High-Resolution Retinal Imaging of Cone–Rod Dystrophy

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Purpose: This study examines a patient with cone–rod dystrophy using high-resolution adaptive optics retinal imaging. Conventional ophthalmoscopes provide limited resolution due to their inability to overcome the eye's optical aberrations. In contrast, adaptive optics ophthalmoscopes correct these aberrations to provide noninvasive high-resolution views of the living retina. To date, adaptive optics ophthalmoscopy has been used mainly to examine the normal retina. Here we use adaptive optics ophthalmoscopy to image cone–rod dystrophy in vivo and compare these results with standard clinical tests.

Design: Observational case report.

Methods: High-resolution retinal images of a patient with cone–rod dystrophy were obtained with the University of Rochester adaptive optics flood-illuminated ophthalmoscope and the adaptive optics scanning laser ophthalmoscope located at the University of Houston and compared with standard clinical tests, including fundus photography, Goldmann visual fields, fluorescein angiography, optical coherence tomography, electroretinography, and multifocal electroretinography.

Main Outcome Measures: Direct measurement of cone density and diameter and comparison of adaptive optics images with standard clinical imaging and functional tests.

Results: Adaptive optics images were acquired at multiple retinal locations throughout a clinically detected bull's-eye lesion. Within the atrophic regions, we observed large areas devoid of wave-guiding cones. In contrast, regions that appeared relatively spared by clinical examination contained a completely tiled cone mosaic. However, in these areas the cones were abnormally large, resulting in a 6.6-fold reduction from the normal peak cone density (patient peak density: 30 100 cones/mm^2, normal peak density: 199 200 cones/mm^2). Multifocal electroretinography confirmed a 5.5-fold reduction in amplitude of the central peak (10.8 nanovolts/degree^2 vs. 59.8 nanovolts/degree^2).

Conclusions: Adaptive optics ophthalmoscopy is a noninvasive technique to observe a patient's retinal pathology directly at a cellular level. It can provide a quantitative measurement of photoreceptor loss in retinal disease. *Ophthalmology 2006;113:1014–1019 © 2006 by the American Academy of Ophthalmology.*

Ophthalmoscopy is a fundamental element of the ophthalmologic examination because it allows the diagnosis of retinal disease by noninvasive observation of the retina through the natural optics of the eye. However, when pathologic changes have reached the level of resolution detectable by the ophthalmoscope, significant (and often irreversible) tissue damage usually has occurred. There has been considerable effort recently to develop retinal imaging modalities with increased resolution.[1–6] One obstacle is the quality of the eye's optics. Correction of lower-order aberrations (defocus and astigmatism) coupled with scanning laser ophthalmoscopy or traditional fundus photography showed modest success in retinal imaging[7] and visualizing individual cells in the retina.[8–10] However, additional improvements in contrast and resolution can be obtained by using a wavefront sensor to measure the ocular aberrations and a deformable mirror to compensate for these aberrations.[3,5] This adaptive optics ophthalmoscopy technique

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