A NEW ALLY IN THE DIAGNOSIS AND MANAGEMENT OF DIABETIC RETINOPATHY

OCTA shows promise for becoming a key imaging tool.

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Since its introduction in 1991,1 OCT has become a staple tool for eye care practitioners. As resolution has improved and normative databases have been developed, OCT is now routinely used to monitor myriad retinal and optic nerve diseases, including glaucoma, age-related macular degeneration, central serous retinopathy, and more. The latest advance in OCT technology is the introduction of OCT angiography (OCTA), which gives practitioners a noninvasive way to image the retinal and choroidal vasculature (Figure 1).

OCTA: A CRASH COURSE

Working on the same basic principles as standard OCT, OCTA takes multiple B-scans of an area of the retina and analyzes the light rays that are reflected. Stationary areas of the retina reflect light in a consistent manner, whereas areas that are more dynamic, such as where blood is flowing through the vasculature, have different reflectance patterns. The differences detected by comparing sequential B-scans reveal patterns of blood flow. By combining the repeated scans, an image of high flow areas throughout the retina can be constructed.

Two main types of light source are used with OCTA: swept source (~1050 nm) and spectral domain (~800 nm). Spectral-domain imaging typically has a higher resolution than swept-source imaging (1-5 µm vs 8 µm respectively), whereas swept-source imaging enables deeper penetration (2.0 mm vs 2.6 mm, respectively),14 therefore allowing better imaging of the choroidal vasculature.

OCTA has the potential to replace or supplement findings from traditional imaging methods such as fluorescein...
angiography (FA) for looking for choroidal and intraretinal neovascular membranes or nets. OCTA is also able to detect areas of low perfusion or nonperfusion, which is indicative of past or ongoing ischemic changes. Such changes are known to play a role in permanent visual damage in retinal arterial and venous occlusions and are believed to contribute to damage in normal-tension glaucoma and early diabetic retinopathy (DR).

THE OCTA DR STORY

DR is the leading cause of visual impairment and preventable blindness in working-age adults, and the prevalence of diabetes is expected to increase. Detection of subclinical DR can lead to earlier treatment of the underlying condition, which not only helps prevent irreversible vision loss and microvascular damage, but also leads to a lower overall burden of disease on both the patient and the health care system.

Further, identification of early changes and changes indicative of rapid progression can allow practitioners to better determine which patients should be monitored more carefully or treated more aggressively. DR has been shown to have a long latent phase, and up to 20% of patients with newly diagnosed diabetes already have some level of retinopathy present. Studies suggest that neural damage often precedes clinically observable microvascular changes. Therefore, finding ways to better detect early DR changes is crucial to providing patients with the best care possible.

One clinical sign that has been correlated with DR changes is enlargement of the foveal avascular zone (FAZ). It has been well documented that hypoxia and resulting retinal ischemia play an important role in the development of diabetic macular edema. An increase in the FAZ area indicates loss of fine capillaries and ultimately reduced blood flow and perfusion to the highly sensitive foveal area. Studies have shown that foveal ischemia can lead to many visual consequences, including but not limited to loss of contrast sensitivity, visual field defects, and poor response to future anti-VEGF treatments.

Numerous studies have been conducted recently using OCTA to document changes such as those in the FAZ in patients with diabetes without signs of DR. With OCTA, a statistically significant increase in FAZ area and a loss of both superficial and deep retinal vasculature density have been noted in patients with type 2 diabetes without previously diagnosed DR. Similar findings have been shown in patients with type 1 diabetes, as well as children, with a positive correlation between FAZ size and duration of disease. Because OCTA to date lacks a normative database, it is difficult to quantify what amount of vascular change is clinically significant. However, for patients with undiagnosed or recently diagnosed diabetes, taking baseline vasculature and FAZ size measurements and monitoring for changes may help guide practitioners’ decision-making.

DRAWING COMPARISONS

FA and indocyanine green angiography (ICGA) remain the gold standards for measuring and analyzing retinal blood flow, but both procedures have limitations. They offer only 2D views of blood flow; take considerable time to perform; carry risks such as anaphylaxis,
such as FAZ area and vessel density, research will further guide clinical decision-making and ultimately establish guidelines for earlier identification of DR changes and progression.

Figure 2. OCTA of the macula of an 82-year-old patient who has had diabetes for more than 30 years. Notice the significant decrease in vessel density in both the superficial (A) and deep (B) capillary layers.

A DIAGNOSTIC MODALITY WITH POTENTIAL

Diabetic neovascularization tends to be superficial, at times even extending into the hyaloid, whereas changes such as intraretinal microvascular abnormalities occur in the deeper retinal layers. Measuring the depth of vascular anomalies allows us to differentiate neovascularization of the disc from collateral vessels. Criteria such as the FAZ area, vessel area density, and vessel perfusion density provide us with new quantifiable data indicative of disease severity. One consideration that must be taken into account when evaluating these factors is that, although results may be consistent within each machine and protocol, they vary across machines. Furthermore, values such as vessel density appear also to vary with patient age and sex, emphasizing the need for a normative database.

Limitations in the quality of OCTA scans, such as sensitivity to aberrant eye movements and the presence of artifacts, will continue to be improved with time. As OCTA technology is further developed and becomes more accurate and affordable, it is likely to replace FA as the gold standard in retinal vascular imaging for diseases such as DR. The rapid, high-resolution, quantifiable imaging possible with OCTA provides practitioners with a sophisticated means of monitoring patients with diabetes for ischemic and microvascular changes. As normative databases are established for criteria


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COVER FOCUS DIABETIC EYE DISEASE

Figure 2. OCTA of the macula of an 82-year-old patient who has had diabetes for more than 30 years. Notice the significant decrease in vessel density in both the superficial (A) and deep (B) capillary layers.

nausea, and vomiting; and do not provide high-resolution images or quantifiable data. OCTA, on the other hand, provides a noninvasive solution to many of these issues, providing high-quality, fast, repeatable data that can be visualized in 3D. OCTA also provides measurements of vessel density and blood flow (Figure 2).

In the context of DR, OCTA often provides better imaging than FA of the capillary plexus of the deep retina, which is the typical location of ischemic changes and subclinical microaneurysms. Although there is not yet a clear consensus on whether OCTA or FA has an overall higher detection rate of microaneurysms, some studies suggest that OCTA may allow superior detection of diabetic microaneurysms by providing better imaging of the deep capillary plexus. OCTA also permits 3D en face analysis to better differentiate retinal neovascularization from intraretinal microvascular abnormalities, a distinction that is difficult to determine on FA.

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