-toxoplasmic drugs, but that was discontinued after further examination of OCT imaging. Subsequent laboratory testing instead revealed a diagnosis of cat scratch disease. In this patient, despite the presence of frank retinal changes, the choroid was relatively unaffected.

CONCLUSION

SS-OCT has a broad range of potential applications for discovering pathology and following it over time. Ultimately, the increased sensitivity, particularly of the choroid and deep structures of the eye, provides new information that assists the clinician in making decisions. Meanwhile, the idea of using multiple imaging modalities to discern disease features is an emerging paradigm across all sectors of eye care. With the potential to perform multiple imaging studies on a single platform, coupled with correlation to anatomic markers across various imaging modalities, the Topcon DRI OCT Triton is poised to be a powerful clinical tool for anterior and posterior segment ophthalmologists. ■

1. Park KH. Role of SSOCT in diagnosis of myopic glaucoma. Presented at Topcon's 3rd International Swept Source OCT & Angiography Conference. July 26-30, 2019; Fort Myers, Florida.
2. Keane P. SSOCTA in proliferative diabetic retinopathy. Presented at Topcon's 3rd International Swept Source OCT & Angiography Conference. July 26-30, 2019; Fort Myers, Florida.
3. Belfort R, Novaes E, Andrade G, et al. Swept Source OCT Angiography in chorio-retinal inflammatory diseases. Presented at Topcon's 3rd International Swept Source OCT & Angiography Conference. July 26-30, 2019; Fort Myers, Florida.

RUBENS BELFORT, MD, PHD
- Head professor of ophthalmology at the Federal University of Sao Paulo and Vision Institute, Brazil
- prof.belfort@clinicabelfort.com.br
- Financial Disclosures: Speaker (Topcon)

PEARSE KEANE, MD
- Consultant Ophthalmologist/NIHR Clinician Scientist, Moorfields Eye Hospital/Institute of Ophthalmology University College
- Pearse.Keane@moorfields.nhs.uk
- Financial Disclosures: Speaker (Allergan, Bayer, Carl Zeiss Meditec, Haag-Streit, Heidelberg Engineering, Novartis, Topcon); Advisory Board (Bayer, Novartis); Consultant (Apellis, DeepMind Technologies, Novartis, Roche)

KI HO PARK, MD, PHD
- Professor and chairman of ophthalmology at Seoul National University and current President of the Korean Ophthalmology Society
- kihopark@snu.ac.kr
- Financial Disclosures: None