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Improved Technology, Speedier Clinics, and Tailored Treatments

A panel of experts review two imaging tools aimed at improving the diagnosis and management of disease.

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Introduction

As the demands of precision medicine continue to grow, so too do patients' expectations of efficient and efficacious office visits. Imaging plays a major role in the diagnosis and management of disease, and the more that is known about a patient's anatomy, the better treatment can be tailored to his or her specific needs.

Two tools available for your clinic—the ZEISS PLEX Elite and the ZEISS CLARUS 700—offer ways by which reliable, detailed imaging reports can be acquired. On the PLEX Elite, clinicians can obtain high-quality OCT angiography (OCTA) images. As we expand our knowledge of OCTA's utility in a number of disease states, it becomes clearer that this noninvasive imaging modality will play a larger role in the diagnosis and assessment of multiple diseases. Royce W.S. Chen, MD, provides a survey of how OCTA may prove useful for a wide variety of disease states, and Sunil K. Srivastava, MD, offers detailed analyses of how OCTA informed his treatment decisions in cases of diabetic retinopathy and uveitis.

The CLARUS 700 may be used to capture multiple imaging modalities in a single session. Jesse J. Jung, MD, explains how the expansive offerings of the CLARUS 700 are improved by a number of software updates, and offers specific examples that illustrate how small changes to image resolution or montaging technology make large differences in disease assessment.

The ZEISS suite of imaging platforms are designed to help you make informed decisions while keeping your clinic running smoothly. The experiences of Drs. Chen, Jung, and Srivastava demonstrate that point well. ■

OCTA's Utility in a Number of Diseases

Imaging on the PLEX Elite speeds up my clinic and provides excellent readouts.

BY ROYCE W.S. CHEN, MD

For the vast majority of my patients across a number of disease states, I order OCT angiography (OCTA) on the ZEISS PLEX Elite. There are a few exceptions: I reserve fundus photography for cases that require multimodal imaging and usually order fluorescein angiography (FA) with indocyanine green for uveitis patients. Still, OCTA has become one of my primary tools, and I have found that by learning to read flow void patterns near choroidal neovascular membranes and by understanding the differences between inflammatory lesions and choroidal neovascular membranes on imaging, I have been able to expand my knowledge of my patients' diseases and tailor my treatments to their specific needs.

In this article, I share images that illustrate how the PLEX Elite has informed my decision-making.

DIABETIC EYE DISEASE

A 35-year-old pregnant woman with type 1 diabetes mellitus presented to my clinic with floaters and for evaluation of diabetic retinopathy (DR). OCTA montage imaging on the PLEX Elite demonstrated extensive proliferative DR (Figure 1). Based on this test, I assessed the patient's degree of neovascularization and proliferation and observed extensive ischemia in the periphery.

I find that in patients with diabetic eye disease who struggle with metabolic control and in pregnant patients for whom FA is a relative contraindication, OCTA readouts such as this one are useful teaching tools. Some patients find an easy-to-understand imaging report instructive. In those patients, I can hammer home a message about the relationship between their diabetes and their visual outcome.

SICKLE CELL RETINOPATHY

My research group at Columbia University is studying the effect of bone marrow transplantation and sickle cell retinopathy in the pediatric and adolescent population. In our first publication, we concluded that OCTA is an effective tool for detecting sickle cell retinopathy in adolescent populations, describing the platform as allowing "more sensitive visualization of retinal thickness and blood flow through the deep and superficial plexuses in the macular region compared with FA."[1] Further, we also found that, "in contrast to ultrawide-field FA, which requires dye injection and produces a 2D image, OCTA is noninvasive and allows visualization of all three major capillary networks (superficial retinal, deep retinal, and choriocapillaris)."[1]

Importantly, this study found that OCTA detected flow voids in the superficial and deep retinal capillary plexuses in the macula of children.[1] The study showed that sickle retinopathy creates macular ischemia earlier than we previously thought. Given the noninvasive nature of OCTA and the evidence that it can be used to identify disease activity, this platform is particularly well suited for evaluating anatomy in patients with sickle cell retinopathy.

Figure 2 shows B-scans (A) and OCTA of the superficial (B) and deep (C) plexuses of a 12-year-old boy with sickle cell disease Hb SS. Flow voids are observed on the OCTA reports. Interpretation of B-scan imaging is informed by OCTA imaging. When I observe certain patterns on a B-scan (ie, temporal thinning), I know that these areas correspond to flow voids on OCTA. I have a more nuanced appreciation for ischemic disease when reports from these two modalities are viewed side-by-side.

AGE-RELATED MACULAR DEGENERATION

OCTA has demonstrated utility for managing cases of neovascularization and both wet and dry age-related macular degeneration (AMD). B-scans offer guidance regarding treatment decisions, and OCTA helps me distinguish lesion type and size.

A recent case from my clinic illustrates this well. An 81-year-old

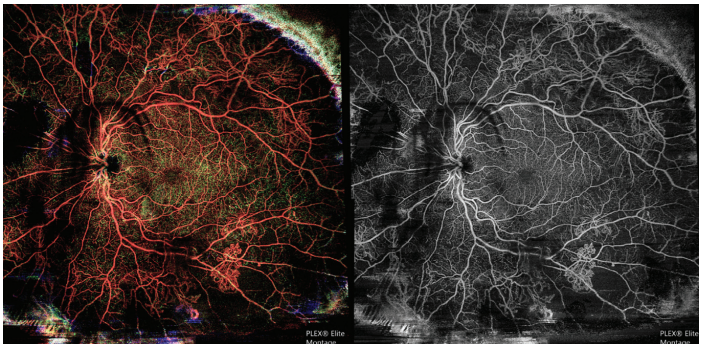

Figure 1. OCTA montage shows peripheral ischemia and extensive proliferative DR in this 35-year-old pregnant patient.

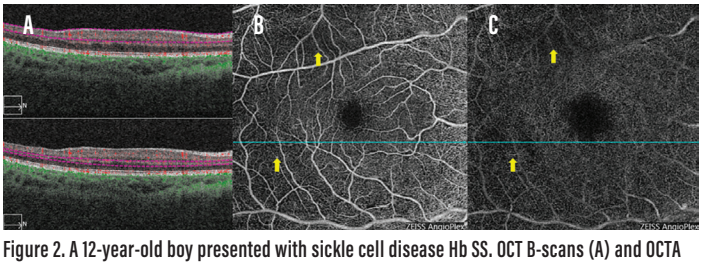

Figure 2. A 12-year-old boy presented with sickle cell disease Hb SS. OCT B-scans (A) and OCTA of the superficial (B) and deep (C) plexuses are seen here. Flow voids are observed on the OCTA reports (B, C, yellow arrows), which in turn inform interpretation of the B-scan.

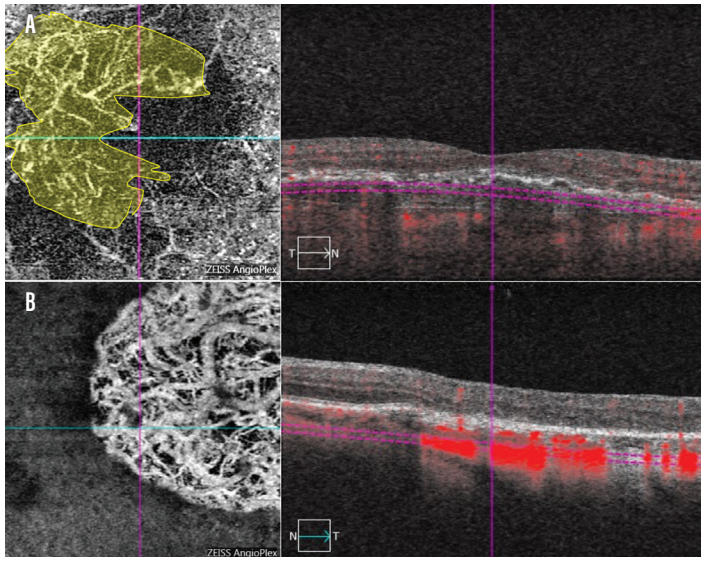

Figure 3. On OCTA, the area of neovascularization is nicely delineated OD in a patient with neovascular AMD (A, area in yellow). OCTA helped determine that a geographic atrophy lesion, rather than neovascularization, was present OS (B).

woman with a history of monthly intravitreal injections of aflibercept (Eylea, Regeneron) presented to the clinic. Examination of her right eye (OD) and left eye (OS) revealed VA of 20/30 and 20/80, respectively.

OCTA helped me identify the area of neovascularization OD, as well as the presence of flow voids around the neovascular area (Figure 3A). The OCTA report OS may lead the untrained observer to conclude that a neovascular membrane is present OS (Figure 3B). However, the corresponding OCT scan demonstrates that this is a geographic atrophy lesion. The OCTA image also lacks the characteristic flow void typically found around choroidal neovascular lesions.

Comparing the OCTA image of a patient without dry AMD (Figure 4A) to images from dry AMD patients (Figure 4B, C, D) demonstrates how OCTA detects areas of disease. Often, these lesions are found in the choriocapillaris and are not detected in the deeper layers of the choroid. In patients with evidence of dry AMD in the choriocapillaris, it is unclear if flow voids arise due to the presence of drusen or if drusen are a risk factor for flow void genesis.

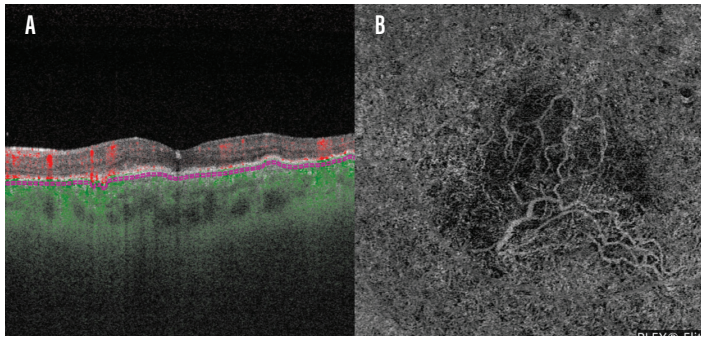

Figure 5. Neovascular membrane and subretinal fluid are imaged on OCT B-scan (A) and a branching network is observed on OCTA (B) in this patient with PCV.

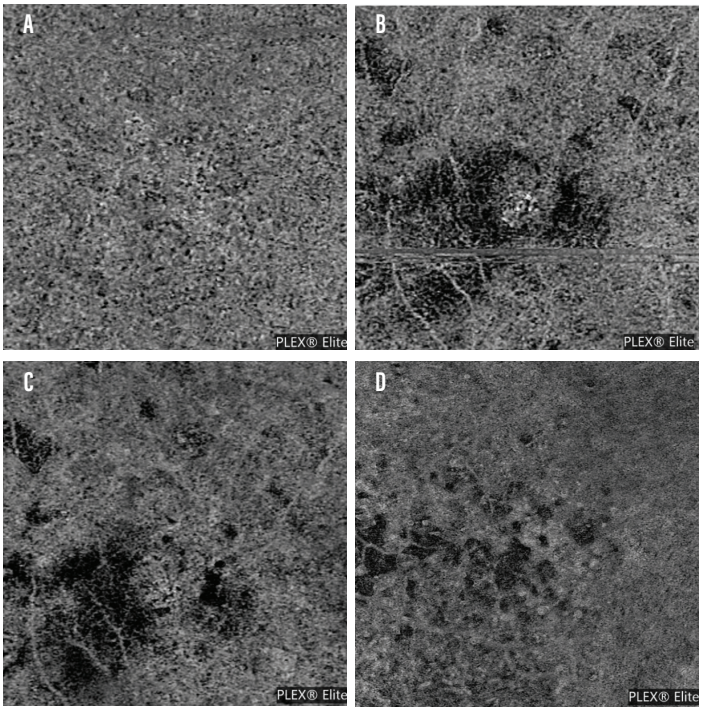

Figure 4. An OCTA scan from the PLEX Elite of a patient without evidence of dry AMD (A) and OCTA scans of patients with dry AMD as detected on imaging (B-D). Patients with dry AMD often present with various flow void patterns.

POLYPOIDAL CHOROIDAL VASCULOPATHY

Detection of polypoidal choroidal vasculopathy (PCV) is enhanced on the PLEX Elite. In the case of a 43-year-old woman with PCV, I noted subretinal fluid and a choroidal neovascular membrane beneath the retinal pigment epithelium on B-scan (Figure 5A). A large branching vascular network was imaged on OCTA (Figure 5B). Because of the clarity with which I could follow the neovascular membrane, I determined that FA imaging was unnecessary. Some other cuts on the OCTA also demonstrated the typical terminal polypoidal changes, and I therefore spared this patient invasive contrast-based imaging.

CONCLUSION

When considering the range of tests we can order for patients, we must prioritize invasiveness, speed, and accuracy. Imaging with the PLEX Elite keeps my patients comfortable; allows me to understand nuances about their particular disease, which in turn allows patient-specific care; and provides imaging results that my patients and I can easily interpret. ■

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1. Pahl DA, Green NS, Bhatia M, et al. Optical coherence tomography angiography and ultra-widefield fluorescein angiography for early detection of adolescent sickle retinopathy. *Am J Ophthalmol.* 2017;183:91-98.

Enhanced Ultrawide-Field Imaging on the CLARUS 700

Multimodal imaging on a single platform and software updates join forces to create a state-of-the-art technology for your practice.

BY JESSE J. JUNG, MD

Ultrawide-field (UWF) imaging has changed the way we manage patients with retinal disease. However, the modality is not without its limitations. On older UWF imaging platforms, these include low resolution (which affects our ability to simultaneously image the area near the optic nerve and the periphery), lack of true color images, and the inability to capture multiple image modalities (eg, fundus autofluorescence [FAF] green, FAF blue, fluorescein angiography [FA], etc) on a single platform. In addition, lid and lash artifacts frustrate our efforts to acquire clean shots of our patients' posterior and peripheral retinas.

The ZEISS CLARUS 700 is a single UWF platform that addresses a number of the issues clinicians encounter in their clinic. True color, FAF blue, FAF green, and FA are all available on the CLARUS 700, as are external photography and infrared imaging (Figure 1).

Rather than use a single white light to acquire UWF true color fundus photographs, the CLARUS 700 uses three different colored light-emitting diodes (LEDs) with broad line fundus imaging to scan the retina during color fundus photography. By using a red LED (585-840 nm wavelength), green LED (500-585 nm), and blue LED (435-500 nm), the platform provides a natural-looking fundus photograph as it appears through direct observation.

Lash and lid artifacts are removed via algorithmic adjustment, providing a cleaner image for assessment. The accuracy and resolution are those of a traditional 45° camera but provide a wide-field view up to 200° with montaging.

The CLARUS 700 houses a trio of features that make the platform easier to use and boosts the data available in the clinic. PrecisionFocus technology enhances our ability to examine a particular region of interest without sacrificing resolution in another area. AutoBright software optimizes an entire series of images (rather than optimizing on an image-by-image basis) for brightness. GazePoint artificial intelligence (AI) technology facilitates montaging by identifying and using the optic nerve as a focal point, providing a superior UWF image.

PrecisionFocus

PrecisionFocus is particularly useful in non-emmetropic eyes. In these eyes, features near the foveal center are in focus, and images in the periphery are rendered in lower resolution.

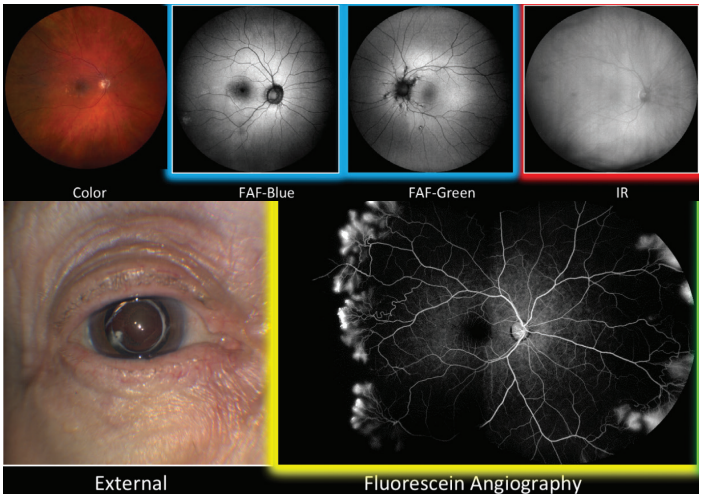

Figure 1. Multiple modalities exist in the single platform on the ZEISS CLARUS 700.

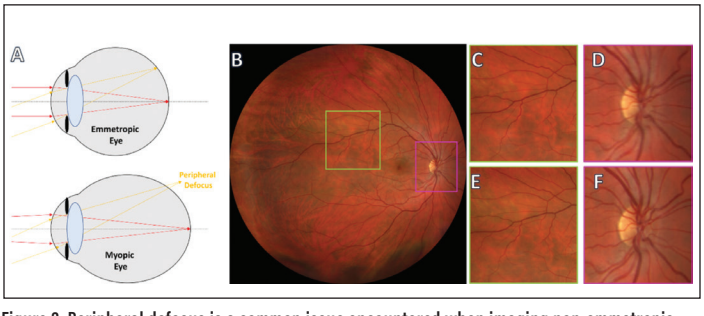

Figure 2. Peripheral defocus is a common issue encountered when imaging non-emmetropic eyes (A). Focusing on the vessels (B, yellow box) in a 90° fundus image of a myopic eye may result in less sharp images near the foveal center (B, pink box). Without PrecisionFocus technology, the vessels (C) are in a higher resolution than the area near the optic nerve (D). When PrecisionFocus technology is used, sharpness is maintained peripherally (E) and centrally (F).

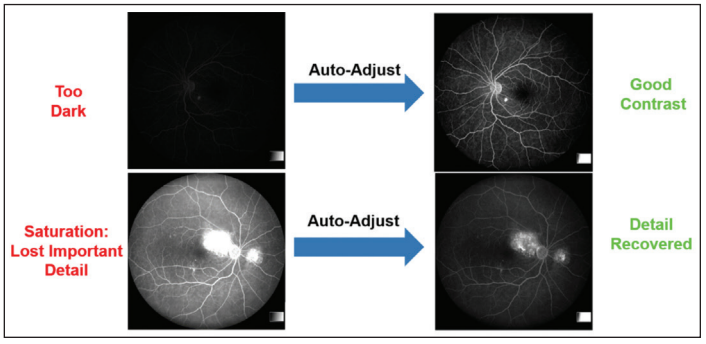

Figure 3. AutoBright technology on the CLARUS 700 adjusts images that are too dark (top row) or too saturated (bottom row) so that the imaging report is readable.

With PrecisionFocus technology, details in the foveal center and the periphery are both rendered in high resolution (Figure 2).

AutoBright

Images that are too dark lack contrast (Figure 3, top row), and images with too much saturation result in lost details (Figure 3, bottom row). AutoBright technology on the CLARUS 700 modifies such images during processing, ensuring that images have proper contrast and detail so as to be useful to the clinician.

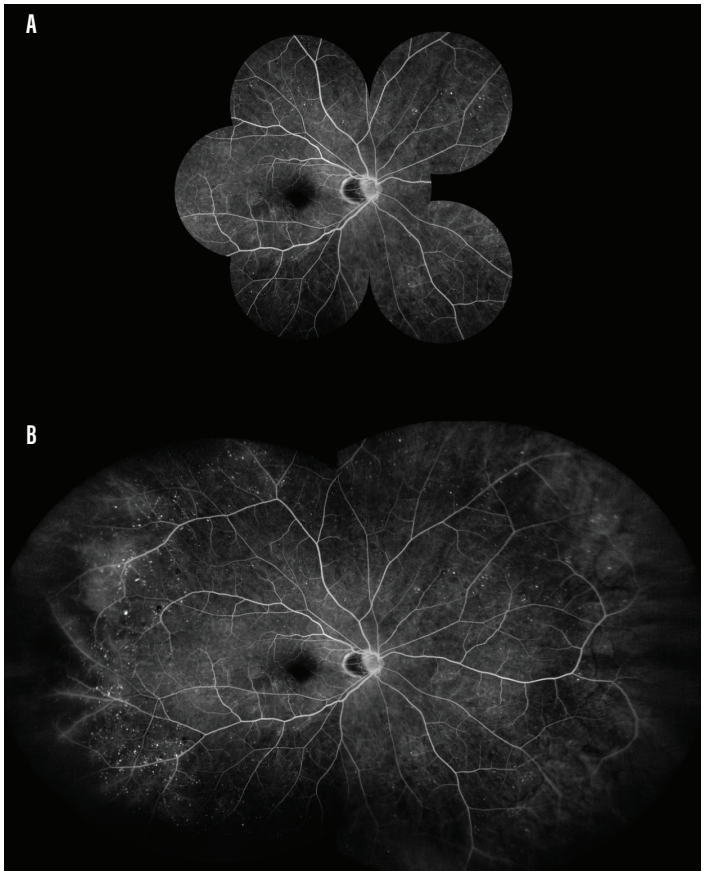

Figure 5. FA imaging of a patient with severe nonproliferative diabetic retinopathy reveals limited data when employing standard 7-field imaging (A). When UWF imaging is employed, the nature and extent of the disease is easily observed (B).

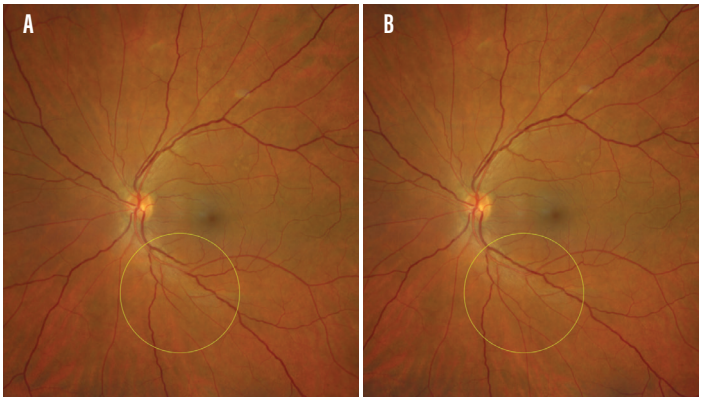

Figure 4. UWF images without perfect fixation may result in the readouts that show, for example, discontinuation of a vessel (A, yellow circle). After applying GazePoint, artificial intelligence adjusts the image, resulting in a readout that shows vessel continuation (B, yellow circle).

GazePoint

GazePoint technology on the CLARUS 700 leverages the power of AI to create fully detailed montage UWF images. When patient fixation is imperfect, the resulting image may be suboptimal. With GazePoint, the optic nerve becomes the point of fixation, resulting in a sharper image (Figure 4).

CASE EXAMPLE

In this patient with severe nonproliferative diabetic retinopathy, limited details are available on standard 7-field imaging (Figure 5A). When UWF imaging on FA is employed, the extent of disease and the severity of leakage are better understood (Figure 5B). With the assistance of PrecisionFocus, AutoBright, and GazePoint technologies on the CLARUS 700, this montage image is in high resolution with appropriate contrast.

DOING MORE WITH LESS

In a busy clinic, efficiency and efficacy are key. By combining multiple modalities on a single platform in the CLARUS 700, my clinic functions productively, and my patients are able to undergo multiple tests in a short period of time. Software updates that allow sharper, more detailed images improve my clinical analysis and allow me to tailor treatments to my patients' specific needs. ■

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OCTA in Diabetic Retinopathy and Uveitis

Advances in imaging technology have led to more effective management of diseases.

BY SUNIL K. SRIVASTAVA, MD

As our clinics grow busier and our imaging options expand, we must balance our desire to learn as much as we can about a patient's anatomy with our requirement to efficiently manage cases. When it comes to imaging, I prioritize speed and accuracy; a test that takes too long to process has the potential to disrupt my clinic, and a test that yields unreliable results is useless.

OCT angiography (OCTA) has become an increasingly important tool in diagnosis and monitoring of diabetic eye disease and uveitis. I have begun to use, among my arsenal of imaging platforms, HD AngioPlex software on the ZEISS CIRRUS 6000 100 kHz spectral-domain OCT/OCTA.

In this piece, I illustrate how new imaging technology informs my clinic's efficiency.

DIABETIC EYE DISEASE

Before ordering imaging tests for patients with diabetic eye disease, I ask myself if the results will affect my management of the case. In cases of diabetic eye disease with the presence of macular edema and/or leakage due to neovascularization, I often order OCT imaging with wide-field fluorescein angiography (FA). I believe imaging of the peripheral retina and assessing the peripheral perfusion and vascular leakage can be useful. At that time, OCTA imaging did not rapidly image the peripheral retina, generate a reproducible readout, or provide measurement data by which to predict disease progression and treatment outcomes.

Recent imaging advances, however, may change the way I practice. Fast and reproducible results allow me to quickly assess the peripheral retina, the patient's diffusion status, and easily identify neovascularization.

Take, for example, the AngioPlex HD software. The platform's 6x6 scans provide 96% more data than standard AngioPlex scans of the same size; for 8x8 scans, the new platform provides 240% more data (Figure 1).

My photography team has been impressed. Overall, their satisfaction with new technologies' speed (particularly useful for patients who tend to blink a lot, which resulted in poor images on slower modalities), rapid montage of images, and improved tracking have led to an improved imaging experience for patients.

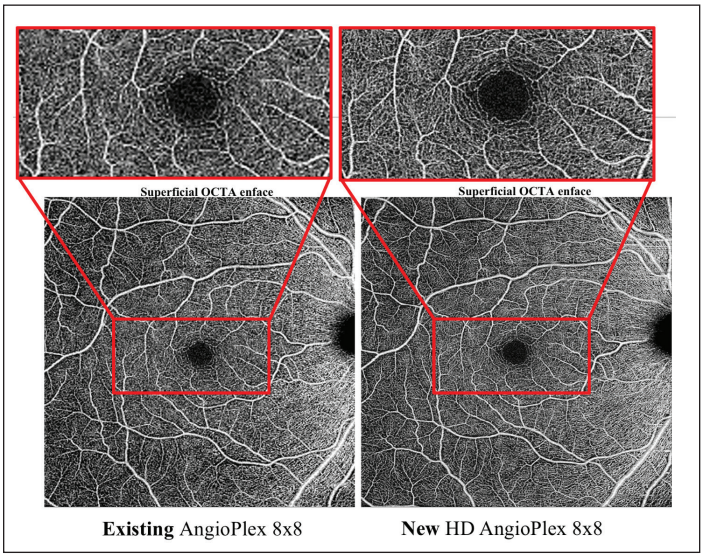

Figure 1. On the AngioPlex HD, 8x8 scans yield significantly more detail and a clearer image compared with the standard AngioPlex system.

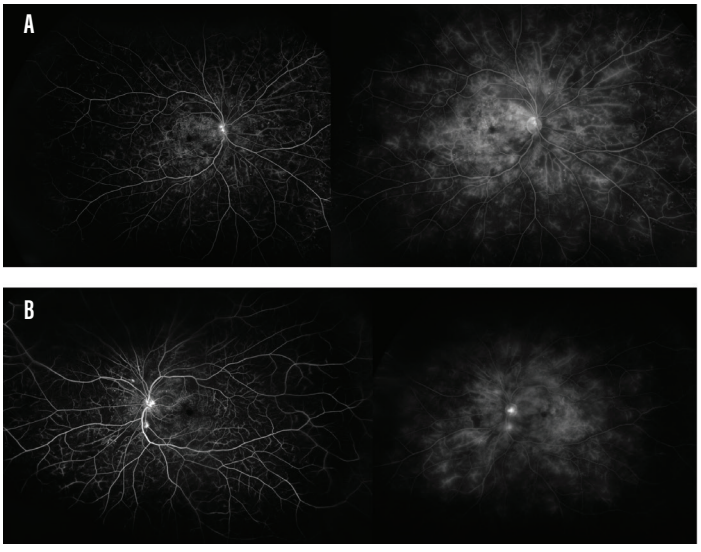

Figure 2. FA imaging results showed that this patient exhibited nonperfusion in the periphery's capillary bed and leakage in the right eye (A) and left eye (B).

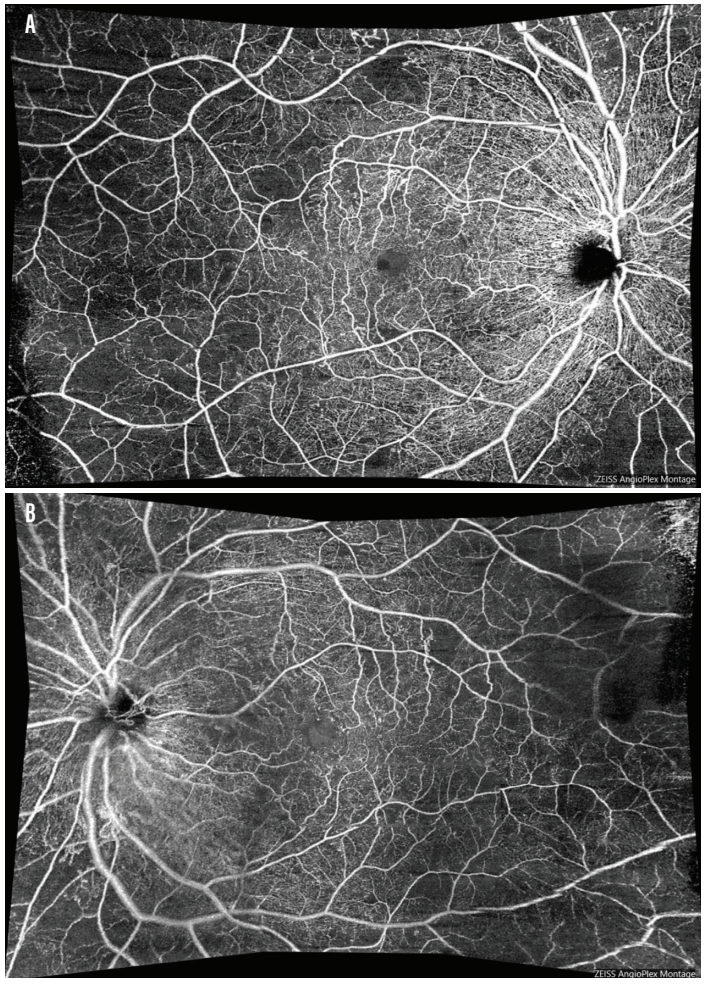

Figure 3. An 8x8 montage image of the right eye (A) and left eye (B) demonstrates severity of nonperfusion, macular edema, and risk of neovascularization.

Case Presentation

A 50-year-old man with type 2 diabetes mellitus and A1C of 9% came to see me. Wide-field FA imaging highlighted the degree of nonperfusion in the periphery in the capillary bed and the degree of bilateral leakage (Figure 2).

OCTA data added to my understanding of this patient's condition. An 8x8 montage image of the right eye (Figure 3A) and left eye (Figure 3B) shows the degree of nonperfusion, particularly in the core. The imaging report allowed me to assess the degree to which the perfusion was compromised and the severity of macular edema, and I was able to assess the risk of neovascularization.

The choice to initiate anti-VEGF therapy was unaffected by this additional information. However, the ability to track this patient over the course of several visits has improved. By relying on OCTA rather than fundus photography and FA, I can quickly gather information on peripheral perfusion status and neovascularization via a less invasive, faster modality.

It is worth noting that images that some may consider less than adequate actually yield a significant payload of information. The images of patients who blink during imaging, fail to follow instructions, or have comorbidities that interfere with imaging (eg, dry eye disease) still produce data that are useful to the clinician.

UVEITIS

Any imaging I order for patients with uveitis must help me identify patterns, assess disease activity, and tell me something new about the patient's disease. Sarcoid uveitis may be particularly well suited for swept-source OCTA (SS-OCTA) imaging because the disease manifests in the choroid. ICG angiography (ICGA) is commonly used for this purpose. My team sought to understand if and how OCTA could be used to manage these cases.

Using ImageJ software, participating clinicians at my practice calculated the number of lesions identified in the choroid and choriocapillaris on ICGA and SS-OCTA. We imaged patients on both ICGA and SS-OCTA. On ICGA, 46 (±34) lesions were identified, compared with 52 (±59) lesions on SS-OCTA (P = .744). Of 15 eyes with active disease that were imaged on the same day, 11 had lesions that were identified by both modalities; the remaining 4 eyes did not have lesions identified by either modality.

We measured 31 eyes with active uveitis on SS-OCTA. Flow voids in the choriocapillaris were noted in 22 eyes, and flow voids in the choroid were observed in 16 eyes.

SS-OCTA imaging reports provide data on segmented tissue layers, as opposed to ICGA, which produces a compressed readout. Our team found this useful for tracking lesion activity in patients with active uveitis.

Given that the rates of lesion detection on the two modalities were not significantly different, and given the availability of distinct tissue layer reports, SS-OCTA provides a more advanced imaging option for uveitis management.

CONCLUSION

Advances in imaging have contributed significantly to my clinical decision-making without sacrificing accuracy, efficiency, or patient comfort. As someone who has a high bar for adopting a new imaging modality in my clinic, I can say with confidence that these technologies reach that bar. ■

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