Editorial

Optical Coherence Tomography Angiography as an Imaging Modality for Evaluation of Diabetic Macular Edema

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Diabetic retinopathy remains a leading cause of blindness worldwide in patients aged 20–64 years.[1] Diabetic macular edema (DME) threating or involving the fovea is a common etiology for vision loss. Traditionally, treatment methods have been guided by contact and non-contact slit lamp biomicroscopy, fluorescein angiography and fundus stereo photography.[1] Fluorescein angiography (FA) is a dynamic, invasive imaging technique first described in 1961 and more thoroughly invested and popularized by Gass in 1967.[2] In principle, this technique uses a series of exciting and barrier filters to visualize fluorescein dye excursion through retinal arterial, capillary, and venous structures as well as the underlying choroid. It remains the gold standard in evaluation of macular perfusion and localizes the area of leakage in non-proliferative diabetic retinopathy, neovascularization in proliferative diabetic disease and detecting choroidal neovascular membrane (CNVM) and other retinal vascular diseases. Though FA provides detailed anatomy of retinal vascular structure and dynamic circulation parameters, it has several limitations: it requires intravenous administration of fluorescein dye, which infrequently results in nausea, gastrointestinal upset, very rarely serious allergic reaction and anaphylaxis. In addition, its time-consuming nature hinders its use in busy clinical settings.[3] Furthermore, interpretation of images is subjective and user dependent. Finally, its use in patients with small pupils or media clarity issues such as vitreous hemorrhage is limited. In 1991, the advent of a new non-invasive imaging technique known as optical coherence tomography (OCT) revolutionized the management of a variety of retinal diseases including macular edema.[4] The principle behind OCT involves directing a beam of infra-red light (830 nm) orthogonal to the surface of the retina while a recorder captures and analyzes the signal reflection.[5] The result is a 3-D reflectance image that provides detailed anatomy of the intra-retinal structures, posterior hyaloid and macular pathology if present. Relative to FA, OCT scans are far less time-consuming and do not require dilation to complete. Kozak et al found the sensitivity for diagnosing macular edema in FA vs. OCT was 98.7 and 96.1%, respectively.[5] In the same study, OCT detected both intra-retinal and sub-retinal fluid in 1.17% of eyes while FA failed to detect any fluid.[6] In another comparative study, OCT was found to be as effective as FA in detecting macular edema and superior in determining the anterior-posterior extent of intra-retinal fluid.[7]

Recently, the development of optical coherence tomography angiography (OCTA) has emerged as a non-invasive volumetric imaging modality that combines desirable qualities of both OCT and FA.[8] In brief, OCTA compares difference in OCT signal or amplitude between sequential OCT scans over the same cross-section to develop a map of blood flow. A 6 × 6 mm scan takes about six seconds to obtain given proper patient positioning, and use of montage stitching software allows a larger macular field of view without compromising resolution.[9] The images are scrolled through retinal layers to provide detailed images of the superficial and deep vascular plexus, major retinal arteries and venules, and the choriocapillaris. Though the image is taken as a fixed point in time and not as a series of images such as in FA, functional data on retinal physiology in addition to structural information can still be gleaned. Capillary density, branching structure, and the presence of microaneurysms may be greatly beneficial to the clinician in determining the extent of diabetic disease otherwise undetectable by standard OCT and FA images today.

Presently, OCTA remains much more prone to artifact than OCT or FA. Larger retinal vessels can cause shadow artifacts with patient movement when segmenting the outer retinal capillary plexus. In addition, OCTA may miss areas of slower blood flow such as fibrotic CNVM as it relies on change between consecutive scans to detect blood flow above a certain flow rate.

Due to its novelty, the data on utilizing OCTA in assessing for diabetic macular disease has been limited but more centers continue to evaluate its feasibility. Salz et al compared OCTA vs. FA in 30 patients with known diabetes and found that OCTA detected fewer microaneurysms but could locate their exact intra-retinal depth.[10] In addition, OCTA allowed for the reproducible delineation of the foveal non-flow zone and perifoveal inter-capillary area.[6] Agemy et al compared OCTA retinal vascular perfusion density to clinical staging in 56 eyes with diabetic retinopathy and found close agreement which could suggest an objective measurement for monitoring macular disease moving forward.[9]

In summary, though OCT and FA will continue to remain as standard imaging modality to assess for diabetic macular disease, OCTA has emerged as a non-invasive, highly detailed structural and objective functional assessment of retinal pathophysiology in afflicted patients. As more practices gain access to this technology, it will provide valuable data to the physician's decision making process in treating DME.

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