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The Use of an Adaptive Optics Vision Simulator to Determine the Optimal Spherical Aberration Correction

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Abstract

Purpose: To use an adaptive optics vision simulator (AOVS) to explore the impact of spherical aberration (SA) on contrast sensitivity (CS). These tests will be used to determine the optimum amount of SA that should be aimed for in customized correction of wavefront aberration.

Methods: A vision simulator was constructed that includes a deformable mirror that makes it possible to simultaneously manipulate the effective ocular wavefront aberration and to measure the resulting visual performance. The vision simulator consists of a wavefront sensor, a deformable mirror to induce and correct aberrations of the eye, and a visual testing path. Subjective measurements of CS at 15 c/deg were performed in five subjects with different levels of naturally occurring SA for a 4.8 mm pupil. CS was measured when SA values of -0.09,0.0, 0.09 and 0.182 microns were induced with the other natural aberrations of the eye both present and corrected for, and for defocus values of ±0.25 D and ±0.5 D.

Results: An AOVS was built that is capable of reducing the RMS wavefront aberration of the eye by a factor of 4 and also allows us to non-invasively test the visual performance that would result from any ocular wavefront aberration resulting from current or future customized aberration correction procedures. Subjects had peak CS performance for varying levels of SA when their natural aberrations were present but average contrast performance peaked for 0 microns of SA. When all higher-order aberrations were corrected, all five subjects' peak performance occurred for 0 microns of SA.

Conclusions: Using adaptive optics, it was determined that contrast performance peaks for complete correction of SA.

Keywords: refractive surgery: optical quality • optical properties • contrast sensitivity