Corneal topographic and axial length changes after 12 months of customized orthokeratology.

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Introduction

Orthokeratology (OK) is a procedure aiming to compensate for refractive error by molding the cornea's anterior surface predictably and reversibly.1 In the case of myopia, the use of a reverse geometry lens design allows to make the central corneal area flatter and the mid periphery steeper compared to baseline curvature.2,3 The modifications are easily seen through corneal topography. In fact, analysis of the topographic maps is the only objective way to determine the effect of a given lens or design on the corneal shape and its efficacy to modify the corneal refractive power. Short-term, and long-term results may vary. Studies suggested that OK induces the same pattern of corneal change over longer periods of wear.

Purpose

This study aims to investigate the stability of corneal topographic changes retrospectively after long-term customized OK lens wear.

Materials and Methods

Participants

- A list of files of persons having consulted CUV – myopia clinic- between January 2017 and 2019 was generated. Only persons with no previous contact lens experience were considered. A total of 256 files was first identified. A selection was then made based on the following criteria: participant must be fitted with OK lens design and had been wearing the same lenses and followed up regularly during at least one year. Consequently, a total of 99 files were kept for analysis. To proceed, a data set from one eye, randomly selected, for each participant, was compiled into an Excel file for further analysis.

Trial Lenses

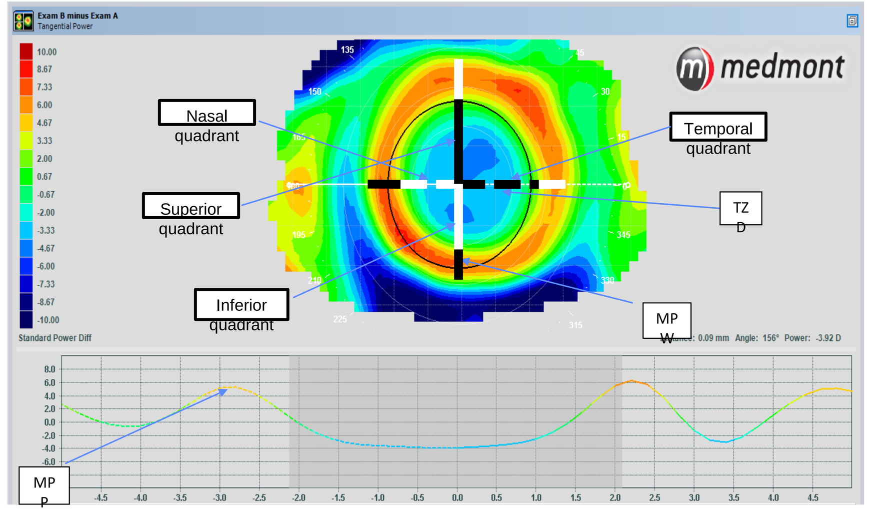
- Each participant was fitted with a reverse geometry lens, individually customized using RGP Designer software and a proprietary CUV template, the lens is designed with 7seven curves and its treatment zone diameter (5.4 to 6.0mm) is proportional to the pupil area of the participant, with a fixed sagittal depth in the reverse curve of 75 microns to generate high convex power independent of the refractive error to correct. A Jessen factor varying from 0.75 to 1.50 is applied. The base curve is made toric if the central cornea shows more than 2D of toricity. Peripheral curves are made toric if the difference between the two principal meridians, using elevation map along the 7 mm ring, reaches 20 um or more. Lens diameter is established to cover 95% of the corneal surface and curves width are balanced accordingly. Edges are profiled to limit tear exchange and favor optimal corneal tissue molding. The sagittal depth of the lens is adjusted through landing zone curves whenever necessary.

Procedure:

To assess the stability of orthokeratology over time, differential maps were generated (Figure 1) from baseline at 1, 3, 6 and 12 months post lens fitting, and evaluated separately in each of the four eye quadrants (Nasal, Superior, Temporal, and Inferior). A single trained reader performed all the analysis. A sample of 10% of the maps was selected and a second reader, masked to the first analysis, was asked to repeat the measurements. Their results were compared.

Corneal Topography:

- The following data were compiled for each eye:
- Treatment zone diameter (TZD): represents a zone where the cornea is flattened, thus generating a negative power (more concave) on the comparative power tangential map. The treatment zone was measured by quadrants from the pupil center as reference (Figure 1)
- Mid-peripheral power (MPP): represents the apex of the power curve displayed on the differential map (Figure 1), expressed in diopters.
- Mid-peripheral power ring width (MPW): represents a steeper corneal area, in millimeters, which generates a positive corneal power difference (more convex) between the baseline and post-fit on the comparative tangential map (Figure 1). The color changes identify the limits of each zone.



Axial Length measurement

Axial Length (AL) was assessed using a biometer (Lenstar LS 900; Haag Streit AG, Koeniz, Switzerland), from each subject, at every six months. Five consecutive measurements were performed at each testing session, and the values were averaged.

Statistical analysis:

- Analysis was made to assess the stability of treatment zone diameter (Zone), mid-peripheral power (Power), mid-peripheral power ring width (Width) over time. All of the analyses were done using SAS version 9.4 for Windows. The SAS procedure MIXED was used for model fitting.

Results

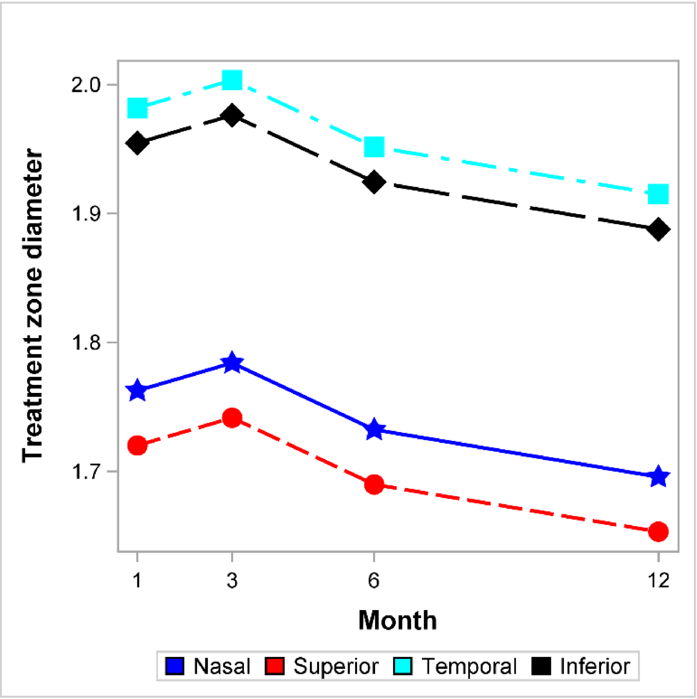
Descriptive results:

- The clinical population is initially composed with 99 Caucasian (46%) and Asian (54%), mostly female (57.7%),
- aged 11.7 + 2.1 years old. Characteristic of this population is shown in Table 1.

Variable	Value and SD
Flattest keratometry (KF)- Diopters	43.18 +/- 1.34
Steepest keratometry (KS)- Diopters	44.32 +/- 1.45
Cornea; Eccentricity- Flat meridian (EF)	0.49 +/- 0.16
Corneal Eccentricity- Steep meridian (ES)	0.31 +/- 0.202
Refraction (Diopters)	-3.27 +/- 1.28
Axial length (mm)	25 +/- 0.81

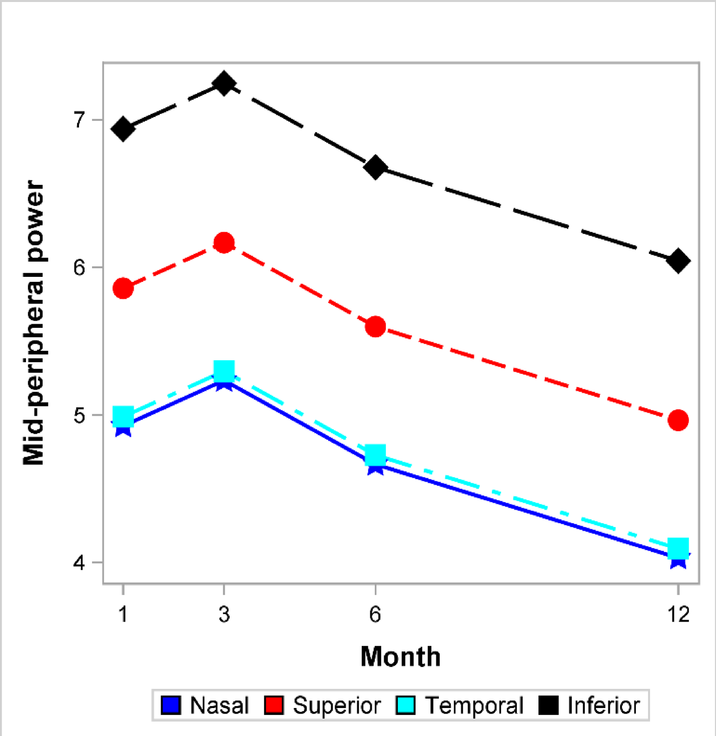
Treatment zone diameter:

There is no statistical difference between the diameter (TZD) found at 1 vs 3 months (p=0.35) or at 1 vs 6 months (p=0.19). However, the results indicate that the zone becomes significantly but slightly smaller at 12 months relative to baseline (-0.067; p=0.004).



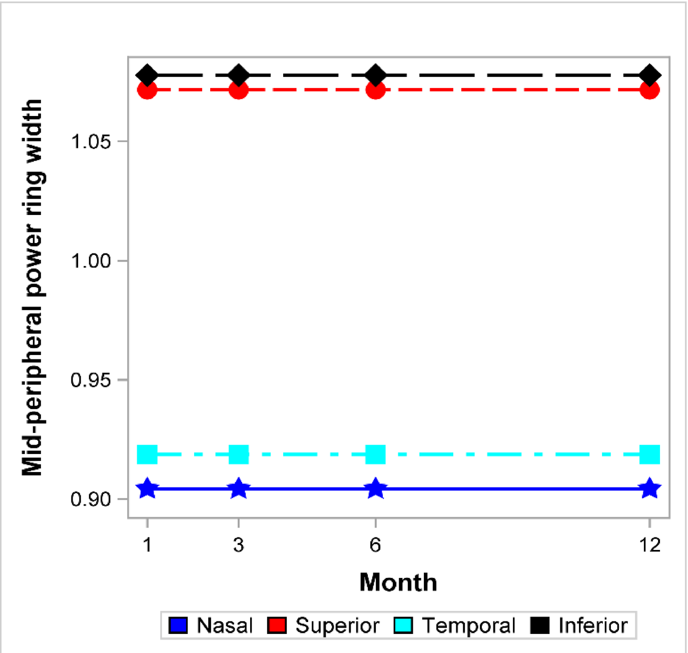
Mid-peripheral power (MPP):

After an initial increase at 3 months, MPP tends to be reduced over time. Similarly, to TZD, the only significant difference occurs at 12 months (MPP= -0.89D) relative to baseline (p<0.001).



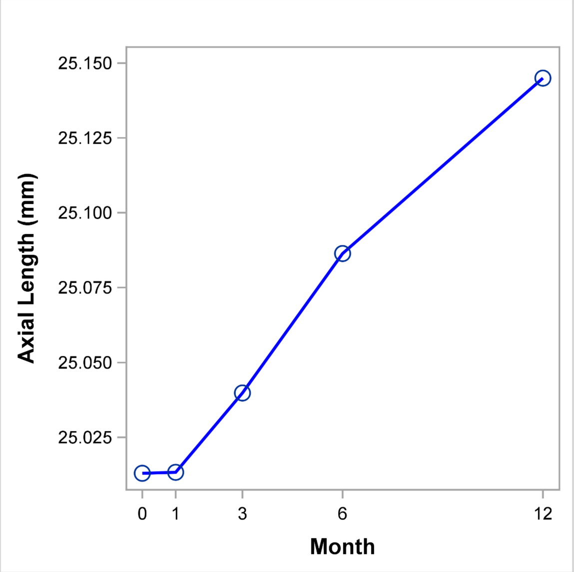
Mid-peripheral power ring width:

There is no significant difference over time. However, the inferior quadrant was found statistically different compared to the nasal, and the temporal quadrants (p<0.001), but not with the superior one.



Axial Lenght:

The increase at 3 months is not statistically significant (p=0.09). By 6 and 12 months however, the increases relative to baseline are statistically significant (p values <0.001), with estimated axial lengths at these time points of 25.24 + 0.073 mm and 25.24 + 0.132 mm, respectively.



Discussion

- This study proves that molding of the cornea, second to OK lens wear, remains stable up to 6 months after first lens application, but is varying on the long term, at 12 months. This may justify recommending changing lenses more often (6 to 12 months) to keep the cornea reshaped optimally over time. More precisely, the results of this study demonstrate that the treatment zone diameter becomes slightly smaller (-0.067mm), but more importantly, the mid-peripheral power decreased by almost 1D, whilst its width remain stable. The vertical quadrants (superior and inferior) have higher power and are larger compared to the horizontal ones (nasal and temporal). This is design dependent.

Conclusions

- This study shows that corneal molding second to the wear of customized OK lens is stable up to 6 months. However, mid-peripheral power becomes lower over a longer time (12 months). This result justifies evaluating and comparing topographical maps over time to adjust treatment and recommendations for lens care and wear.

References

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