Optical Coherence Tomography Angiography, the powerful new imaging modality for clinical ophthalmology

Optical coherence tomography angiography (OCTA), a new type of optical coherence tomography (OCT), can produce high-resolution, three-dimensional (3D) angiograms of the retina and choroid and identify subretinal neovascular blood vessels. OCTA is becoming one of the most important diagnostic tools in ophthalmology and enables clinicians to evaluate structural changes in different retinal diseases. In this issue, an up-to-date review article provides readers with detailed information pertaining to technical principles, image processing, and clinical applications of OCTA in various retinal diseases.

OCTA utilizes a high OCT scanning speed and performs repeated scans at the same location, and then identifies blood vessels by detecting red blood cell flow. In such a way, OCTA can be used to construct a 3D dataset to represent the vascular portion of the scanned tissue and automated or semi-automated segmentation boundaries. Accurate segmentation of the structural image provides efficient evaluation of retinal and choroidal vasculature to differentiate between healthy and diseased retina. In the presentation of scanning data, the 3D flow data are usually represented as 2D images and coordinated with the structural data to yield detailed information on the depth of vascular abnormalities such as retinal or choroidal neovascularization (CNV).

Given that OCTA can be used to quantitatively evaluate retinal abnormalities, many metrics have been chosen to measure vascular abnormalities in different eye diseases, including flow index, vessel density, nonperfusion area measurements, and perfusion density mapping. Among them, flow index is more sensitive for detecting metabolic and physiologic changes in retinal tissue. Vessel density is beneficial for the diagnosis and monitoring of vascular pathology. The authors of the review in this issue also summarize the quantitative parameters of OCTA in various eye diseases to facilitate their diagnosis, monitoring, and treatment.

Many artifacts occurring in OCTA may lead to inaccurate interpretation and inappropriate decision-making. Media opacity, pupil vignetting, and defocusing of light beams can result in images of low quality, which in turn obscure the visualization of inner eye components and generate unreliable flow information. The review’s authors point out that the latest version of OCTA uses longer wavelength light sources, accurate focusing and centering of the OCT beam, and pupil dilation to reduce the presence of artifacts due to weak OCT signal. In addition, motion artifacts induced by patients’ bulk tissue and saccadic eye movements can be reduced by motion correction technology and an eye tracking system.

OCTA has been widely applied in the clinical diagnosis of ocular diseases. As summarized by the review’s authors, OCTA can be used to diagnose the different types of CNV in age-related macular degeneration and other retinal diseases.
degeneration (AMD), monitor responses to antivascular endothelial growth factor (VEGF) treatment, and evaluate subretinal fibrosis due to AMD.\textsuperscript{[11]} In central serous chorioretinopathy, OCTA can detect blood flow abnormalities and associated structural changes.\textsuperscript{[12]} In nonneovascular AMD, choroidal flow impairment within and beyond the margins of the atrophied area can be detected through OCTA.\textsuperscript{[13]}

Importantly, some limitations of OCTA are noted and summarized by the authors in the review in this issue. One is a small field of imaging (confined in the posterior pole), which can be resolved by the use of higher speed OCT systems to facilitate wide-field OCTA scans. Other limitations include the presence of numerous artifacts pertaining to flow projection, shadow, motion, and signal strength variations, which interfere with image interpretation.

In conclusion, OCTA can provide noninvasive simultaneous 3D structural and blood flow information in the evaluation of retinal and optic nerve diseases. Quantification of angiographic information can be used to monitor treatment responses, for example, capillary dropout in glaucoma and diabetic retinopathy, occult and nonexudative CNV, and the flow response to anti-VEGF therapy. In the future, more research and technological improvements may further promote the use of OCTA as a powerful tool in eye care.

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\textbf{Jiann-Torng Chen} \\
Department of Ophthalmology, Tri-Service General Hospital, National Defense Medical Center, Taipei, Taiwan, ROC \\
Address for correspondence: Prof. Jiann-Torng Chen, Department of Ophthalmology, Tri-Service General Hospital, Number 325, Section 2, Chenggong Road, Neihu District, Taipei City 114, Taiwan, ROC. E-mail: jt66chen@gmail.com
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