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FINE RETINAL STRIAE ASSOCIATED WITH EPIRETINAL MEMBRANE VISUALIZED USING ADAPTIVE OPTICS

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Abstract

Purpose—To describe a case of fine retinal striae visualized using an adaptive optics flood illuminated (AO-flood) fundus camera in a patient with vision loss from an idiopathic macular epiretinal membrane (ERM).

Methods—A case report of a 48-year-old woman with recent vision loss from ERM imaged using an AO-flood fundus camera and high resolution Fourier-domain optical coherence tomography (Fd-OCT) before and 3 months after vitrectomy.

Results—Visual acuity improved from 20/70 to 20/20 after vitrectomy. Preoperative Fd-OCT showed severe cystoid macular edema with irregularities in the outer nuclear layer which consists of cell bodies of photoreceptors. Preoperative AO-flood en face images showed dark linear striae of approximately 10 μm width overlying the cone mosaic that improved following surgery, concurrent with improvement in visual acuity and morphologic changes on Fd-OCT.

Conclusion—Microstructural changes within the retinal layers resulting from macular traction from ERM can be visualized using an AO-flood fundus camera and Fd-OCT. They can appear as fine linear striae in AO-flood en face images. Further studies are needed to correlate these changes with vision loss associated with this condition.

Idiopathic epiretinal membrane (ERM) is a common vitreoretinal condition that can develop in healthy eyes.¹ It can result in vision loss and metamorphopsia in some eyes, but the mechanism for the vision loss associated with this condition is unclear. Some studies have shown a correlation between macular thickening on Stratus optical coherence tomography (OCT) and vision loss, but macular edema does not always result in vision loss.^{2,3} Electrophysiologic studies have shown inner and outer retinal abnormalities associated with ERM, but these changes do not always correlate with visual acuity.^{3,4} Vitrectomy surgery is commonly performed when visual disturbance is significant. However, despite surgical removal of the membrane, only up to 70% of eyes have significant improvement in vision, and macular profile on OCT rarely returns to normal after surgery.⁵ In this study, an adaptive optics flood illuminated (AO-flood) fundus camera and a high resolution Fourier-domain OCT (Fd-OCT) instrument developed at our institution were used to image the macula in a patient with ERM before and after vitrectomy to study microstructural changes that may correlate with vision change.

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Case Report

A 48-year-old woman presented with recent vision loss in the right eye. Best-corrected distance visual acuity in that eye was 20/70. Fundus examination revealed an elevated ERM with macular traction (Figure 1A). High resolution Fd-OCT showed marked cystoid macular edema with irregularity in the outer nuclear layer near the fovea but normal appearing inner segment–outer segment junction of photoreceptor layer (IS-OS) (Figure 1B). En face images of the macular photoreceptor mosaic acquired with our AO-flood fundus camera showed fine linear dark striae of approximately 10 μm width overlying extrafoveal cones (Figure 1C). Vitrectomy surgery with membrane peeling was performed. Three months later, best-corrected distance visual acuity was 20/20 and no residual metamorphopsia was noted subjectively or on Amsler grid. Postoperative Fd-OCT showed mild residual macular edema (Figure 2A). Postoperative AO-flood en face fundus image of the same extrafoveal region showed a marked decrease in these striae (Figure 2B).

Discussion

In this report, an AO-flood fundus camera and an Fd-OCT instrument were used to image the macula in a patient with vision loss from ERM to study microstructural morphologic changes that may correlate with vision change. Adaptive optics technology has been incorporated into various imaging systems to increase transverse resolution. With fundus imaging, AO technology makes it possible to resolve individual cones in the macula in vivo.^{6,7} The AO-flood fundus camera used in this study has transverse resolution of approximately 2.5 μm , and each bright spot in the en face image represents reflectance originating from the inner segment–outer segment junction of a cone photoreceptor.⁶ Adaptive optics imaging systems have been used to assess and quantify changes in cone density associated with retinal dystrophies.^{6,7} The high-resolution Fd-OCT used in this study provides axial resolution of 4 to 4.5 μm and transverse resolution of 10 to 15 μm .⁸ It has been used to study microstructural changes in the retina associated with various macular pathologies, including macular holes and neovascular age-related macular degeneration.^{8,9}

In this report, preoperative AO-flood en face images of the macular cones showed linear striae overlying the cone mosaic which were less evident following surgery, concurrent with improvement in visual acuity and macular edema on Fd-OCT. Whether these striae resulted from direct traction on the photoreceptor layer or shadowing from irregularities in the overlying outer nuclear layer (ONL) seen on Fd-OCT is unknown. Since the ONL consists of cell bodies of the photoreceptors, irregularities in this layer seen on Fd-OCT is consistent with disruption of the photoreceptor layer resulting from traction. Since macular thickening on OCT does not always result in vision loss associated with ERM, other morphologic changes in the macula may contribute to vision loss.³ Electrophysiologic studies have shown both outer and inner retinal layer dysfunction associated with vision loss in eyes with idiopathic ERM.^{3,4} This report shows that an AO-flood fundus camera and Fd-OCT can be used to visualize subtle changes within the retinal layers in eyes with ERM. Disruptions or irregularities of the photoreceptor layer can occur, as shown by irregularities in the ONL on Fd-OCT. Such changes may appear as fine striae on AO-flood en face images.

Further studies are needed to correlate these morphologic changes within the retina with vision loss associated with this condition. Although changes in foveal photoreceptor morphology is likely to have more impact on vision than the extrafoveal changes noted in this study, foveal cones are too small to image clearly using the current AO-flood imaging system.¹⁰ In addition, the cone mosaic is often difficult to visualize using the AO-flood fundus camera in eyes with macular edema due to increased light scatter (unpublished data). Thus, this is the first and only case of retinal striae visualized using AO-flood imaging

modality to date. With development of newer retinal imaging systems, such as Fd-OCT that incorporates adaptive optics technology, this latter limitation of the current AO-flood system may be overcome, allowing microstructural changes in the macula to be analyzed in more detail in pathologic eyes. Continuous development in retinal imaging technology will allow further correlation between these morphologic changes and vision loss associated with this condition.

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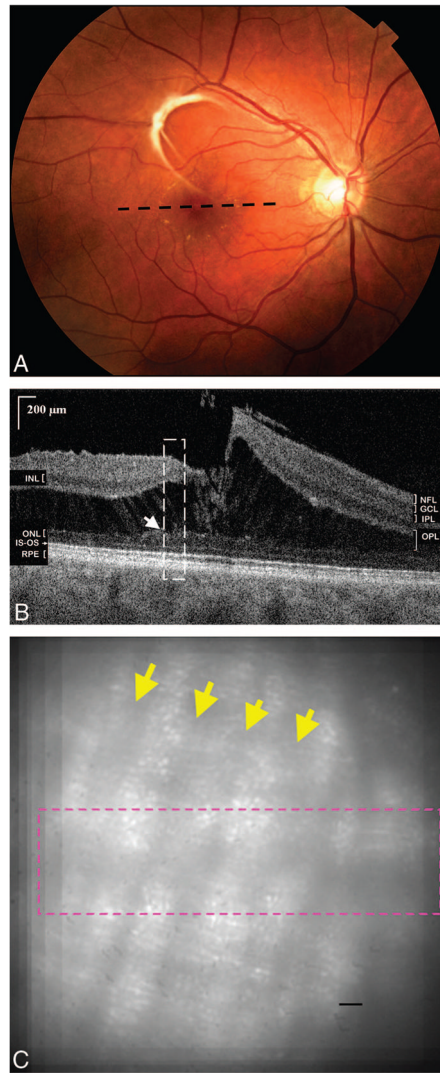


Fig. 1. High resolution Fourier-domain optical coherence tomography (Fd-OCT) and adaptive optics flood en face image of the right macula with vision loss due to an idiopathic epiretinal membrane. **A**, Fundus photography showing a diffuse elevated epiretinal membrane with traction on the macula. Best-corrected visual acuity was 20/70. Dotted line corresponds to the Fd-OCT image presented. **B**, High resolution Fd-OCT 6 mm horizontal B-scan centered at the fovea with axial resolution of 4 to 4.5 μm and transverse resolution of 10 to 15 μm , showing marked cystoid macular edema with foveal traction. The photoreceptor outer segment layer, i.e., inner segment–outer segment junction (IS-OS), appears normal. However, irregularities in the outer nuclear layer (ONL) are noted near the fovea (arrow). **C**, Adaptive optics flood en face image of macular cones showing dark linear striae overlying the cone mosaic (arrows). Extrafoveal images were taken 2 degrees temporal to the fovea using 550 nm wavelength and 40 nm bandwidth imaging light source. The region of the macula imaged is represented by the dashed box in **B**. Scale bar, 10 μm . Each bright spot represents the reflectance from cone IS-OS. The broken box shows a shadow from the same overlying retinal blood vessel. The dark linear vertical line seen in the right side of the figures and not marked with an arrow also represents a shadow from the overlying retinal vessel. NFL = nerve fiber layer; GCL = ganglion cell layer; IPL = inner plexiform layer;

INL = inner nuclear layer; OPL =outer plexiform layer; ONL = external limiting membrane;
RPE = retinal pigment epithelium.

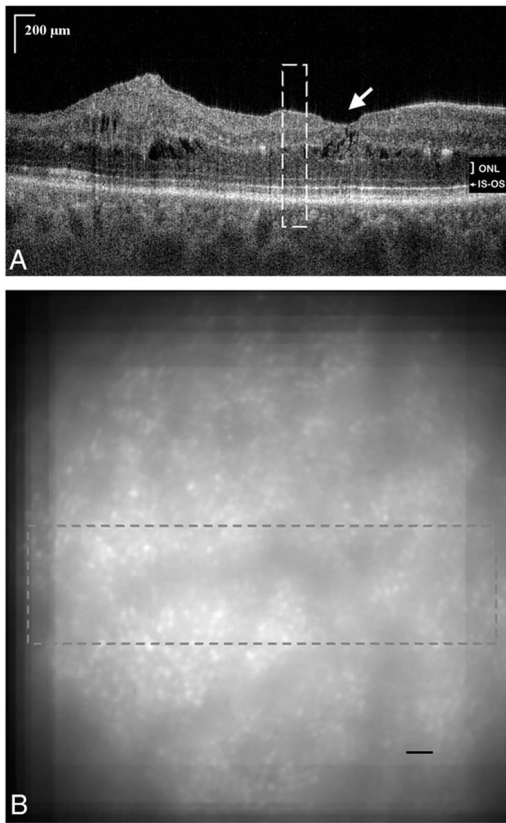


Fig. 2. High resolution Fourier-domain optical coherence tomography (Fd-OCT) and adaptive optics flood en face image of the right macula 3 months after vitrectomy surgery for idiopathic epiretinal membrane. **A**, High resolution Fd-OCT 6 mm horizontal B-scan image centered at the fovea with axial resolution of 4 to 4.5 μm and transverse resolution of 10 to 15 μm showing mild residual macular edema with residual traction temporal to the fovea (arrow denotes fovea). Best-corrected visual acuity was 20/20 with no metamorphopsia. **B**, Adaptive optics flood en face images of macular cones after vitrectomy showing marked decrease in the previously noted dark striae, concurrent with improvement in vision and macular edema. Extrafoveal images were taken 2 degrees temporal to the fovea using 550 nm wavelength and 40 nm bandwidth imaging light source (corresponding to dashed box in Figures 1B and 2A). Each bright spot represents the reflectance from cone inner segment–outer segment junction. (The broken box shows a shadow from the same overlying retinal blood vessel seen in both the preoperative and postoperative images. The dark linear vertical line seen in the right side of the figure also represents a shadow from the overlying retinal vessel seen in both preoperative and postoperative images.) Scale bar, 10 μm . ONL = outer nuclear layer; IS-OS = inner segment–outer segment junction of photoreceptor.