

Reports

Retinal Vasculitis Imaging by Adaptive Optics



Retinal vessels may be affected by inflammatory processes of various origins, usually within the context of uveitis. Retinal vasculitis can lead to vascular occlusion and/or rupture of the blood–retinal barrier, and therefore can be the cause of severe visual loss. Retinal vasculitis is usually defined by the presence of ophthalmoscopically visible whitish perivascular infiltrates. Veins are more often affected than arteries. Additional evidence of vascular inflammation is the staining of the vessel walls on fundus fluorescein angiography (FFA). However, the sensitivity and specificity of these diagnostic tests are unknown.

Adaptive optics (AO) is an optoelectronic technology first developed in astronomy that was later found to improve the lateral resolution of fundus images. This kind of imaging allows the visualization of microstructures of the retina such as photoreceptors and capillaries. We recently reported that AO imaging allows quantitative analysis of microvascular structures, especially measurement of arteriolar wall thickness.¹ To our knowledge, there has been to date no report of AO imaging in eyes with retinal vasculitis. Because AO fundus imaging is a very sensitive method to map areas of loss of retinal transparency,² we hypothesized that inflammatory infiltrates around vessels may be detected as well. Herein, we describe the AO aspect of retinal vasculitis in 3 subjects, which illustrates its contribution for characterizing and monitoring this condition.

The research adhered to the tenets set forth in the Declaration of Helsinki, and approval of the local Ethics Committee (St. Antoine Hospital, Paris, France) was obtained. Each subject received full oral and written information and gave consent before inclusion. Color fundus photographs and scanning laser ophthalmoscope fluorescein angiography were performed using standard methodologies. Infrared AO flood imaging of the fundus (rtx1, Imagine Eyes, Orsay, France) using a protocol previously described¹ was performed by 2 experienced operators (M.H.E. and M.P.) in 3 eyes of 3 subjects diagnosed with retinal vasculitis. They were 1 woman and 2 men, whose age ranged from 29 to 56 years. Diagnoses were ocular Lyme borreliosis ($n = 2$) and presumed ocular tuberculosis ($n = 1$). All had clear media and no evidence of anterior chamber or vitreous inflammation.

Color fundus photographs, FFA, and AO images of each subject are presented in [Figures 1 to 3](#) (available at www.aojournal.org). Color fundus photographs showed focal periphlebitis in all subjects. By FFA, all eyes had focal leakage of fluorescein and 2 eyes (cases 1 and 3) had foci of dye staining along major vessels. Although venous parietal structures are seldom seen in normal eyes, by AO imaging several foci of perivascular opacification were found in eyes with retinal vasculitis. These areas on both sides of the vessels were 20 to 100 μm wide, several millimeters long, and had well-defined outer limits. The venous lumen often showed focal narrowing at these sites. In case 1, minimal fluorescein leakage colocalized with perivascular infiltrates seen by AO, although in all subjects, some areas of perivascular opacification seen by AO appeared normal on fundus photographs. In case 3, perivascular infiltrates disappeared after treatment.

Overall, we found that AO imaging significantly improved detection and characterization of retinal vasculitis compared with fundus photography and FFA. Indeed, AO imaging revealed infiltrates in segments of the vessels with no or minimal changes detected otherwise. Therefore, AO demonstrates that perivascular infiltrates may be more extensive than suggested by conventional imaging.

The pathophysiologic significance of paravascular opacification seen by AO may be either a paravascular cellular infiltration or a parietal thickening. In animal models of experimental autoimmune uveoretinitis, histology showed cellular infiltration corresponding with the perivascular opacification seen by funduscopy.³ In humans, histopathologic studies of Behçet's disease-affected eyes have shown segments of mural inflammatory infiltration of retinal veins and perivascular space.^{4,5} Therefore, although in our cases AO could not resolve the venous wall, it is likely that opacified areas seen by AO were owing to paravascular cellular and/or fluid accumulation rather than parietal thickening.

Another interesting perspective of our study is that AO imaging may identify subclinical retinal vasculitis, i.e., that is not detected by ophthalmoscopy or FFA. This may contribute to diagnostic optimization and workup of a variety of general inflammatory diseases. For instance, the presence of retinal vasculitis during multiple sclerosis is associated with a more severe form.⁶ Because AO imaging may also contribute to better understand the process leading to vascular occlusion, it may help to identify patient at risk of severe visual loss. We therefore conclude that AO imaging may be a useful tool for the detection, early diagnosis, and thus management of retinal vasculitis.

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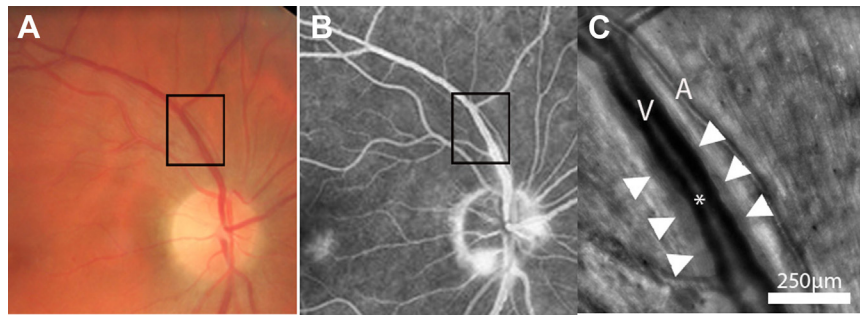


Figure 1. Case 1, a 52-year-old man with bilateral ischemic retinal vasculitis related to Lyme borreliosis. **A**, Color fundus photograph. **B**, Fluorescein angiography (FFA) revealing leakage from the disc and major temporal veins of the posterior pole together with extensive microvascular remodelling in the foveal area. **C**, Adaptive Optics (AO) imaging of the area indicated in panel **A** (A, arteriole; V, vein). Note the presence of perivascular opacification (arrows in **C**) suggestive of inflammatory infiltration, surrounding an area of focal venous narrowing (asterisks in **C**; bars, 250 μ m).

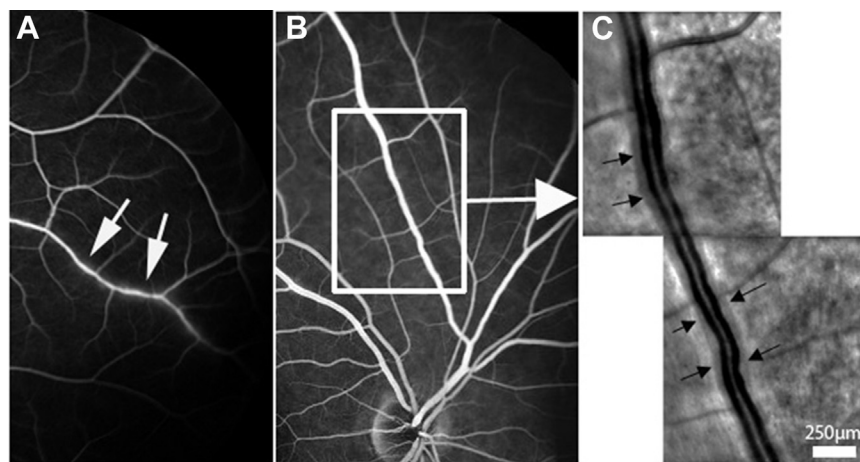


Figure 2. Case 2, a 29-year-old woman diagnosed with Lyme disease based on a history of tick bite and positive anti-*Borrelia* antibodies in serum. **A**, **B**, Fluorescein angiography (FFA) revealing peripheral retinal vasculitis in the right eye but not in the left (**A**). **C**, Adaptive optics imaging of the area indicated in **B** (in the midperiphery of the right eye) showed a loss of transparency along a venule (arrows), which had a normal appearance on FFA (**B**; bars, 250 μ m).

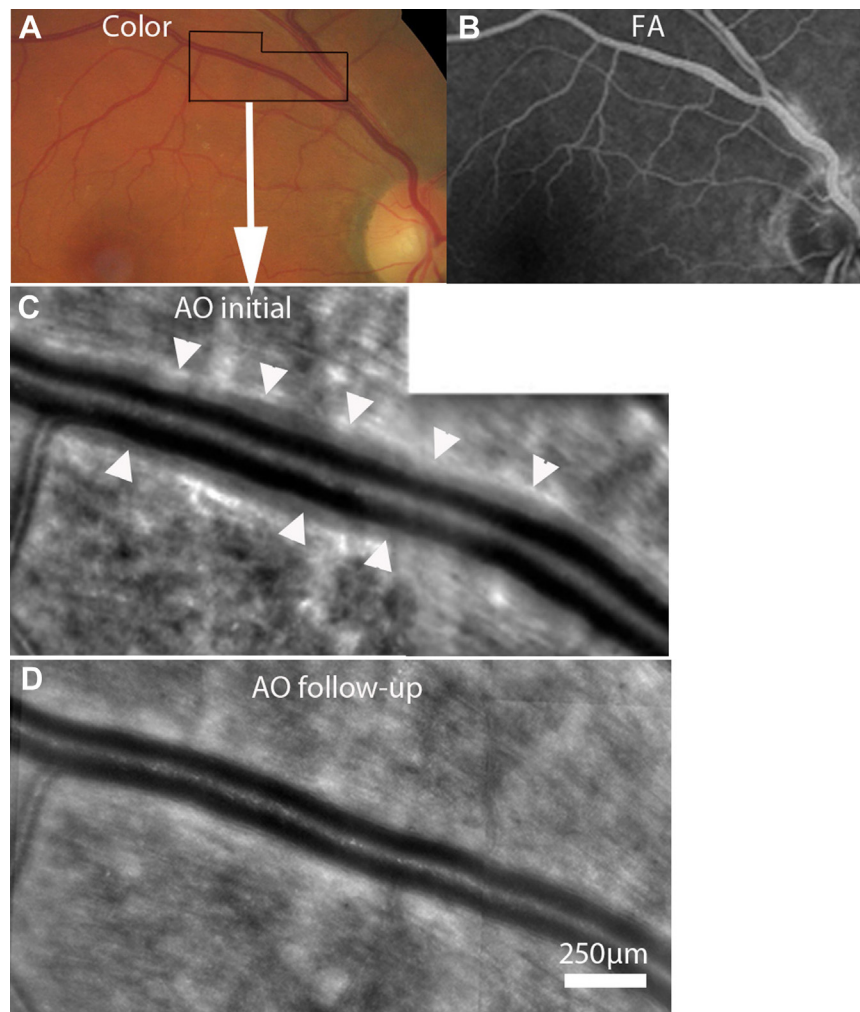


Figure 3. Case 3. Multimodal imaging of the fundus of a 56-year-old man with retinal vasculitis presumably related to tuberculosis. **A**, color photograph. **B**, Fluorescein angiography (FA) showing a focal leakage of fluorescein from a superotemporal vein adjacent to the disc. **C**, **D**, Composite Adaptive Optics (AO) Near Infra-Red (NIR) imaging of the area indicated in **A**, which corresponds to a distal site on the same leaking vessel. AO imaging showing a loss of transparency around the venule (arrowheads) without detectable dye staining on FFA. **D**, Three months after initiation of combined antituberculosis and corticosteroids treatment, AO NIR imaging showed the disappearance of perivascular infiltration.