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Diagnosis and Follow-Up of Nonexudative Choroidal Neovascularization With Multiple Optical Coherence Tomography Angiography Devices: A Case Report

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Abstract

Nonexudative choroidal neovascularization (CNV) is a new phenomenon that has only recently been described in the literature with the advent of optical coherence tomography angiography (OCTA) imaging. The authors present a 1-year longitudinal follow-up of a nonexudative CNV lesion secondary to age-related macular degeneration. This report describes the appearance of the lesion on two commercially available spectral-domain OCTA devices and one prototype swept-source OCTA device. Management of these cases is still debatable. Watchful waiting with regular follow-up using serial OCTA to monitor disease progression has been valuable in this case.

INTRODUCTION

Optical coherence tomography angiography (OCTA) is a new technology that images vascular structures without exogenous contrast. Multiple cross-sectional OCT scans are acquired in rapid succession from the same tissue location and are processed using an algorithm identifying pixel-by-pixel changes as a result of erythrocyte movement. These images are then combined to allow a volumetric analysis and generate a three-dimensional depth-resolved image of the vasculature.¹ OCTA generates vascular contrast from blood flow and can potentially visualize choroidal neovascularization (CNV) that is not visible on fluorescein angiography (FA).^{2,3} We report herein a patient with age-related macular degeneration (AMD) and an asymptomatic CNV followed for 1 year using both spectral-domain OCTA (SD-OCTA) and swept-source OCTA (SS-OCTA) technology in addition to standard multimodal imaging.

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CASE REPORT

A white female with a strong family history of AMD presented at age 65 with right eye metamorphopsia and scotoma with subretinal hemorrhage and intraretinal fluid on OCT associated with a CNV. Best corrected visual acuity was 20/30. She was treated with three intravitreal anti-vascular endothelial growth factor (VEGF) injections (aflibercept; Eylea; Regeneron, Tarrytown, NY) over the course of 12 months. Since the last treatment, this eye has remained asymptomatic for 2 years with no signs of exudation on OCT or FA, despite the sustained presence of a distinct CNV on OCTA (Figure 1: A to E).

At age 67, this patient's asymptomatic left eye was imaged on structural SD-OCT using the Zeiss Cirrus HD-OCT v8 (Carl Zeiss Meditec, Dublin, CA) (Figure 2: C1 to C3), on SD-OCTA with the RTVue XR Avanti (Optovue, Fremont, CA) (Figure 2: D1 to D3), and on SS-OCTA with an ultra-high speed, long wavelength prototype (Massachusetts Institute of Technology, Cambridge, MA) (Figure 2: E1 to E3). The prototype device uses a high-speed vertical cavity (VCSEL) as the light source and operates at a 400 kHz A-scan rate and 1,050-nm wavelength. The CNV was visualized in the SD-OCT images using the automatic segmentation of the retinal layers at the level of the choriocapillaris, generated by the AngioVue software in an orthogonal view. In order to correct for automated segmentation error and projection artifacts, which can obscure the full extent of the CNV, the segmentation slab was manually adjusted, using corresponding structural OCT B-scans as a guide for the placement of two parallel segmentation lines at sequential depths, in order to best visualize the CNV complex. A custom C++ application was used for processing the SS-OCT images, and Image J (National Institutes of Health, Bethesda, MD) was used for visualization.

Structural SD-OCT did not reveal intraretinal or subretinal fluid; however, SD-OCTA and SS-OCTA demonstrated a distinct CNV lesion (Figure 2). FA did not show evidence of leakage (Figure 2B). The patient was asymptomatic and therefore not treated.

SD-OCTA and SS-OCTA follow-up exams performed every 2 months to 3 months over 12 months indicated no changes in the morphology of the CNV. The patient remains asymptomatic with unchanged visual acuity and no signs of exudation on structural SD-OCT in either eye.

DISCUSSION

This case demonstrates that OCTA can document nonexudative CNV, either after successful anti-VEGF treatment or in treatment-naïve, asymptomatic eyes clinically staged as intermediate AMD. Based on the current treatment paradigms in standard of care, nonexudative CNV lesions are considered clinically inactive when there is no leakage of fluid noted on standard imaging assessments.² Due to this inactivity and lack of leakage, these CNV lesions are difficult to diagnose and it is only with the advent of SD-OCTA that longitudinal follow-up of these lesions has been possible.

In this case report we compared three OCTA devices for visualizing nonexudative CNV lesions. SD-OCT operates at a wavelength of approximately 840 nm compared to

approximately 1,050 nm in the SS-OCT. The longer wavelength improves image penetration below the retinal pigment epithelium and into the choroid, and SS-OCT is less susceptible to sensitivity roll-off, enabling superior visualization of the CNV in the right eye (Figure 1: C to E).^{4,5} All three OCT devices documented a nonexudative CNV lesion in the left eye (Figure 2: C to E).

Nonexudative CNV lesions are a new phenomenon and as such the clinical management of the condition has not been determined.² Recently published data suggest that the presence of a stable neovascular complex may not always be detrimental and may serve to reduce the rate of retinal pigment epithelium atrophy progression in patients suffering from AMD.⁶

In patients with nonexudative CNV, two possible treatment strategies should be considered. Anti-VEGF treatment could be indicated, guided by OCTA results, in order to avoid CNV recurrence or activation. A second option is watchful waiting, using longitudinal OCTA to monitor CNV progression, and treating with anti-VEGF injections only if the lesion becomes active with signs of fluid on OCT. This management strategy was applied for this case. The lesions have remained stable in both eyes: 2 years after treatment in the right eye and 1 year after initial observation with no treatment in the left eye.

CONCLUSION

With OCTA, it is possible to visualize asymptomatic, nonexudative CNV lesions that are not identified or that are considered clinically inactive on standard imaging assessments with structural OCT or FA.² Management of these cases is still debatable. Watchful waiting with regular follow-up using serial OCTA to monitor disease progression has been valuable in this case. Further research is required to ascertain the prevalence of these lesions, the rate at which they become active, and whether they require treatment.

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Figure 1.

Multimodal imaging of the right eye. (A) Fundus photograph with drusen and a retinal pigment epithelial defect. (B) Fluorescein angiography. (C) Spectral-domain optical coherence tomography angiography (SD-OCTA): Zeiss Cirrus HD-OCT. (C1) 3 mm × 3 mm en face OCTA with manual segmentation to optimize the visualization of the choroidal neovascularization (CNV). (C2) 3 mm × 3 mm structural en face OCT at the corresponding layer. Note the shadow from retinal vasculature causing projection artifacts at this level, apparent using all three devices. (C3) Corresponding cross-sectional OCT. (D) SD-

OCTA:OptoVue RTVue XR Avanti. (D1) 3 mm × 3 mm en face OCTA with manual segmentation to optimize the visualization of the CNV. (D2) 3 mm × 3 mm structural en face OCT at the corresponding layer. (D3) Corresponding cross-sectional OCT. (E) Prototype swept-source OCTA. (E1) 3 mm × 3 mm en face OCTA with manual segmentation of the retinal layers to best visualize the CNV. (E2) 3 mm × 3 mm structural en face OCT at the corresponding layer. (E3) Corresponding cross-sectional OCT.

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Figure 2.

Multimodal imaging of the left eye. (A) Fundus photograph. (B) Fluorescein angiography with no leakage noted throughout the transit of the dye. (C) Spectral-domain optical coherence tomography angiography (SD-OCTA): Zeiss Cirrus HD-OCT v8. (C1) 3 mm × 3 mm en face OCTA with manual segmentation to optimize the visualization of the choroidal neovascularization (CNV). (C2) 3 mm × 3 mm structural en face OCT at the corresponding layer. Note the shadow from retinal vasculature causing projection artifacts at this level, apparent using all three devices. (C3) Corresponding cross-sectional OCT. (D) SD-OCTA:

OptoVue RTVue XR Avanti. (D1) 3 mm × 3 mm en face OCTA with manual segmentation to optimize the visualization of the CNV. (D2) 3 mm × 3 mm structural en face OCT at the corresponding layer. (D3) Corresponding cross-sectional OCT scan. (E) Prototype swept-source OCTA (SS-OCTA). (E1) 3 mm × 3 mm en face OCTA with manual segmentation of the retinal layers to best visualize the CNV. The CNV is better visualized on SS-OCT device due to increased penetration with the longer wavelength. There is less background noise noted around the CNV compared with the two SD-OCT devices. (E2) 3 mm × 3 mm structural en face OCT at the corresponding layer. (E3) Corresponding cross-sectional OCT.

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