4.7 Adaptive optics retinal imaging in the mouse eye

With the remarkably good optical quality of the mouse eye for imaging the retina, it's possible to obtain high quality retinal images even without using AO [62–65]. However AO can provide additional improvements in both lateral and axial resolution and retinal image contrast. The diffraction-limited *in vivo* resolution is ~0.7 μm for lateral resolution, and ~6 μm for axial resolution (calculated for 550 nm wavelength and 2 mm pupil size). Apart from providing diffraction-limited imaging, AO can also increase the pupil size that can be used for imaging, correct both lower and higher order aberration at video rates, and increase light collection efficiency for confocal or two-photon imaging. The ability to capture the entire wave aberration in the anesthetized mouse eye over a fully dilated pupil with reflected light is promising for high-speed adaptive correction of mouse retinal images. The amount of higher order aberrations measured over the 0.49 NA (2 mm pupil) mouse eye is similar to what is measured in the normal human eye over a 0.18 NA (6 mm pupil) [66] thus is correctible by AO. An adaptive optics instrument customized for *in vivo* imaging of the mouse retina with this improved wavefront sensing method is currently under development.

5. Conclusions

Using a wavefront sensor that favors backscattered light from a specific retinal layer in the mouse eye, we have improved the quality of wavefront sensor spots and thus improved aberration measurements in the mouse eye. Contrary to common belief, we measured the mouse eye to be myopic, and the optical quality of the mouse eye to be remarkably good. An instrument constructed with this improved wavefront sensor technique may provide a faster and more effective correction for the mouse eye aberrations using AO. This instrument can potentially achieve a lateral resolution at least two times higher than that of the human eye, and an axial resolution at least four times higher than that of the human eye. Such an instrument could allow microscopic imaging and monitoring of retinal development, disease progression, or the efficacy of therapy in single animals over time.

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