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OPTOMETRY AND VISION SCIENCE

GUEST EDITORIAL

Imaging and Measurement in the Eye: Now and Ahead

Nearly all the eye's structures, from the retina at the back of the eye to the tear film at the front, can now be imaged and measured *in vivo* with outstanding resolution and precision. Imaging and measurement of the eye is fundamental to both research and clinical practice in optometry, and the technologies to do this have mushroomed exponentially in recent decades. The capabilities of these current imaging technologies are most impressive, allowing the visualization of the fine structure of the eye that was not conceivable 20 years ago. From the observation of corneal nerve fibers and epithelial cells and the three-dimensional visualization of the retina and optic nerve head to the imaging of individual photoreceptor cells, these remarkable advances in our ability to image and measure the eye have changed the way optometry is practiced clinically and have led to numerous important scientific discoveries. As these advanced imaging methods continue to develop, the potential for imaging ocular structures down to the cellular level in everyday clinical practice has become a reality, and the potential to improve patient care is truly stunning.

In this feature issue of *Optometry and Vision Science* (OVS), we showcase many of these newer techniques for imaging and measuring the eye. In creating this issue, it was our aim to not just focus on a single aspect of ocular imaging but to provide a broad overview of our current ability to image many of the eye's different structures, from the posterior to the anterior eye with a range of different cutting edge techniques, and to identify the likely future directions and capabilities of these imaging technologies. We also highlight the impressive application of these technologies and the likely extension into clinical practice of the very latest advances.

The lead review article in the issue demonstrates current and future abilities of optical coherence tomography (OCT) to image both anterior and posterior eye structures, illustrated with striking figures.[1] A number of other excellent review articles are also included from pioneers in the field, highlighting and summarizing the state-of-the-art of ocular imaging.[2–5] High-quality original research articles provide highly detailed, functional, or 3D images at the retinal, choroidal, and optic nerve level.[6–20] Others reveal important functional imaging of the lens and ciliary body.[21–24] And still others cover imaging and critical measurement of the lids, cornea, and tear film.[25–30] The many leading researchers and clinicians in this field have provided a diverse range of articles emphasizing the capabilities of current ocular imaging technologies. They illustrate the promising future directions of these technologies and techniques in this rapidly evolving area.

Many of the techniques presented are highlighted by stunning figures (see Figure 1 for some examples). Also take time to look at the supplementary digital content with impressive digital movies emphasizing the dynamic and 3D nature of many imaging techniques. All supplementary data are available at the OVS website.

A number of original research articles use current imaging technologies to provide significant new insights into the structure and function of the eye in both health and disease. Imaging of the ciliary body is performed with OCT to enhance our understanding of the mechanism of accommodation in both adults[22] and children[23]; techniques such as polarization sensitive imaging,[16] panoramic fundus autofluorescence,[7] and spectral domain OCT imaging[17, 18, 20] are shown to enhance the detection and characterization of a range of retinal and optic nerve pathologies; and adaptive optics retinal imaging illustrates subclinical vascular and cellular retinal changes in diabetic retinopathy.[19] All these articles highlight how advances in imaging have revolutionized the way the eye is examined and understood both in clinical and research practice.

Some articles describe exciting important new methods and extensions to current technologies for imaging the eye.[6–9, 28] For example, two new OCT instruments are illustrated that provide high-speed images of the anterior eye[28] and high-speed long-wavelength polarization-sensitive images of the posterior eye.[8] They present new possibilities for understanding the detailed structure of these tissues in both healthy and diseased eyes.

In fact, many of the novel methods that are showcased in this feature issue of OVS have the potential to further expand the clinical use of advanced imaging techniques that may have been previously limited to laboratory-based research methods in the past. A "clinical planning module" for adaptive optics (AO) retinal imaging is described which allows reliable steering of an AO system to image clinical features of interest in the retina,[9] and a new method of AO-guided microperimetry to allow retinal structure/function relationships to be examined in fine detail is also presented.[6] These will impact future clinical practice. One can imagine a clinic in the near future where a patient's retina is examined with wide-field retinal imaging to detect a retinal lesion and then by targeted AO imaging of the retinal region of interest to clearly diagnose the lesion followed by the use of AO-guided microperimetry to examine the functional effects of the retinal lesion.

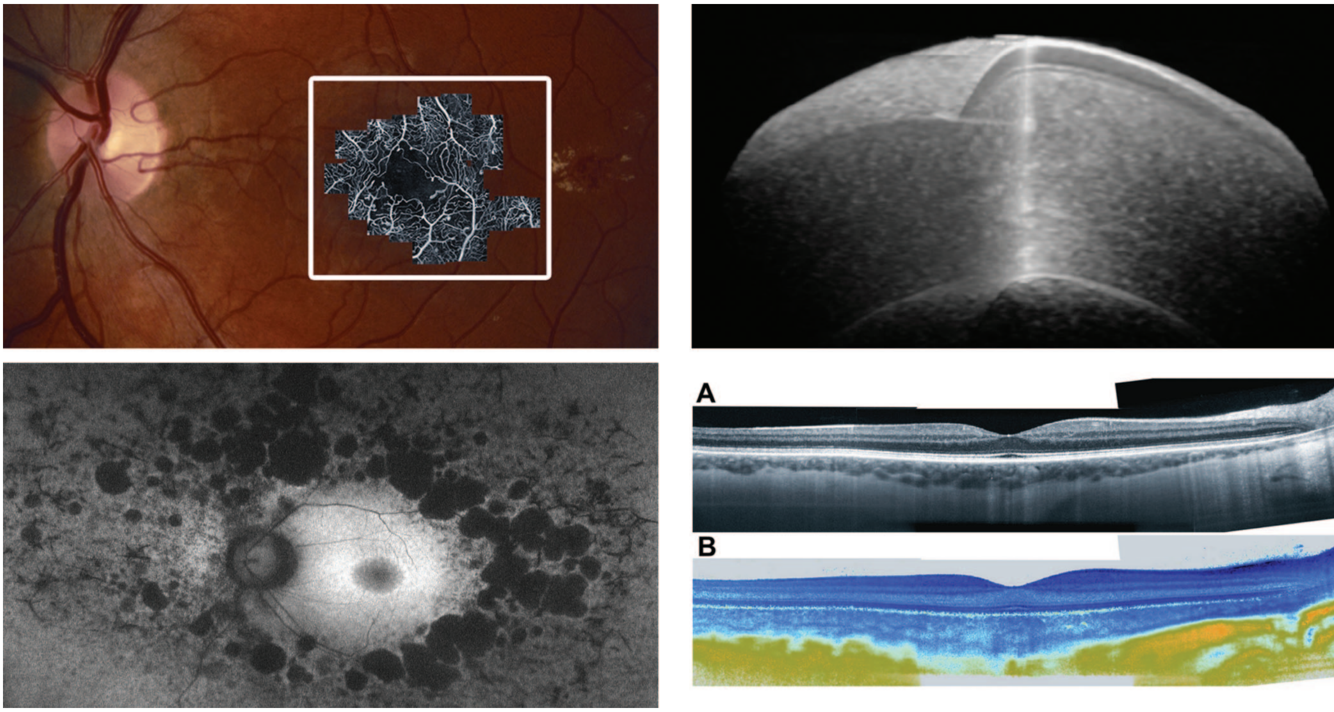

FIGURE 1

Just a few examples of the stunning images presented in the feature issue, illustrating the dramatic advances in our ability to image the eye in recent years. These images include high-resolution imaging of foveal capillaries with adaptive optics scanning laser ophthalmoscopy[19] (top left), three-dimensional reconstruction of the cornea from a newly developed high-speed anterior segment OCT device[28] (top right), a panoramic autofluorescence image of a case of retinitis pigmentosa[7] (bottom left), and cross-sectional image of the retina and choroid [showing the intensity image (A) and phase retardation image (B)] derived from a high-speed, long-wavelength polarization-sensitive OCT device[8] (bottom right).

The expected advances in ocular imaging, highlighted in this feature issue, have the potential to dramatically expand our understanding of the normal structure and function of the eye, improve the detection and diagnosis of pathology, and enhance our ability to monitor treatments and progression of disease in both the anterior and posterior eye. With ongoing improvements in imaging speed and resolution and with the application of innovative methods to improve the clinical usefulness of ocular imaging techniques, the future of ocular imaging is bright!

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