How OCTA Has Changed Retina Practice

French researchers and clinicians have contributed greatly to the literature on this emerging imaging modality.

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The introduction of OCT angiography (OCTA) in France has generated great interest among retina researchers and clinicians. Most centers specializing in retina wasted no time purchasing OCTA devices, and French teams have published many articles on the topic. In this article, we describe the impact of OCTA on daily retina practice in France by reviewing a panorama of OCTA applications in different indications, summarizing key publications of French teams working with this technology, and presenting questions to several internationally recognized French experts in OCTA (see Ask the Experts).

OCTA AND CNV

The advent of OCTA has changed our practice in the initial workup of patients with exudative age-related macular degeneration (AMD), resulting in a decrease in the number of fluorescein angiography (FA) and indocyanine green angiography (ICGA) examinations carried out (Figure 1). In our center, the figures speak for themselves. Performing an examination with dye injection used to be the rule in the initial assessment of choroidal neovascularization (CNV). Now, the indications for this type of examination have decreased by two-thirds.

Current practice is to first perform structural OCT combined with OCTA in patients with suspected CNV. When structural OCT features are consistent with CNV and OCTA identifies a neovascular network, then clinicians perform only retinal photography. However, if there is still doubt, FA and/or ICGA are performed.1

In practice, for type 1 and 2 CNV, the diagnostic sensitivity of OCT is high, allowing clinicians to make a

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Figure 1. Patient with neovascular AMD in the left eye. Retinal photography shows the disappearance of the foveal reflex (A). Macular mapping shows retinal thickening in the area of the exudation: color presentation (B) and quantitative presentation (C). B-scan shows a bridge arch-shaped exudation above fibrosis (D). OCTA shows a CNV pattern (E).
diagnosis with no need for dye injection in most cases. In type 2 CNV, a sensitivity of 100% has been reported in some series. In type 1 CNV, the sensitivity is close to 90%. In retinal angiomatous proliferation (RAP, also known as type 3 CNV), diagnosis may be more challenging. Indeed, the neovascular tuft, classically described within the external retinal layers, is not always easy to identify, although in a recent series using new-generation OCTA devices, the detection rate was high. Similarly, the sensitivity of OCTA to identify CNV in vascularized pigment epithelium detachment or polypoidal choroidal vasculopathy is lower than in other types of CNV. Detection is enhanced when the user switches from automatic segmentation to manual segmentation.

Furthermore, comparison of structural OCT and OCTA imaging can help to differentiate active CNV from quiescent CNV and to choose appropriate therapeutic management: anti-VEGF injections in active CNV and simple monitoring for quiescent CNV. To date, we do not consider OCTA alone a sufficient tool to make a diagnosis of CNV recurrence. There is no consensus in the literature regarding activity features in the absence of neovascular exudation, and CNV growth is not a retreatment criterion for us.

Depending on the type of CNV, the sensitivity of OCTA may vary. It is very high in types 1 and 2 CNV in AMD, but lower in CNV complicating high myopia. In highly myopic eyes, artifacts are more frequent, and the small size of CNV makes them more difficult to detect.

**Differential Diagnosis of Challenging Cases**

The use of OCTA has improved detection of CNV in challenging cases. Bousquet et al assessed the frequency of flat irregular retinal pigment epithelium detachment (FIPED) associated with chronic central serous chorioretinopathy (CSC) using OCTA and showed that one-third of FIPEDs in chronic CSC...
contained CNV. They reported that OCTA detected CNV more frequently than other imaging modalities. In pachychoroid associated with FIPED, Hage et al showed the utility of OCTA for identifying CNV. Although the possible occurrence of type 1 CNV complicating the course of chronic CSC should not be ignored, these authors said, all cases of FIPED should not be mistaken for active CNV and systematically treated with anti-VEGF therapy. OCTA appears to be useful for making this determination.

CNV associated with acquired vitelliform lesions typically occurs during the collapse phase of the acquired vitelliform lesion life cycle. In adult vitelliform macular degeneration, OCTA can aid in the diagnosis of associated CNV, whereas FA is often noncontributive due to the fluorescence of the pseudoserosal retinal detachment.

**OCTA AND DIABETES**

OCTA provides structural and topographic analysis of microvascular abnormalities associated with diabetic retinopathy (DR), including microaneurysms and intraretinal microvascular abnormalities. Moreover, it identifies and characterizes DR complications such as diabetic macular edema (DME) and preretinal neovascularization. OCTA can also help clinicians to better understand some of the mechanisms associated with DME formation.

In DR, OCTA provides excellent qualitative and quantitative assessment of macular perfusion (Figure 2). This imaging modality allows users to analyze theplexuses at different depths. It also requires no fluorescein injection and therefore avoids the leakage that can complicate the analysis of vascular details on FA. OCTA software provides multiple quantitative indicators for characterizing macular perfusion. Many studies have highlighted the relationships between macular and peripheral perfusion.

Is there a significant enough correlation between macular ischemia and peripheral DR so that OCTA can replace the subjective assessment of peripheral perfusion, for example with ETDRS classification of DR; or at least can OCTA help to complete this assessment by defining risk phenotypes? Most studies agree that there is a relationship between macular perfusion and stage of DR.

In OCTA devices from several manufacturers, foveal avascular zone (FAZ) dimension and vascular density measurements can be used to evaluate macular perfusion. In patients with diabetes, analysis of the FAZ shows a low correlation with the stage of DR. Vascular density is rather well correlated with DR stage, although there is a discrepancy between studies regarding the best index to be used to assess vascular density.

To date, however, these OCTA tools cannot replace the standardized methods recommended by ETDRS classification, especially because OCTA measurements do not provide specific thresholds for each stage of ETDRS classification. Improvements in this area by researchers and device manufacturers are therefore needed before clinicians will eventually be able to classify, diagnose, and monitor DR with OCTA without performing a fundus evaluation.

OCTA could also be used as a prognostic indicator of VA. As recently demonstrated by Dupas et al in patients with type 1 diabetes without DME but with severe nonproliferative or proliferative DR, VA may be associated with the degree of capillary loss in the deep vascular complex (DVC).

**OCTA AND VEIN OCCLUSIONS**

OCTA can be used in vein occlusion to characterize macular changes induced by the occlusion. Glacet-Bernard et al showed a significant correlation between macular vascular density as quantified automatically on OCTA and peripheral nonperfusion seen on FA. Thus, OCTA could help to identify high-risk patients with retinal vein occlusion who might benefit from further evaluation with FA.

**OTHER MICROVASCULAR ABNORMALITIES**

In macular telangiectasia (MacTel) type 1, which affects both the superficial vascular plexus and the DVC, OCTA was shown to be less effective than FA to

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**Figure 2.** Patient with DME in his right eye. Sixty degree (A) and ultra-widefield (B) retinal photography showing nonproliferative DR. Colorimetric mapping showing retinal thickening corresponding to severe DME (C). Superficial vascular plexus showing enlargement of the FAZ and reduced vascular density; in the corresponding B-scan below, flow appears in red (D). DVC showing reduced vascular density; vascular density and FAZ parameters below in table (E).
document the telangiectasia. Conversely, in MacTel type 2, the vascular changes are mainly located in the deep vascular plexus (DVP) and are poorly imaged by FA. The temporal parafoveal DVP is the first area affected, characterized by the appearance of progressive capillary rarefaction and dilatation and abnormal capillary anastomosis. Secondly, abnormal dilated anastomoses are observed between the two plexuses. Finally, neovascular complications, which occur in about 15% of cases, have been shown to be more easily diagnosed with OCTA than with FA.

In paracentral acute middle maculopathy OCTA has improved the understanding of the pathophysiology as a vascular disease. Paracentral acute middle maculopathy is characterized by acute and chronic attenuation of DVP flow. Familial retinal arteriolar tortuosity (Figure 3) is characterized by tortuosity of second- and third-order retinal arterioles associated with mutations in the COL4A gene. Veins are never involved. An increased tortuosity of second- and third-order retinal arteries has been shown in the superficial vascular plexus up to the arteriole termination. No change has been noted in the DVC.

**INFLAMMATION AND OCTA**

The deep retinal FAZ seems to be enlarged in eyes with noninfectious posterior uveitis, both in the presence and the absence of macular edema. Multimodal imaging allows the characterization of macular lesions in multifocal choroiditis. The integration of OCTA in the multimodal approach appears to be useful for distinguishing neovascular lesions from inflammatory lesions. The combined findings of conventional imaging (ie, photography, OCT, FA, ICG) and OCTA demonstrate distinct features of inflammatory lesions and CNV in multifocal choroiditis, allowing the appropriate management of these sight-threatening lesions. However, OCTA alone cannot distinguish active and inactive CNV, and it should be integrated into a multimodal approach.

**AN IMPORTANT TOOL WITH ADDITIONAL POTENTIAL**

Progress is still needed with OCTA software and hardware to reduce the frequency of artifacts, improve the acquisition process, enlarge exploration fields, and standardize procedures so that they will be less dependent on technicians. Nevertheless, despite its limitations, OCTA is now a valuable tool in the multimodal assessment of retinal diseases.

The experience of French researchers and clinicians at multiple centers, as outlined above, has contributed to the body of knowledge on this relatively new imaging modality, and we see no reason why these contributions will not continue as OCTA is integrated into routine clinical retina care.


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