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Abstract Title:	**Optical and Visual Quality With Multifocal Contact Lenses**
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Purpose: Multifocal contact lenses (CLs) are a common alternative to correction of presbyopia. Their failure to produce adequate visual quality or significantly expanded depth-of-field (DOF) in some patients is often attributed to lack of neural adaptation. We hypothesize that much of the effect is optical, and relies on coupling effects of the CL and the underlying ocular optics. We investigated this question by measuring total aberrations, and through-focus (TF) visual function in eyes wearing multifocal soft CLs.
Methods: We measured total aberrations (using a laser ray tracing system with a circularly symmetric sampling pattern) and visual acuity (Snellen E, 4 alternative forced choice paradigm) on 4 healthy cyclopeged eyes from 4 subjects (28±5 years). Each eye was measured without CL, with multifocal CL (Essilor Rythmic multifocal) of +3.5D (multiCL+) and -3.5D (multiCL-), and with a reference monofocal CL (monoCL, Proclear Cooper Vision) of -3.5D. All CLs had the same base radius (8.60 mm) and similar material. TF Modulation transfer functions and simulations of retinal images of acuity charts were obtained from the wave aberrations, and Strehl ratio was used as a metric. Visual acuity was measured TF at steps of 0.5 D (30 trials per focus and stimulus duration of 0.5 s). All comparisons were performed for 4-mm pupil diameters.
Results: 1) We found high correlations between aberrations of the naked eye and aberrations of the eye with any of the CLs (r=0.98 for multiCL+, 0.93 for multiCL-, and 0.81 for the monoCL, on average; $p<0.0001$ in all cases), indicating conformity of the CL to the cornea. 2) Negative spherical aberration was induced with 11 out of 12 CLs (mono or multifocal) (-0.10±0.02 for multiCL+, -0.04±0.09 for multiCL-, -0.09±0.04 for monoCL). 3) Only multiCL+ increased DOF (in 2 cases), at the expense of optical quality losses, as shown both from optical and visual acuity measurements. 4) Simulated TF image quality correlates well with TF visual acuity, indicating that optical aberrations are a major cause for the intersubject variability in visual function, and for the limits in the performance of the CLs.
Conclusions: 1) Ocular aberrations play a major role in the visual outcomes with soft multifocal CLs. 2) Negative multifocal CLs behave essentially as monofocal CLs, while the positive (thicker) multifocal CLs seem to expand DOF some, confirming previous results from our lab on an in vitro model. 3) Understanding the coupling of the ocular optics to the CL is essential to improve current designs, prior to attribute their failure or success to neural effects.

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