Ultra-Widefield Retinal Imaging

The latest device in this category allows enhanced detection, monitoring, and management of retinal disease.

By SriniVas Sadda, MD

The peripheral retina is the site of pathology in many vision-threatening eye diseases, especially retinal vascular disorders. Our understanding of the clinical relevance of peripheral findings is rapidly advancing, and it is already clear that identifying and monitoring these findings over time may be essential to improving disease management. Ultra-widefield (UWF) retinal imaging, which allows for true ultra-wide visualization—up to 82% or 200° of the retina—with a single, noncontact digital capture (Optomap, Optos) has become a crucial tool for ongoing research in this area. UWF imaging is an essential component of our clinical practice, and these devices have demonstrated utility in screening, diagnosis, monitoring, and treatment planning for a wide variety of the most significant manifestations of retinal disease, including diabetic retinopathy (DR), retinal vein occlusion (RVO), age-related macular degeneration (AMD), uveitis, and vasculitis.

CALIFORNIA

The latest generation of Optos’s UWF retinal imaging devices, California (Figure 1), was launched in early 2015. Not only does California provide the widest image field and broadest functionality of any available widefield imaging device, but it also incorporates hardware and software enhancements that transcend some of the technological boundaries of previous UWF systems.

Hardware

California is built around a proprietary scanning laser ophthalmoscope designed specifically for UWF imaging. It incorporates a unique ellipsoidal mirror that produces a virtual point inside the eye to permit single-capture imaging of the biggest area of retinal surface of any available system. Two low-power red and green lasers scan the retina simultaneously, allowing visualization of the sensory retina to the retinal pigment epithelium (RPE) and the deeper structures from the RPE to the choroid. This technology also makes dilation optional for imaging, permitting high-resolution capture through pupils as small as 2 mm and through significant cataract and other media opacities. New optical hardware enhancements in California correct for aberrations produced when scanning substantially off axis. The result is increased imaging resolution across the entire retina during scanning to produce greater imaging clarity in the far periphery and consistency across the entire image. There is no need to steer the shot to ensure that all quadrants, particularly superior and inferior, can be visualized in greater detail.

California is a tabletop device, and thanks to revisions to internal optical hardware and to its optomechanical design, it provides a full suite of UWF features in a compact footprint. The patient chinrest has been reconfigured for comfort and stability, and an integrated three-axis translation stage permits better operator control. The California also utilizes patient position to facilitate image automatic capture. Coupled with an increased capture frame rate,
autocapture enables successful nonmydriatic imaging with California in a matter of seconds.

Imaging Modalities
California offers all of the UWF imaging modalities available on prior Optos devices, including composite color, red-free, autofluorescence (AF) and fluorescein angiography (FA; Figure 2), as well as a new capability, indocyanine green angiography (ICG; Figure 3). Interwoven angiography enables parallel capture of FA and ICG images without manually switching between imaging modes. Research is now under way to correlate findings on UWF ICG images with clinical observations and confirm their full diagnostic and prognostic value. Meanwhile, the availability of ICG on an UWF platform provides an important opportunity to improve diagnosis and management of inflammatory retinal diseases as well as deep retinal and choroidal disorders such as polypoidal choroidal vasculopathy and central serous retinopathy.

Software
California’s Optomap images are managed and reviewed with enhanced ProView software, which correlates the output of the optical imaging system with ocular geometry to map each pixel to a consistent, spherical geometry. This preserves angular features and enables an accurate representation of the retina, essentially overcoming the inherent distortion caused by projecting a 3-D spherical object in two dimensions. ProView also allows consistent presentation across all imaging modalities and patient gaze angles for accurate image registration that facilitates instantaneous multimodal image overlay and comparison.

In addition, comparisons can be made between different image capture dates by scrolling through stored images. These features provide the basis for disease tracking over time and support precise measurement of retinal pathology. Sharing Optomap images within the practice or with other offices is also quite easy. Browser-based, platform-independent image review enables simple integration and easy access to UWF images from any connected computer or tablet in an HIPAA-compliant environment. Archiving images in the cloud also facilitates storage and referral management.

WIDENING CLINICAL APPLICATIONS
The advances incorporated in California provide a new level of precision and efficiency in UWF imaging at a time when its clinical utility is being widely explored and validated. For example, results of a recent 4-year study demonstrated the clinical significance of peripheral lesions detected with UWF imaging in predicting a three- to nearly fivefold increased risk of DR progression and the onset of proliferative disease. With UWF imaging in this setting, patients at substantially higher risk for vision loss who might otherwise have been missed using standard fundus photography were identified. In an earlier paper, the same group demonstrated that incorporating UWF imaging in an ocular telehealth program identified DR 17% more often, reduced the proportion of ungradable images to less than 3%, and shortened the time required for image evaluation by 28%, compared with standard Early Treatment Diabetic Retinopathy Study (ETDRS) 7 standard fields.

A 4-year study being performed by the Diabetic Retinopathy Clinical Research Network (DRCR.net) was designed to determine the relative risk of a two-or-more-step worsening in DR between patient cohorts with and without predominantly peripheral lesions as visualized on UWF imaging. Peripheral nonperfusion, detected with UWF imaging, has also been evaluated as a predictor of the extent of edema and potential treatment response in RVO. This work facilitated the development of an ischemic index.
that correlates with macular edema. My colleagues and I have shown a high prevalence of peripheral disease in aging eyes. Use of UWF imaging in a subset of patients in the Age-Related Eye Disease Study 2 (AREDS2) also revealed that peripheral abnormalities are common in patients with AMD, with up to 75% of eyes showing drusen, pigmentary abnormalities, and atrophy outside of the field of view provided by standard imaging. This confirmation that AMD is not a disease confined to the posterior pole has important implications for improving our ability to better understand its pathogenesis and devise new therapeutic approaches. In another study of 130 eyes in 69 patients with uveitis and vasculitis, UWF ICG imaging performed at three participating institutions detected 67% more disease than standard ICG angiography, resulting in changes to patient management in 51% of cases.

CONCLUSION
Just as the availability of ocular coherence tomography made us recognize how much we were missing with standard biomicroscopy, the continued optimization of UWF retinal imaging technology underscores how important it is to be able see, understand, and document what is happening in the retinal periphery quickly, easily, and regularly. Incorporating state-of-the-art, purpose-built optical imaging technology, multiple imaging modalities, advanced software functionality, and a compact design with new features that improve ease of use for both the operator and the patient, California is a sophisticated and useful UWF platform. As ongoing research translates into broader applications in the clinic, we are likely to find that UWF imaging will become more indispensable for the detection, monitoring, and management of retinal disease.

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