Short-term optical and visual performance of soft contact lenses for myopia management

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Introduction

Soft contact lenses indicated for myopia control present different power profiles[1] inducing myopic defocus[2] or simultaneous competitive myopic defocus[3] on the peripheral retina while maintaining an acceptable visual performance for distance[4]. The best efficacy performance of these designs is related to their optical profile[5], the amount of peripheral defocus induced[6] and by the correct position of lens optics[7]. Most of the lenses available for this aim are "one size" and some are used as "off-label" solution option not allowing to ECPs the possibility to modify their optical profile and geometric parameters to improve the relationship with patient's eyes. The aims of this study are to evaluate the short-term effects of common soft contact lenses indicated for myopia control on ocular high order aberrations (HOAs), dysphotopsia, and high and low contrast visual acuity (VA).

Methods

Sixteen healthy, myopic volunteers between 16 and 27 years of age (19.5±2.7 years) participated in this study. Best-corrected high contrast (HCVA) and low contrast (25% Michelson) (LCVA) visual acuity were evaluated with a logMAR Bailey-Lovie test chart and dysphotopsia (a light disturbance phenomenon of vision that includes specific phenomena such glare, starburst, and haloes), measured with the light distortion analyzer (LDA, CEORLab),[8] were obtained from the right eyes without a contact lens. Dysphotopsia was quantified considering the light disturbance index (LDI%)[8]. HOAs were analyzed using a pyramidal aberrometer (Osiris, CSO) and Strehl Ratio (SR) using a double pass technique (HD Analyzer, Visiometrics) for 4 mm pupil diameters. The pupil diameter for the analysis was selected considering the average values founded in young population in normal light conditions[9]. All subjects were fitted with four different soft contact lens designs indicated for myopia control (Table 1). All the measurements were repeated with every lens design after 30 min from lens application. Each measurement were repeated three times and the average values used for the analysis.

Lens	Manufacturer	Lens name	Material	Design	Replacement	Parameters			
						ADD (D)	BC (mm)	DIA (mm)	SAG 35° (µm)
1	*Cooper Vision*	*MiSight*	Omafilcon A	Multiconcentric	DD	N/A	8.7	14.2	3664
2	*Visioneering Technologies*	*NaturalVue multifocal*	Etafilcon A	EDOF Catenary	DD	N/A	8.3	14.5	3905
3	*Mark'ennovy*	*Mylo*	Filcon 5B	EDOF	Monthly	1.50	8.3	14.5	3715
4	*Cooper Vision*	*Biofinity Multifocal*	Comfilcon A	Center Distance Multifocal	Monthly	2.50	8.6	14.0	3584

Table 1. *Contact lens used for the study, DD daily disposable*

Results

Considering the non-parametric nature of the data Wilcoxon signed ranks test was applied for pairwise comparison between baseline measures and each lens tested. There were no statistically significant differences in best-corrected high contrast VA between baseline values and the different contact lens tested, while low contrast the VA values were lower for all the lenses tested ($p<0.05$). The latter showed higher values for multiconcentric and multifocal designs (respectively 0.28±0.13logMAR and 0.23±0.15logMAR) and lower values for the non-monotonic and aperiodic and catenary designs (respectively 0.16±0.18logMAR and 0.18±0.14logMAR) (Fig.2). Compared with baseline, the multiconcentric, the center distance multifocal, the catenary optics and non-monotonic and aperiodic optic all induced a significant increase in (HOAs), from 0,125±0.088µm to respectively 0,385±0.061µm, 0,367±0.036µm, 0,275±0.056µm and 0,157±0.063µmv (Fig.3). Considering Zernike components with the same lens designs, spherical aberration [C(4,0)] presented a significant positive shift (from 0,022±0.014µm, to respectively 0,142±0,061µm, 0,102±0.022µm, and 0,171±0.026µm) and a significant negative shift with the non-monotonic and aperiodic optic design (-0,040±0.038µm) (Fig.3). In the same way horizontal [C(3,+1)] and vertical [C(3,-1)] coma increased in positive direction for all lens designs (respectively from 0,021±0.061µm and 0,057±0.051µm, to 0,195±0,086µm and 0,151±0,139µm, 0,242±0.069µm and 0,124±0.106µm, 0,135±0.034µm and 0,092±0.075µm) except the non-monotonic and aperiodic design where the increase was in negative direction (-0,057±0.049µm and -0,045±0.093µm)(Fig.3). All lens design induced a low effect on trefoil terms (Fig 3) and a significant reduction of SR from baseline (Fig.4). Only the multiconcentric and multifocal design induced a significant increase of dysphotopsia (Fig.5).

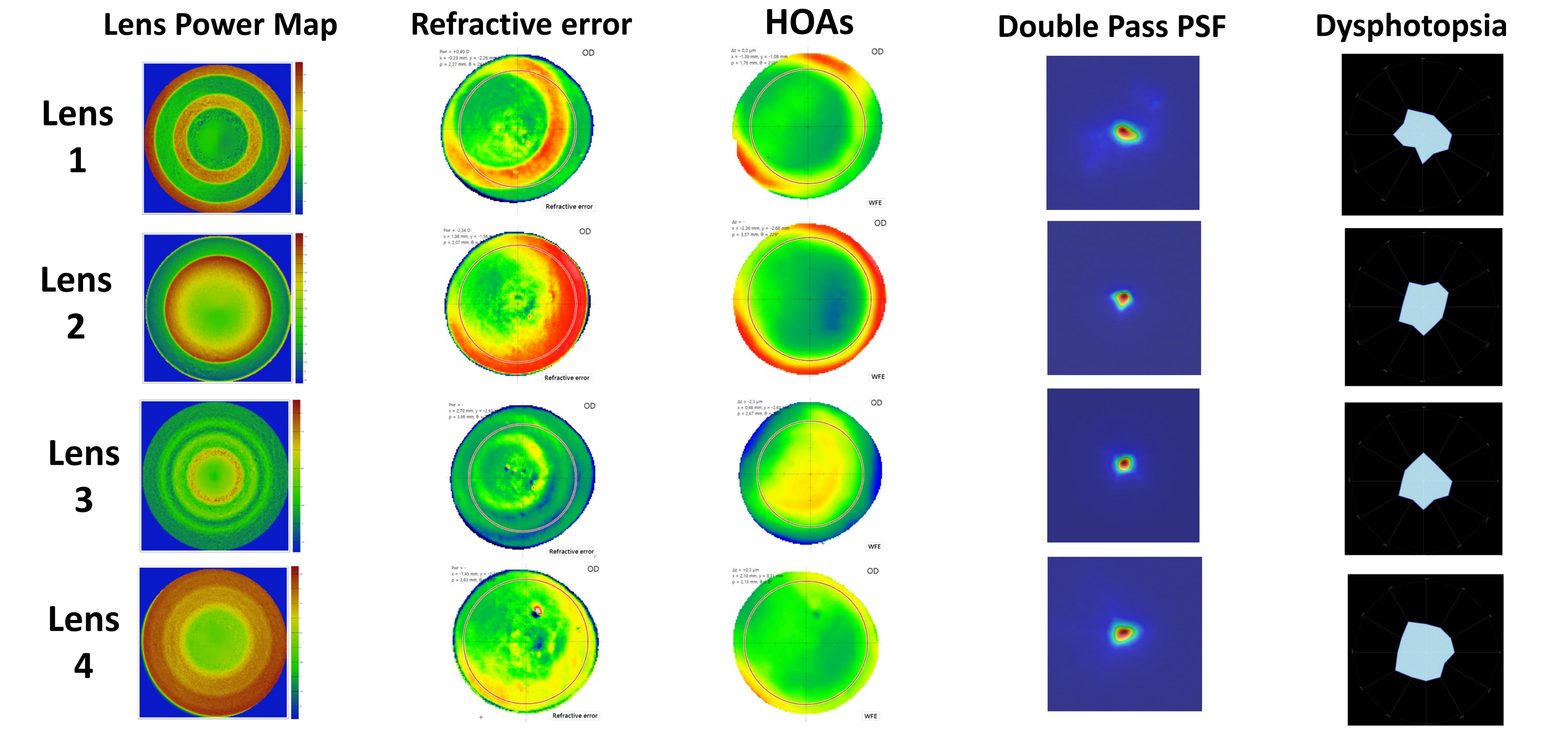

Figure 1. *Example of the effects induced by the CLs tested on: distribution of refractive error point by point, HOAs, double pass point spread function (PSF) and dysphotopsia.*

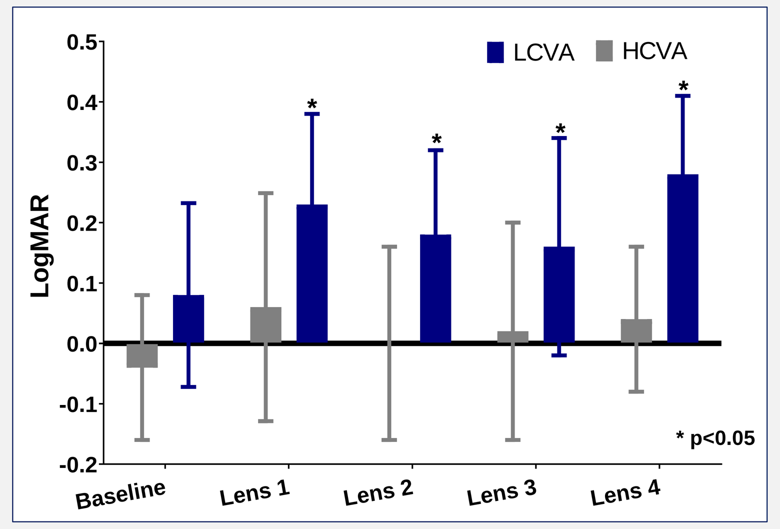

Figure 2. *High and low contrast VA with different lenses*

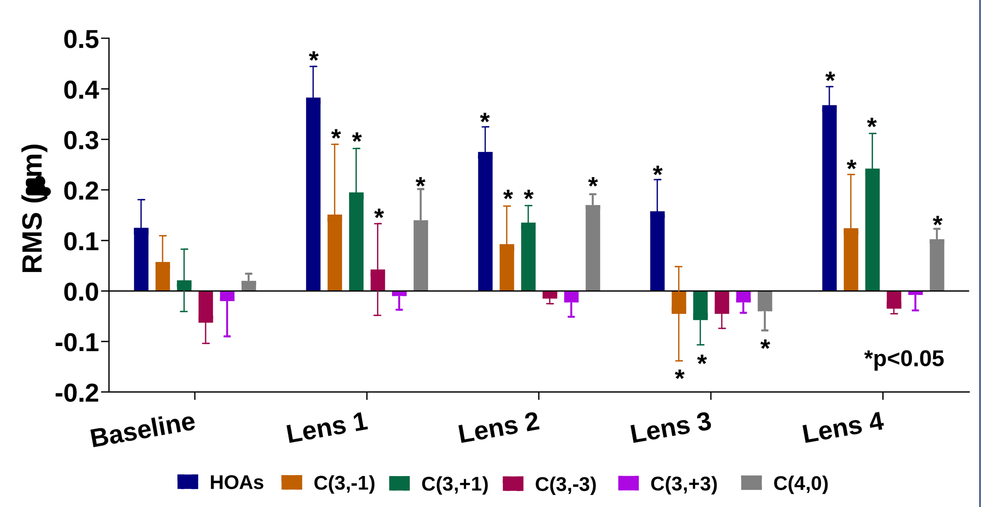

Figure 3. *Effect of different lens designs on high order aberrations*

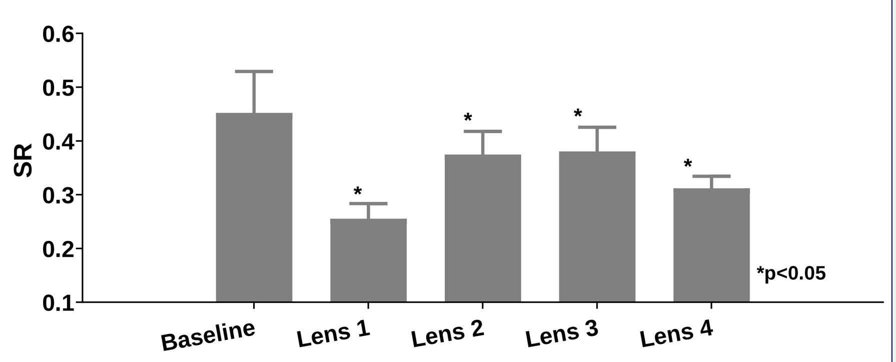

Figure 4. *Effect of different lens designs on Strehl Ratio*

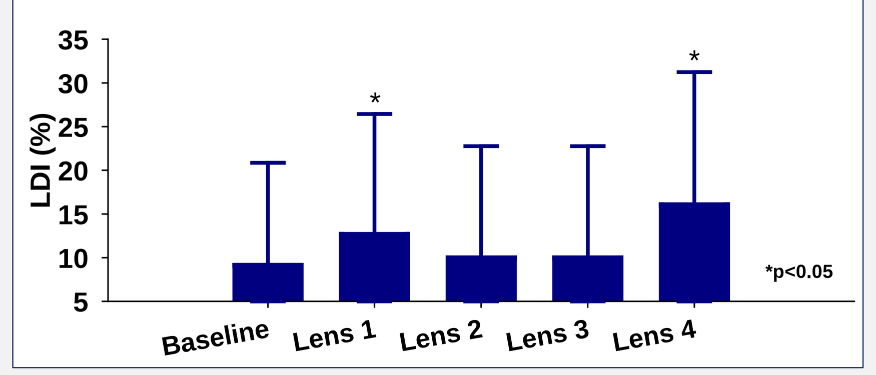

Figure 5. *Effect of different lens designs on dysphotopsia*

Discussion and Conclusions

Although there is strong scientific evidence demonstrating the effectiveness of soft CLs on myopia control it is still unclear what the optimal optical pattern is that should be provided to the retina to obtain the most effective result.[10] There is also limited evidence to help practitioners predict how an individual will respond to intervention and to choose the most appropriate modality.[11] Knowing the optical profile of the lenses available is not enough since their effect can be influenced also by the relationship between their geometrical parameters and the anterior segment on CL position, with different effect on optic that is applied to the retina and possible negative interactions with treatment efficacy.[1] This poster is one of the first in its nature looking at the differences on-eye optical projection of soft CLs for myopia management out in the market today that are used on a daily basis. All the lens tested compared with baseline provide satisfactory distance high contrast VA, but a reduction in low contrast VA and an increase of the HOAs values. Considering the Zernike components as expected by the optical profiles all CLs induced a positive shift of SA except for lens 3 where its non-monotonic and aperiodic design induced low negative shift on this component. A similar behavior was found for vertical and horizontal coma with positive shift for all CL design except for lens 3 where their shift was in negative direction. The Increase of coma components could be induced by the decentration of CLs optic with respect to the line of sight[12] and their higher value founded with the lens 1 and 4 justify the higher reduction of LCVA and increase of dysphotopsia obtained with these lenses. Considering the dysphotopsia future studies are necessary to evaluate the effect of neuroadaptation with wearing time as for multifocality induced by CLs or IOLs.[13]

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