Objective & Subjective Visual Response to Decentered Multifocal Optics

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Introduction

When simultaneous designed multifocal contact lenses are fit on presbyopic patients, concentric optics are designed under the assumption that the optical center aligns perfectly with a wearer's line of sight or visual axis. However, a lens placed on eye is not guaranteed to perfectly center (Fig.1).

This study evaluated what effects, if any, apparent alignment of near-center multifocal optics in relation to subject's visual axis has on overall success of multifocal contact lens wear.

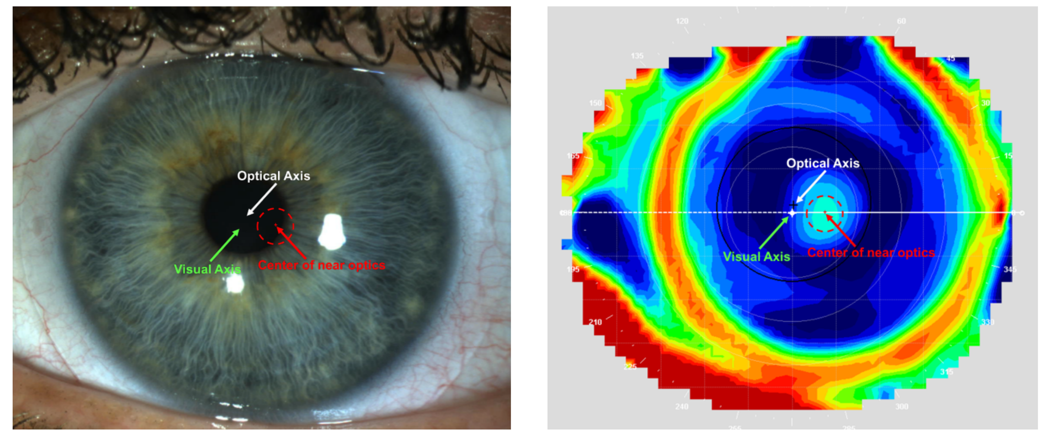


Fig. 1. A tangential difference map overtop a near-center multifocal contact lens, OS. The landmarks of interest are highlighted (*right*). Overlay of the exact same landmarks onto a lens on eye, OS, show the potential positioning of near optics temporal to the visual axis (*left*).

Methods

Twenty-One (21) subjects who met the Ferris State University's Institutional Review Board approved study protocol criteria were enrolled in this randomized, masked clinical trial.

During the initial visit, baseline measurements were acquired and a diagnostic fitting of the SpecialEyes 54 Multifocal Contact Lenses in Hioxifilcon D material occurred. Topography was performed overtop the lenses. The distance from the visual axis to the approximate center of near optics was measured using the instrument's built-in software to determine the mismatch between the two points. Two pairs of lenses were ordered, one with centered optics and the other with optics displaced nasally 1.0 mm.

Methods

At the follow-up visit, the first set of lenses were placed on eye and settled for a minimum of 10 minutes before evaluating. Once appropriate fit was confirmed via slit lamp evaluation, topography was performed overtop the lenses to again measure the amount of mismatch. LogMAR visual acuity at both distance and near were recorded.

Additionally, each subject rated their binocular distance and near visual acuity, and their ability to view the following specific targets held at set distances:

1. Article in a magazine
2. Email on a cell phone
3. Usage instructions on an eye drop bottle

For each viewing tasking, subjects were asked, "*On a scale from 1 to 10, with 10 being the best vision and 1 being the worst, how would you rate the quality of your vision*?" All near sighted tasks were performed at 16 inches in a light – controlled exam lane. The same procedures were repeated for the second set of lenses.

Results

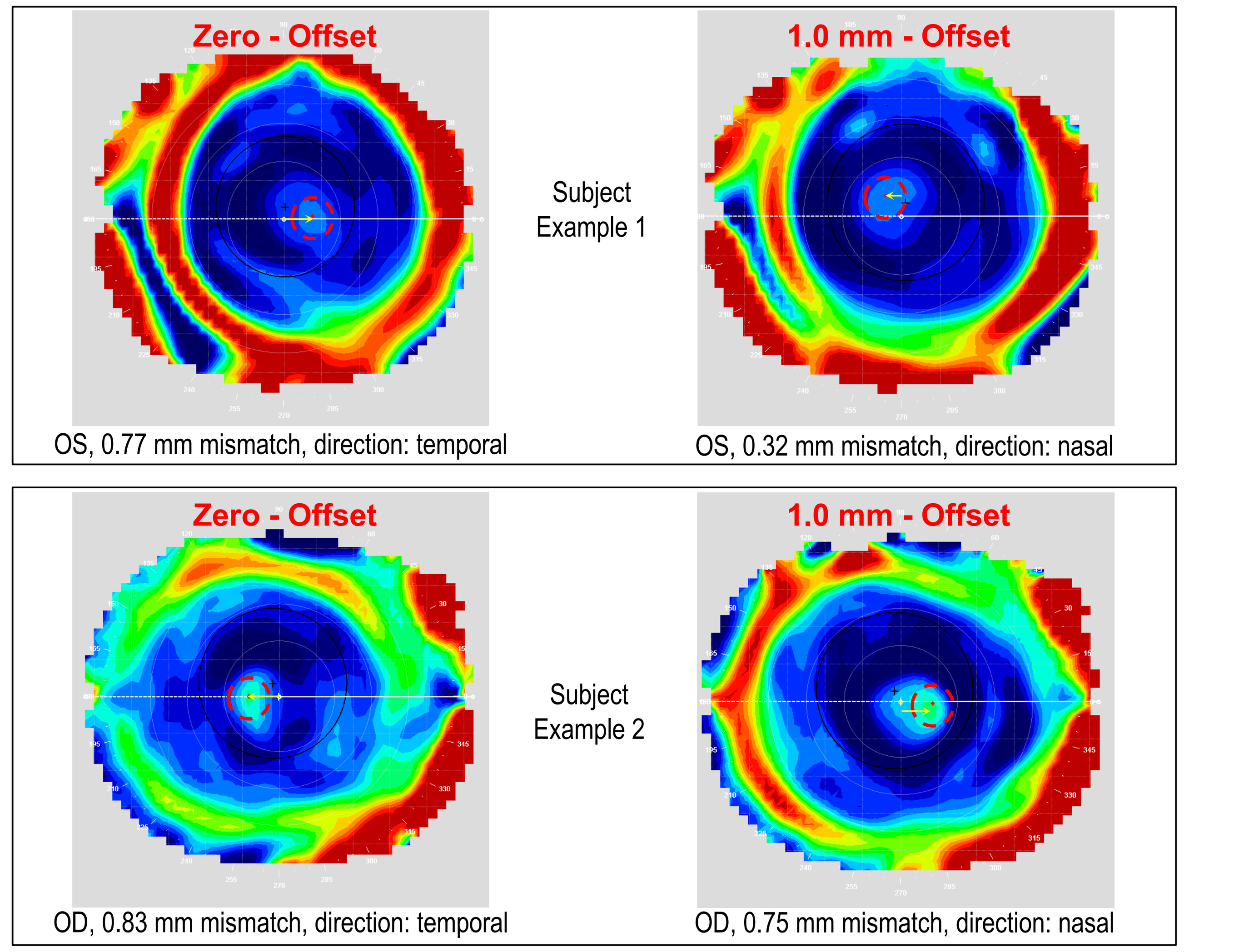
The average age of our cohort was 53.8 years (+/- 6.5) with a refractive prescription range of +2.50D to -5.25D (sph), -0.25D to -1.75D (cyl), and +1.00D to +2.50D (add).

	OD (mm)		OS (mm)	
Average (St Dev) Pupil Size Ambient Light = 201 lux (+/- 6 lux)	3.78 (+/- 0.77)		3.85 (+/- 0.75)	
Average (St Dev) Diagonal Visible Iris Diameter	11.41 (+/-0.34)		11.47 (+/- 0.74)	
Average Mismatch (+ = Temporal)	1.0 mm Offset	Zero Offset	1.0 mm Offset	Zero Offset
	-0.02 (+/- 0.36)	0.64 (+/- 0.21)	-0.19 (+/- 0.17)	0.78 (+/- 0.22)

Table 1. Summary of select baseline data (average pupil size and visible iris diameter) and average mismatch values that were measured while wearing each pair of lenses during the second study visit (See subject examples).

Results

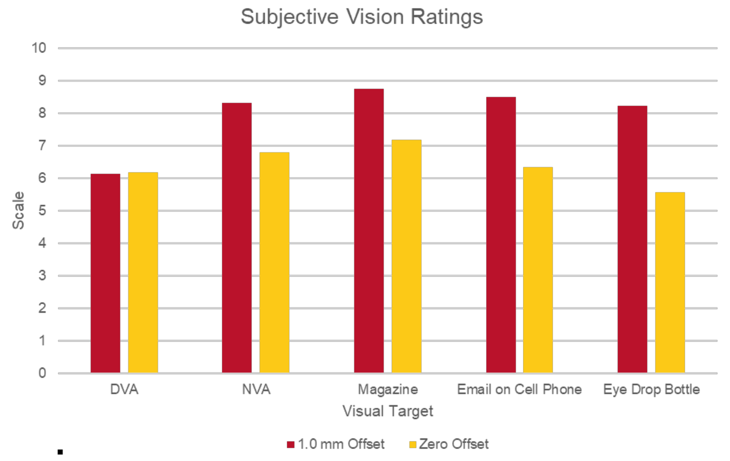
Difference topography maps were utilized comparing no lens wear at baseline with multifocal lens wear, both zero offset and 1.0 mm offset near optics, at study visit #2. The average mismatch values along the horizontal meridian were measured (Table 1).



All (100%) of measured mismatches were located temporal to the visual axis for the zero offset lenses compared to 61% in the 1.0 mm offset lenses. The average binocular distance visual acuity (DVA) while wearing the 1.0 mm offset lenses and the zero offset lenses were 0.08 (+/- 0.07) and 0.11 (+/- 0.12), respectively. The average binocular near visual acuity (NVA) while wearing the 1.0 mm offset lenses and the zero offset lenses were 0.03 (+/- 0.09) and 0.09 (+/- 0.10), respectively.

A critical p-value (α) of 0.05 was used to denote statistical significance. There was no statistically significant difference (SSD) in objective measurement of distance visual acuity with either lens pair ($p = 0.43$).

Results



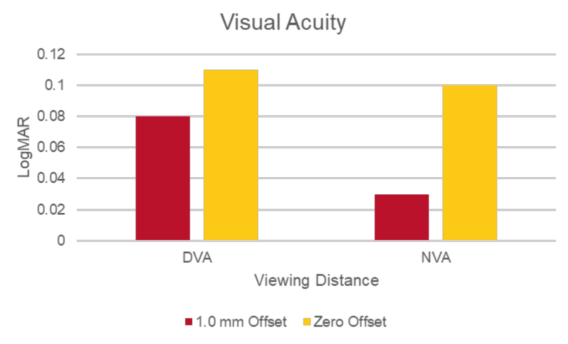


Chart 1 (*left*) shows average subject ratings when view various targets at different distances.
Chart 2 (*right*) shows the average LogMAR acuity, distance and near, for each lens pair worn.

However a SSD exists at near viewing distances ($p = 0.04$) and in subjective responses when viewing various targets, with 19 out of 20 subjects who completed the study favoring the lens pair with offset near optics.

Discussion & Conclusion

This evaluation found that a 1.0 mm nasal offset of near optics provided both a statistically and clinically significant difference for subject performance and preference when viewing various types of near targets. Distance viewing was similar regardless of lens pair worn.

Although the difference in near viewing is quantitatively equivalent to approximately one line of objective visual acuity in an exam lane, subjectively there was a significant increase in quality of vision. Examples of feedback directly from subjects while wearing multifocal lenses with offset near optics as compared to the pair with zero offset optics:

- *There are no overlapping letters.*
- *I have less of a 3D effect.*
- *The double letters are gone.*
- *I don't see a halo around the letters anymore.*

Quality of vision can be improved by nasally decentering the optics in near-center multifocal lenses. Further analysis is ongoing.

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