Orthokeratology: Does a Smaller Treatment Zone Induce Progressive Benefits?

Austin Schipper, OD; Bruce Morgan, OD, FAAO; Stephanie Ramdass, OD, MS, FAAO

Ferris State University
Michigan College of Optometry
Vision Research Institute

Introduction

Orthokeratology (Ortho-K) is the process of reshaping the corneal curvature during overnight lens wear to correct refractive error. In June of 2002 the Food and Drug Administration (FDA) approved Ortho-K in the United States for treatment up to -6.00 diopters (D) of myopia with or without up to -1.75 D of astigmatism.[1] Since receiving FDA approval, patients of all ages have been experiencing the benefits of clear distance vision without correction. While children have an active accommodative system and notice no difference in near vision, patients with presbyopia require reading glasses or a variation in fit that provides mono-vision for near work.

Center-distance soft multi-focal contact lenses have a variety of power profiles to provide optical correction for distance and near.[7] Some designs have a 3 mm diameter center-distance zone that quickly transitions and plateaus to the add power at a 4 mm diameter (Figure 4). Poor distance vision, poor near vision, and dryness contribute to contact lens dropout in the presbyopic patient population.[8] Due to the complex power distribution in soft multi-focal lenses, centration is required for optimal vision, and any lens movement has potential to reduce both distance and near vision. Furthermore, the presence of a contact lens contributes to ocular dryness, potentially leading to additional lens movement and blurred vision.

Ortho-K lenses provide an option for distance correction without the dryness experienced from lens wear. This study aims to determine if patients with presbyopia appreciate a measurable difference in near vision by providing a treatment zone and power profile similar to a center-distance soft contact lens.

Methods

Participants in this study consisted of current multi-focal contact lens wearers with prescriptions within the FDA approval for Ortho-K lens wear. All participants had a comprehensive dilated eye examination within the last year and were able to achieve 20/20 vision at distance and near given appropriate corrective lenses. All participants were absent of ocular pathology. Nine participants, for a total of 18 eyes, were included in this study; eight participants were female, one participant was male. The average age of participants involved in this study was 51±5.14 years-old with a minimum age of 46-years-old and a maximum age of 61-years-old. The average spherical amount of myopia was -2.44±1.21 D with an average astigmatism of -0.43±0.43 D. The average ADD power determined by fused cross-cylinder (FCC) testing was 1.97±0.24 D. The average pupil size was 3.49±0.44 mm.

Participants were optimally refracted and baseline corneal topographies were obtained using a Medmont E300 corneal topographer. Paragon Vision Science Corneal Refractive Therapy (CRT) lenses were then selected by using the fitting card provided in the trial lens set. Participants returned for a one-day follow-up to ensure centration and again at one-week to repeat baseline measurements.

At the one-week follow-up, corneal topographies were repeated to determine treatment zone size and magnitude of correction. Participants were refracted to correct for any residual refractive error and FCC testing determined the ADD. Monocular near visual acuity was tested through optimal distance correction without an ADD. Refractive difference maps were used to determine treatment zone size (Figure 1); axial difference maps were used to determine the change in power at a given diameter (Image 1). Average treatment was determined at 0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 3.50, 4.00, and 4.50 mm around the apex of the cornea (Figure 2).

Results & Discussion

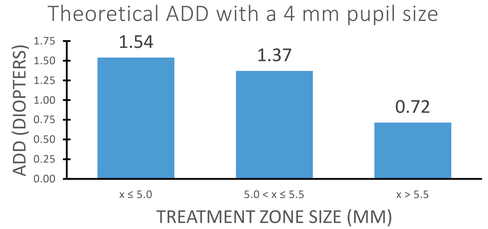

Figure 1: Comparison between treatment zone size and overall ADD at a 4 mm pupil

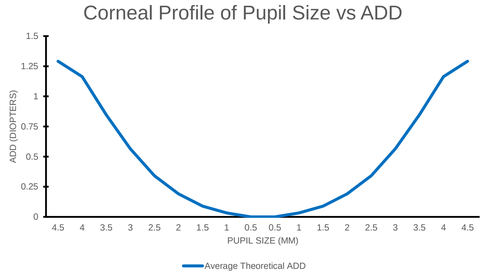

Figure 2: Average ADD in the periphery given pupil size

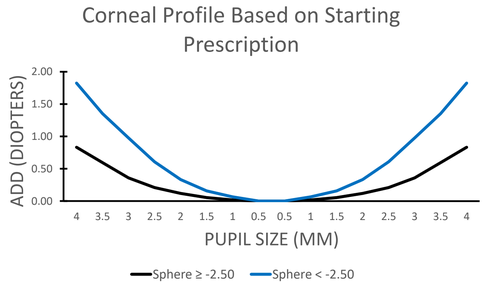

Figure 3: Average ADD in the periphery for starting prescriptions greater and less than -2.50 D

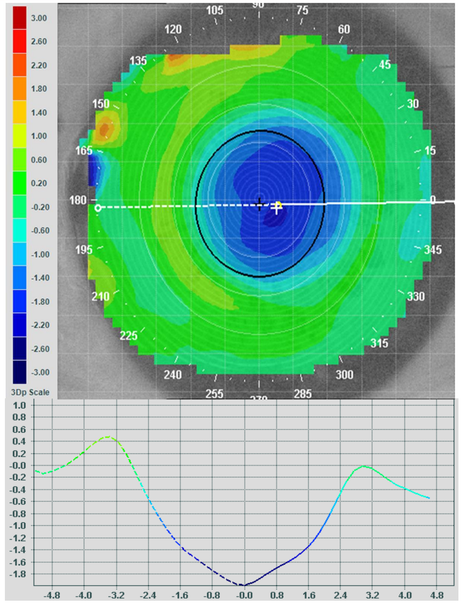

Image 1: Axial difference map with power profile from center of cornea to periphery

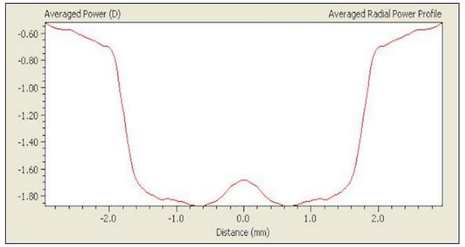

Figure 4: Power profile of a center-distance -2.00 soft multi-focal lens with a +2.00 ADD

Results & Discussion

- Axial difference maps indicate a smaller treatment zone is correlated with a higher magnitude of ADD in the periphery (Figure 1).
- An average of all the axial difference maps suggests a 4.5 mm pupil should experience an average of 1.29 D ADD (Figure 2).
- Myopia greater than 2.50 D displays an axial difference map that indicates a higher ADD in the periphery than if 2.50 D or less (Figure 3).
- Accurate replication of a center-distance soft multi-focal power profile was difficult to attain with the Paragon CRT lens. (Image 1 and Figure 4).
- Unaided near vision improved by one line for 10 eyes and was unchanged in eight eyes. There was no correlation between treatment zone size and improved visual acuity.
- Average FCC testing prior to treatment was 1.97±0.25 D, when repeated following treatment, average FCC testing was 1.92±0.17 D.
- Five subjects reported they were happy with distance and near vision and wanted to continue wearing Ortho-K lenses.

While axial difference maps indicate an average of 1.29 D ADD through a 4.5 mm pupil, this does not appear to reflect a significant improvement in unaided near vision. This suggests a disconnect between topographical axial difference map findings and a clinically significant change in ADD power. Important to note, FCC testing is not consistent with subjective results in all cases and may not be an accurate measurement of near success in presbyopic patients in Ortho-K.

Conclusion

Further research is required to determine if lens parameter changes (i.e. smaller optic zone, variation in reverse geometry curves) can be made to provide a similar power profile to center-distance multi-focal contact lenses and if those changes induce a clinically significant change in uncorrected near vision. The population of patients with presbyopia continues to grow and their visual needs must be met in order to improve contact lens dropout rates. The technology provided by Ortho-K lenses has the potential to be one way of meeting the visual and comfort demands of the presbyopic population.

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