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COMPENSATION OF CORNEAL ABERRATIONS BY THE INTERNAL OPTICS IS BETTER IN HYPEROPIC EYES

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Abstract

Purpose: We showed that the lens partially compensates for the corneal aberrations in young eyes (Artal et al., *Journal of Vision*, 1, 1, 2001). In order to better understand the underlying reasons of such compensation, we explored the dependence of the relative aberrations induced by the cornea and the internal media with the refractive error of the subjects.

Methods: We measured both ocular and corneal wave-front aberrations for 6 mm pupil diameter in two groups of young subjects: myopes ($n=57$; 29.2 ± 7.1 years old) and hyperopes ($n=16$; 33 ± 7.9 years old). Refractive errors ranged from -8 to $+7$ D defocus and -3.75 to $+5.5$ D astigmatism. Ocular aberrations were measured using our own research prototype Hartmann-Shack wave-front sensor, while corneal aberrations were obtained by using a ray-tracing procedure from the elevation maps provided by a corneal topographer. The internal aberrations were calculated subtracting corneal from ocular aberrations, using the center of the pupil for registration. In every eye, we also estimated the distance from the corneal vertex to the pupil center, which is related to κ angle. This angle is highly dependent on the subject's refractive error.

Results: The average RMS_e of the high order ocular aberrations was lower than the corneal RMS_c in the two groups: 0.32/0.41 microns (myopes) and 0.26/0.53 microns (hyperopes). The average compensation factor ($1 - RMS_e/RMS_c$) was higher in the hyperopic group (0.51) than in the myopic group (0.22). This is mainly due to a significant increase of horizontal coma: the average values for cornea/internal were 0.09/-0.1 microns in myopes versus 0.35/-0.3 microns in hyperopes. The average distance from the

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corneal vertex to the pupil center was also higher in hyperopes (0.26 mm) than in myopes (0.07 mm). Average spherical aberration was similar within all subjects: positive for the cornea (0.19 microns) and negative for the lens (−0.14 microns). The horizontal decentration of the pupil is correlated with both corneal ($r^2=0.59$) and internal ($r^2=0.65$) horizontal coma.

Conclusions: Corneal aberrations are partially compensated by internal aberrations in most young eyes. We found a higher compensation factor in hyperopic eyes, which usually have a larger κ angle. These results supports a simple passive mechanism for the compensation: a displacement of the cornea with positive spherical aberration induces a positive coma, while this same displacement for the lens, with a similar but with opposite sign spherical aberration, induces a negative coma, that nearly cancels that of the cornea.

Keywords: optical properties • refractive surgery: optical quality



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