

## Wide-field imaging - An update

We congratulate Kumar *et al.* for putting together an extensive review article that elaborately covers most of the aspects of wide-field and ultra-widefield imaging.<sup>[1]</sup> We would like to highlight a few points that would add to the knowledge of our understanding of this very useful diagnostic modality. Current ultra-widefield (UWF) imaging modalities provide numerous options for evaluation and documentation of posterior segment namely color images, red-free images, fundus autofluorescence (FAF), fluorescein angiography (FA), and indocyanine green angiography (ICGA).

Carl Zeiss company developed the first fundus camera in 1926, providing a 20° and later 30° view of the posterior pole.<sup>[2]</sup> Early widefield imaging, capturing more than the standard 30° view, was performed using a traditional camera; the use of a fixation lamp and mirror then allowed for the creation of a 19-photo, 96° montage.<sup>[2]</sup> Currently, with advances in retinal imaging one can capture up to 200° of the retina in a single capture.

The terms widefield and ultra-widefield were used interchangeably without a clear agreement on their definitions. Based on anatomical landmarks, the definition of these two terms were formalized by a consensus group of retinal imaging experts.<sup>[3]</sup> Widefield image was defined as a single-capture, fovea centered image, which captures retinal features beyond the posterior pole, but *posterior* to the vortex vein ampulla, in all four quadrants. UWF was defined as a single-capture, fovea centered image, which captures retinal features *anterior* to the vortex vein ampullae in all four quadrants.<sup>[3]</sup>

### Current UWF Imaging Systems

#### Optos

The Optos cSLO (confocal scanning laser ophthalmoscopy) (Optos PLC, Dunfermline, UK) is capable of imaging up to 200° of the fundus in a single capture. The system provides the ability to capture pseudocolor imaging, FAF, FA, ICGA, and most recently, optical coherence tomography (OCT). Limitations of this device include peripheral distortion, pseudocolor imaging, and lash artifact. The advantages include quick acquisition time, non-requirement of contact lens, or mydriasis.<sup>[4]</sup>

#### Heidelberg wide-angle system

The attachment of a noncontact removable lens to the Heidelberg Spectralis or Heidelberg Retinal Angiograph cSLO (Heidelberg Engineering, Inc., Heidelberg, Germany) allows for an UWF view of up to 105° of the retina. However, lash artifacts are noted to be less significant compared to Optos.<sup>[5]</sup>

#### Clarus

The Clarus (CLARUS 500, Carl Zeiss Meditec AG, Jena, Germany) is an UWF imaging system that captures up to 133° of the retina. Clarus provides true color imaging and includes a partially confocal optics function, which reduces lash and lid artifacts. Clarus is useful when more detailed and true color retinal imaging is required.<sup>[6]</sup>

#### Staurenghi lens system

Staurenghi *et al.* developed combined contact and noncontact handheld lens system coupled with cSLO. (Ocular Staurenghi 230 SLO Retina Lens; Ocular Instruments Inc, Bellevue, Wash) This system images up to 150° of the retina. Limitations include the need for a skilled photographer who is able to place and maintain a contact lens on the ocular surface to acquire images.<sup>[7]</sup>

#### RetCam

The RetCam (Clarity Medical Systems, Inc, Pleasanton, CA) is well-suited to primarily image neonatal and pediatric patients because it is portable and can be placed directly on the patients unable to position themselves. It is mainly used in screening for retinopathy of prematurity.<sup>[8]</sup> Retcam is capable of imaging up to 130° of retina. A major limitation is the illumination occurs through the cornea and any media opacities will hinder the image quality.

### Limitations of Current Imaging Systems

The biggest limitation of current imaging systems is inability to image retina from ora to ora in a single capture. There are multiple challenges in image acquisition like need for a skilled photographer, media opacities like corneal aberrations, cataract, lid and lash artifacts, pseudocolor images, and peripheral distortions. Another challenge is representing a three-dimensional image on a two-dimensional flat surface, leading to distortion. The distortion is particularly apparent in the far temporal and nasal periphery where lesions may look bigger than they truly are with indirect ophthalmoscopy.<sup>[5]</sup>

### Future Directions

Current multimodal imaging platforms include FAF, FA, and ICGA, and additional imaging technologies such as swept-source OCT, widefield OCT angiography will continue to push the capabilities of UWF imaging. The incorporation of these new modalities may translate into improved disease diagnosis and management of various retinal pathologies.

In the era of electronic medical records, traditional color fundus drawings have significantly reduced. These drawings are biased by inter-observer variation and reproducibility is questionable. UWF imaging comes to the rescue in such situations, not only is it helpful for the documentation but is also very useful teaching modality. Better documentation helps us in monitoring disease progression and proper patient counseling. Further research is needed for the development of devices to acquire wide-field images using mobile phone cameras or smaller portable devices. With the advent of UWF imaging, teleconsultations for vitreoretinal diseases can also be done in the near future, which has become the need of the hour in this pandemic situation.

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