Power profile and sagittal height differences of soft contact lenses indicated for myopia control

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Introduction

The strategy for soft contact lenses designed for myopia control is to induce myopic defocus[1] or simultaneous competitive myopic defocus[2] on the peripheral retina while maintaining an acceptable visual performance for distance[3]. The best efficacy performance of these designs is related to their optical profile[4], the amount of peripheral defocus induced[5] and by the correct position of lens optics[6]. Most of the lenses available for this aim are “one size” and some are used as “off-label” solution option, with their optical characteristics often not always available. This observational study aimed to report the differences in power profile and posterior sagittal height (SAG), of the most common soft lenses used for myopia control, to potentially give eye care practitioners (ECPs) more insight in what they are fitting.

Methods

Eight different soft contact lenses indicated for myopia control (on-label and off-label) were selected for the study (Table 1). Three lenses of each lens type were stored in standard saline solution for 24h prior to measurement following ISO18369-3[7] recommendations. The optical radial power profiles were measured using the NIMO EVO (Lambda X, Nivelles, BE) optical lens analyzer, using a wet cell with saline solution at 20°C. To obtain the measurement of SAG a spectral domain OCT-based lens analyzer Optimec is830 (Optimec Systems, Malvern, UK) was used. The measurements were obtained after the lenses were allowed to equilibrate for approximately 20 minutes at both 20°C (room temperature and ISO standard) and 35°C (eye temperature) using the TC20i (Optimec Metrology, Malvern, UK). Each lens was measured three times average values are reported at each temperature.

Manufacturer	Lens name	Material	Design	Replacement	Parameters labelled		
		Name			BC (mm)	ADD (D)	DIA (mm)
Cooper Vision	*MiSight*	Omafilcon A (Hy)[a]	Multiconcentric	Daily Disposable	8.7	N/A	14.2
Menicon / Visioneering Technologies	*Bloom / NaturalVue multifocal (OL)*	Etafilcon A (Hy)[a]	EDOF[c]	Daily Disposable	8.3	N/A	14.5
Seed	*1 Day Pure EDOF (OL)*	2-HEMA, MMA, EGDMA (Hy)[a]	EDOF[c]	Daily Disposable	8.4	Mid	14.2
Johnson & Johnson	*Abiliti*	Senofilcon A (Si-Hy)[b]	Torus	Daily Disposable	7.9	N/A	13.8
Cooper Vision	*Biofinity Multifocal CD (T) (OL)*	Comfilcon A (Si-Hy)[b]	Multifocal	Monthly	8.6	2.50 (C)	14.0
Cooper Vision	*Proclear Multifocal CD (T) (OL)*	Omafilcon B (Hy)[a]	Multifocal	Monthly	8.6	2.50 (C)	14.2
Mark’ennovy	*Mylo (T)*	Filcon 5B (Si-Hy)[b]	EDOF[c]	Monthly	8.3 (C)	1.50	14.5 (C)
Cooper Vision	*Byo Premium MC (T)*	Ultima (Si-Hy)[b] (C)	Multifocal	Quarterly	8.6 (C)	2.50	14.5 (C)

Table 1. Lenses analyzed; (T) toric design available, (C) more parameters available, (OL) off label for myopia control

Results

Radial power profiles of contact lenses analyzed vary widely between the different designs. Based on this analysis, the lenses can be divided into four main profile categories: 1) multiconcentric (with sharp changes of power in three rings of power surrounding the central distance zone for *MiSight*), 2) multifocal (with center distance for *Biofinity CD*, *Proclear CD* and *BYO MC*), 3) EDOF[c] (with catenary optics[d] *Bloom/NaturalVue multifocal* and non-monotonic and aperiodic[e] optic *1 Day Pure EDOF* and *Mylo* and 4) “torus”[f] (Abiliti) (Fig.1). Considering an optical zone measured of 8mm, the difference between the minimum and maximum power within one lens designs can be high - with the highest difference (>5.00D) for the *Bloom/NaturalVue multifocal* and *Abiliti* and the lowest difference (2.00D) for the *BYO MC* lens. Of the eight lenses analysed, the *MiSight, Proclear CD, Biofinity CD* and *BYO MC* designs all have a central zone with a constant power for distance over a diameter between 2.8mm (*Proclear CD, Biofinity CD*) and 4.0mm (*BYO MC*); the other lens designs show a gradual profile in the lens center. The lenses tested showed considerable differences for SAG values. Considering the measurement at 20°C, the highest SAG value was the *1 Day Pure EDOF*, and the lowest the *Proclear CD* (delta-SAG 221 µm). At 35°C all the lenses presented a reduction of SAG compared with SAG at 20°C; the highest value was the *1 Day Pure EDOF*, and the lowest the *Biofinity CD* (delta-SAG 307 µm) (Fig.2).

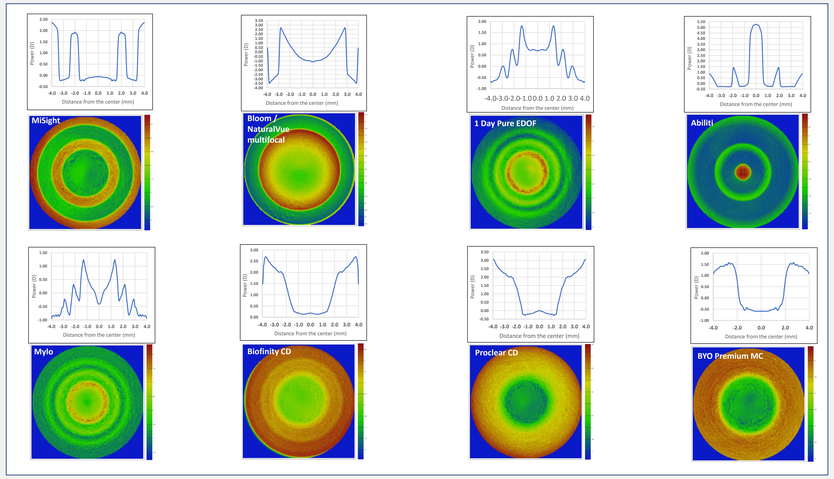

Figure 1. Radial power profile and color power map of lenses analyzed; for a better comparation between different designs the radial power profiles were plotted removing the labelled lens power from the raw data.

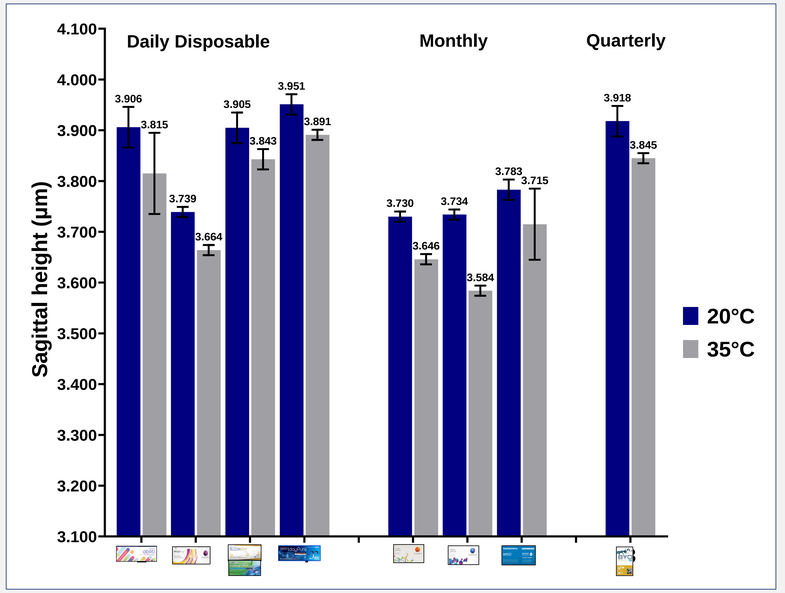

Figure 2. Sagittal height for measurements obtained at 20°C and 35°C of lenses analyzed; (mean±SD)

Conclusions

Important differences between the lenses tested were observed; for the optical profile characteristics, but also for lens parameters. Different optical profiles can potentially induce different myopia progression effects. ECPs may choose one of the four principal categories over another when changing lens design, as this may influence peripheral refraction, high order aberrations, accommodation, binocular vision and quality of vision[3]. In addition, the different SAG values between lenses can induce a different interaction with anterior segment with possible effect on lens centration and optics. Based on these results it seems that for a more effective myopia control treatment with soft contact lenses, ECPs may be advised to perform additional measurements such as the pupil diameter, ocular sagittal height and ocular aberrations, in order to select which, contact lens design could be more effective, although this needs more work. Differences between measurements at 20°C, at 35°C, can be substantial, and also needs more work to be confirmed.

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Appendix:

a) **Hy: hydrogel**
b) **Si-Hy: silicone hydrogel**
c) **EDOF: extended depth of focus**
d) **Catenary optic profile:** design with a power change that can be pictured as the U-like shape
e) **Non-monotonic and aperiodic optic profile:** design there were no discrete power zones and the power varied above and below the normal mean power
f) **Torus optic profile:** design with a non coaxial peripheral toroidal ring of positive power.

References:

1. José M González-Méijome J.M., et al.Strategies to Regulate Myopia Progression With Contact Lenses: A Review. Eye Contact Lens. 2016 Jan;42(1):24-34.
2. Smith E.L., et al. Eccentricity-dependent effects of simultaneous competing defocus on emmetropization in infant rhesus monkeys. Vision Res. 2020 Dec;177:32-40.
3. Qing Li Q., Fengzhou Fang F. Advances and challenges of soft contact lens design for myopia control. Appl Opt. 2019 Mar 1;58(7):1639-1656.
4. Christine F Wildsoet C.F., et al. IMI - Interventions Myopia Institute: Interventions for Controlling Myopia Onset and Progression Report. Invest Ophthalmol Vis Sci. 2019 Feb 28;60(3):M106-M131.
5. Zengfang Yu Z., et al. Efficacy and Safety of Different Add Power Soft Contact Lenses on Myopia Progression in Children: A Systematic Review and Meta-Analysis. Ophthalmic Res. 2022;65(4):398-416.
6. Cathleen Fedtke C., et al. Association between multifocal soft contact lens decentration and visual performance. Clin Optom. . 2016 Jun 28;8:57-69.
7. ISO 18369-3: 2017 Ophthalmic optics—Contact lenses—Part 3: Measurement methods.