phthalic imaging has undergone numerous advances in recent decades, as an unprecedented series of new technologies have expanded our methods of viewing the posterior pole of the eye. From the development of digital photography to the introduction of scanning laser ophthalmoscopy (SLO), to time domain and then spectral-domain optical coherence tomography (OCT), each new viewing modality has helped to increase ophthalmologists’ understanding of posterior segment disease. Currently, there is a dawning realization in the ophthalmic community that viewing only the posterior pole is no longer enough. The pathology of several vision-threatening diseases lies in the retinal periphery, beyond the frame of many of our current imaging modalities. We are realizing that events outside of our typical 30° or 50° or even 100° frame of reference have an influence on the posterior pole, and we need better ways of looking beyond our traditional visual boundaries.

We now have access to established technologies that offer a field of view of up to 200°, providing much more complete visual access to the periphery. While these technologies continue to be evaluated, we have found them helpful for day-to-day screening, diagnosis, treatment, and follow-up. I routinely use wide-field imaging on almost every patient I see in our tertiary center at Weill Cornell Medical College.

This article outlines some of the technologies available for wide-field imaging and some of the indications for and uses of this imaging that we have found helpful in clinical practice.

**ADVANCING TECHNOLOGIES**

Traditional fundus cameras provide a standard 30° field of view. Therefore, technologies that provide a greater imaging angle are referred to as wide-field or wide-angle imaging. The term ultra-widefield has also been used to describe newer technologies that provide up to a 200° viewing angle.

The first method of obtaining wide-field retinal images was through the use of montages, with multiple standard 30° fundus images of different portions of the retina arranged into a mosaic to show a larger area. This multiple-image approach has been reported to provide a total of up to almost a 100° field of view.

Pomerantzeff described the use of a contact lens-based system that provided a 148° field of view, using transpupillary and transscleral illumination. Clinical evaluation of the device showed that it could obtain good images, but some were of limited resolution because of the limitations of the light source.

The Retcam (Clarity Medical Systems Inc.), which debuted in 1997, uses a contact-lens based system with a fiberoptic light source to capture digital images of the retina and display them on a computer monitor. The device is capable of a 130° field of view with the selection of the widest-angle contact lens. This technology has primarily been used with pediatric patients, and is also useful for patients who are unable to be positioned in front of a standard fundus camera. The Retcam has limited applicability in adults because illumination is provided through the crystalline lens, and even a slight lens opacity results in poor quality images.

The technology introduced by Optos in 2000 applies SLO technology to wide-field imaging, using a confocal SLO to capture peripheral retinal images with up to a 200° field of view. No mydriasis or contact lens application is needed, and views out to the ora serrata are possible in compliant patients. In recent years, the Optos 200Tx has become our standard device for ultra-widefield imaging.

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**Increasing Role for Ultra-widefield Imaging in Retinal Care**

Important pathology lies in the periphery in several diseases.

BY SZILÁRD KISS, MD
Nonmydriatic Widefield Imaging for Diabetic Retinopathy Comparable to ETDRS Photography in Half the Time

BY MATHEW W. MACCUMBER, MD, PhD

The growing incidence of diabetes is placing significant demands on ophthalmic practice for the diagnosis and management of diabetic eye disease. The need for rapid, early and accurate assessments of disease progression and treatment success is rising. Ultra-widefield retinal imaging can meet these requirements, particularly by facilitating the critical inspection of the retinal periphery. The comparability of ultra-widefield (Optos optomap) images with standard diagnostic techniques has now been demonstrated.1 Investigators at the Joslin Diabetes Center’s Beetham Eye Institute and Harvard University conducted a validation study in 103 diabetic patients, each of whom received nonmydriatic ultra-widefield imaging (100° and 200°), nonmydriatic ETDRS 7-field 35-mm photography (30°), and ETDRS fundus examinations by retina specialists. The optomap images compared favorably to fundus photography and clinical examination for assessing diabetic retinopathy and diabetic macular edema but required less than half the image-capture time of the ETDRS standard, not including the time needed to dilate the eye. The 2 imaging techniques exactly matched for clinical level of diabetic retinopathy in 84% of patients and were within 1 level of agreement in 91%. Sensitivity and specificity of ultra-widefield images for detecting the presence or absence of diabetic retinopathy diagnosed on ETDRS photographs were 99% and 100%. These findings point to the potential role of ultra-widefield retinal imaging in the management of diabetic eye disease. Meanwhile, the clinical value of rapid-capture, high-resolution images of the periphery is being investigated at other centers. Among dozens of studies utilizing Optos ultra-widefield technology reported at this year’s ARVO meeting, including a presentation of the Joslin results, were several that underscored the importance of peripheral imaging for early detection and treatment selection.1-4

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We have also used the Staurenghi lens system (Ocular Instruments Inc.), a multicomponent contact lens-based system compatible with a confocal SLO system, providing up to a 150° field of view. We used this system for wide-field fluorescein and indocyanine green angiography and autofluorescence studies with Heidelberg confocal SLO technology.

Most recently, at the 2012 American Society of Retina Specialists meeting, Heidelberg Engineering introduced a noncontact, ultra-widefield angiography module for its Spectralis and HRA models.7 While we do not have direct experience with this new technology, which is to become commercially available in 2013, the company states that the dedicated widefield lens attaches to the camera head and is exchangeable with existing 30° and 55° lenses. We look forward to evaluating this technology when it becomes available to us.

PRACTICAL APPLICATIONS

Currently, as noted above, we use the Optos device routinely for wide-field imaging. There are some macular disorders for which I prefer to obtain non-wide-field images, but otherwise, for angiography or even a color photo, I use the wide-field device. The technology does not require dilation, but our patients are routinely dilated, so the vast majority of images we obtain are through dilated pupils. An ophthalmic photographer operates the device and captures the images.

For diabetic patients with macular edema or nonproliferative diabetic retinopathy, wide-field imaging helps
to determine the presence of any peripheral ischemia that may require treatment, in addition to evidence of neovascularization.

We now use wide-field autofluorescence to image the periphery in patients with age-related macular degeneration (AMD) and central serous chorioretinopathy, looking for findings outside the posterior pole that may give an indication of the duration of the pathology or the extent of disease burden. Ultrawide-field autofluorescence is also being used in a subset of patients in the AREDS II study to subclassify patients with dry AMD.

For any pathology that I want to document, whether background retinopathy or a nevus, I order a wide-field color photograph. In addition to the pathologies enumerated above, analysis of wide-field images can be useful in patients with numerous other conditions affecting the retinal periphery, including retinal detachments, retinal vein occlusions, uveitis, and vasculitis.

There are some drawbacks to the Optos technology. The system uses two lasers, red (633 nm) and green (532 nm), to create its images, resulting in somewhat unrealistic rendering of color images. In addition, there is no live feedback, no view of the fundus before the image is taken. However, if a poorly oriented image is obtained, this is easily overcome by having the patient look up, down, left, or right for subsequent images until the pathology is properly imaged.

**CASE REPORTS**

**Case 1.** A young woman presented with significantly decreased vision in her left eye (hand motions). Ultrawidefield color fundus photography showed extensive retinal vasculitis (Figure 1), which was confirmed with ultrawidefield fluorescein angiography (FA; Figure 2). Careful examination of the right eye showed absolutely no evidence of uveitis or vasculitis, and this was confirmed by FA of the right eye (Figure 3). With an unremarkable comprehensive systemic workup, the patient was treated locally with intravitreal injection of a dexamethasone implant (Ozurdex, Allergan) in the left eye. Ten days after this injection, vision in that eye improved to 20/40. Ultra-widefield FA showed significant improvement of the vasculitis and extensive nasal nonperfusion (Figure 4). Following retinal laser photocoagulation to the areas of ischemia, ultra-widefield FA showed an excellent outcome (Figure 5).

**Case 2.** A man with uncontrolled type 2 diabetes presented for retinal evaluation. The traditional 7 standard field ETDRS photograph showed some mild nonproliferative diabetic retinopathy changes (Figure 6). Optos ultra-widefield FA demonstrated extensive peripheral nonperfusion and ischemia with peripheral areas of neovascularization (Figure 7). This patient thus was diagnosed with proliferative diabetic retinopathy, which will warrant closer monitoring and perhaps earlier intervention.
In addition to clinical and clinical research uses, ultra-widefield imaging has tremendous potential for other applications, including screening and telemedicine. With the current epidemic of diabetes, a nonmydriatic camera that captures images of the retina out to 200° could be a valuable asset in endocrinologists’ or primary care physicians’ offices, allowing ophthalmologists to screen images remotely for signs that may require follow-up. Similarly, ultra-widefield technology, particularly the Retcam, has proved useful in pediatric practices for screening low birthweight babies for retinopathy of prematurity.

While the gold standard of peripheral retinal examination remains the binocular indirect examination with scleral depression, the use of ultra-widefield imaging will continue to expand in screening, clinical, and research settings. Its proper role in the management of patients with posterior segment disease will emerge as we gather more experience with these technologies.

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