Adaptive optics-a state-of-the-art

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Optical coherence tomography (OCT) and other imaging modalities, such as scanning laser ophthalmoscopy (SLO), fail to provide sufficiently detailed images of the photoreceptor microstructure, primarily due to aberrations in ocular optics. These aberrations can be compensated for by using imaging systems that incorporate adaptive optics (AO), including a wavefront sensor to measure the ocular aberrations and a deformable mirror or spatial light modulator to compensate for these ocular aberrations.The addition of AO to imaging systems, such as the flood-illuminated ophthalmoscope, SLO equipment, or OCT, has permitted researchers in the identification ofretinal nerve fiber bundles, blood flow, and individual cone photoreceptors.

We developed anoriginal prototype of an AO-SLO system, through which we have been investigating cone photoreceptor abnormalities in patients with various retinal diseases.AO-SLO images showed abnormal cone mosaic patterns and reduced cone densities in eyes with resolved central serous chorioretinopathy;moreover, these abnormalities were associated with visual acuity loss.AO-SLO images of eyes with epiretinal membrane showed abnormal cone mosaic patterns, described as “microfolds” in the foveal photoreceptor layer; the presence of these microfolds was associated with the occurrence of metamorphopsia, indicating that microfolds may be involved in the formation of metamorphopsia.AO-SLO images of eyes with idiopathic macular telangiectasia(MacTel) type 2showed unique dark regions in the cone mosaic along with decreased cone density that was associated with decreased vision, even in areas with normal vasculature; these featuresmay represent early neuronal changes involved in the pathogenesis of MacTel type 2.Thus, high-resolution imaging using AO-SLO enables the detectionof microstructural abnormalities thatcannot be observedthrough commercially available SLO or OCT;hence, enhancing our understanding of various macular diseases and glaucoma.