How Important Is Optical Placement in Multifocal Lenses?

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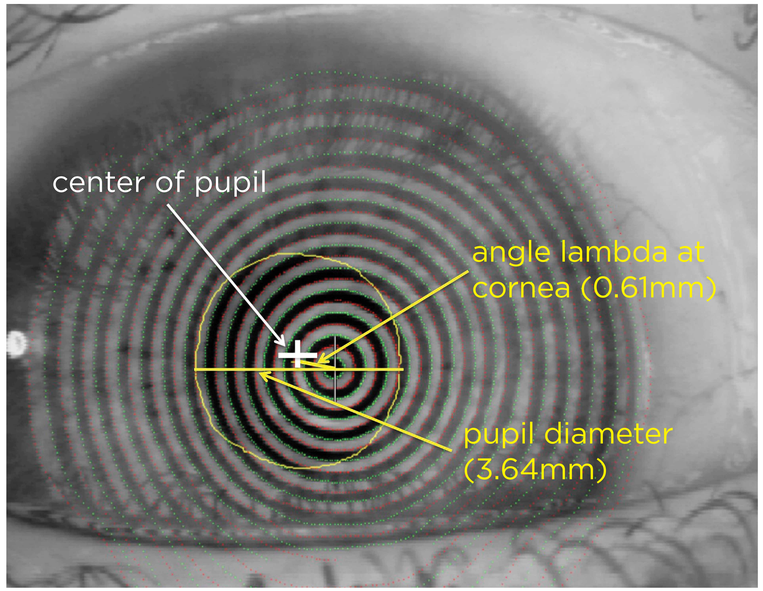

Figure 1 Distance between visual axis and pupillary axis as identified with the Keratron Scout topographer.

Introduction

Angle lambda (or angle kappa) has been well defined in the literature as the angle between the pupillary axis and visual axis. In most individuals, there is a positive angle lambda resulting from a visual axis that is nasal to the pupillary axis. There is significant individual variability in this angle based on the anatomical relationship between the fovea, lens, pupil and cornea.[1]

Although it is possible to calculate the actual angle, this is seldom performed clinically. It is a relatively easy task to determine where the visual axis and the pupillary axis intersect the cornea by simply having a patient view a fixation light, then viewing the light reflex off of the cornea and comparing it to the location of the pupil. The actual distance can be measured using a topographer (Figure 1).

When a patient views a fixation target, the visual axis can be mapped. This is the direct line from the object to the portion of the fovea with the highest level of resolution, which is indicated by the center of the Placido ring image on the cornea. The geometric center of the pupil represents where the pupillary axis intersects the cornea. By measuring the distance between where the visual axis and the pupillary axis intersect the corneal plane, we can determine how great of a discrepancy there is between these axes. Many contemporary topographers will perform this measurement automatically.

A patient's success or failure in adapting to multifocal contact lenses is often relative to the patient's expectations; however, there are cases where that does not adequately explain a failed outcome. Angle lambda can be one of the critical predictors of success with soft, simultaneous-design, multifocal contact lenses. Most commercially available soft multifocal lenses contain their optics on the front surface of the lens, which makes it feasible to visualize the various zones of a multifocal contact lens using a topographer.[2]

Unfortunately, if this measurement is taken and the lens optics do not align over the line of sight, there is not currently a simple way to realign the lens optics over the line of sight. This case report will review the outcomes for a patient who was fit with a novel, soft, simultaneous-design, multifocal contact lens in which the multifocal optics were manipulated so the near optics were aligned with the patient's line of sight.

Methods

The subject of this case report is a 43-year-old female wearing simultaneous-design soft multifocal contact lenses in both eyes. The current lens design was optimized for both distance and near vision. Even with optimization, the patient always felt that her near vision wasn't as good as she wanted it to be. All ocular health findings were normal. Her manifest refraction was:

OD -1.00-0.25 x 065 20/20
OS -1.00 sph 20/20
Add +1.50 OU 20/20

Pupil diameter was measured with a Keratron Scout topographer, as shown in Figure 2. The patient's pupil diameter in bright illumination was OD 2.86 mm and OS 2.87 mm, as denoted by the green ring in the topography. The patient's pupil diameter in dim illumination was OD 5.34 mm and OS 5.52 mm, and is denoted by the red ring in the topography. The large cross denotes the line of sight, while the small crosses denote the geometric center of the pupil. The green cross indicates the center of the constricted pupil and the red cross indicates the center of the dilated pupil. The distance between the visual axis and the geometric center of the pupil and the direction in degrees from the visual axis in bright illumination were OD 0.49 mm @ 171 and OS 0.54 mm @ 020. The measurements under dim illumination were OD 0.50 mm @ 176 and OS 0.56 mm @ 015.

The patient was initially fit with prism-ballasted hioxifilcon D 54% diagnostic lenses with the following parameters:

OD -3.00 / +1.50 add / 8.2 / 14.6
near-center diameter 2.0 mm offset 0.30 mm nasally
OS -3.00 / +1.50 add / 8.2 / 14.6
near-center diameter 2.0 mm offset 0.30 mm nasally

During subsequent over-refraction and fit assessments, topography over the 0.30 mm offset center-near multifocal lenses revealed a 0.30 mm difference between the patient's line of sight and the center of the near optics (Figure 3a). A set of trial lenses was ordered to address this discrepancy, increasing the nasal offset from 0.30 mm to 0.60 mm to align the center of the near optics over the patient's line of sight. The patient was refit with prism-ballasted hioxifilcon D 54% lenses with the following parameters:

OD -1.00 / +1.50 add / 8.4 / 14.6
near-center diameter 2.0 mm offset 0.60 mm nasally
OS -1.00 / +1.50 add / 8.4 / 14.6
near-center diameter 2.0 mm offset 0.60 mm nasally

Topography over the new 0.60 mm offset, near-center multifocal lenses confirmed alignment of the center-near optics over the patient's line of sight (Figure 3b).

The trial lenses were dispensed to the patient, who was instructed to remove the lenses in the evening and clean and store them with Opti-Free PureMoist. The patient returned for evaluation one week after dispensing and again four weeks after dispensing, and was asked several questions about real-world conditions and experiences with the study lenses.

Results

During the follow-up evaluations, a standard Snellen near point card was used to determine the patient's level of near vision. With her habitual lenses, she could only read the 20/40 line with both eyes. With the study lenses, the patient was able to obtain OU 20/20 near visual acuity at dispensing and OU 20/25 near visual acuity at the final visit. While the patient reported no noticeable improvement when viewing computer screens or her cell phone, she did score the near vision as better when looking at printed material. At the conclusion of the study, the patient was asked which lenses she preferred overall; she stated that she preferred the study lenses and wished to continue with them.

Discussion

Many factors contribute to the success of multifocal contact lenses. As this study has shown, the alignment of the lens optics can be of great importance. The optics of soft, simultaneous-design, multifocal contact lenses can be optimized by prism-ballasting the lens and moving the optics so that they are centered over the patient's line of sight. This is a proof-of-concept lens that proved successful.

Four other patients were fit following a similar procedure, using a similarly designed lens with appropriate lens powers and optical centration. The most notable finding for all of the patients was their subjective improvement in near vision.

This seems to be a viable strategy for future investigation with larger numbers of patients to determine the true magnitude of improvement. It may also provide a solution for patients seeking alternatives to currently available presbyopic lens correcting options.

Conclusion

A new lens design that offers the opportunity to de-center the multifocal optics and align with a patient's visual axis may provide a promising outlook for patients with a large angle lambda. This case report demonstrates the success that is possible with such a design.

Special Thanks

To SpecialEyes, for supporting this research and for the flexibility in providing the lenses that were used.

To Patrick Caroline and Matthew Lampa, for introducing me to the concept of "line of sight" and its importance in multifocal lens fittings.

References

1) Benjamin, William J. "Chapter 10: Ocular Motility." Borish's Clinical Refraction. 2nd ed. Butterworth-Heinemann, 2006. 329-330. Print.

2) Lampa, Matthew; So, Kelvin; et al. "Assessing Soft Multifocal Contact Lens Centration With the Aid of Corneal Topography"; poster presented at Global Specialty Lens Symposium; 2013.

Figure 2 Right eye and left eye topography of the bare cornea prior to multifocal fitting. The large cross represents the patient's line of sight, while the small red and green crosses indicate the geometric center of the pupils. The green ring represents the constricted pupil in bright illumination and the red ring denotes the dilated pupil in dim illumination. As evident by topography, there is approximately a 0.50 mm difference between the geometric center of the pupils and the patient's line of sight.

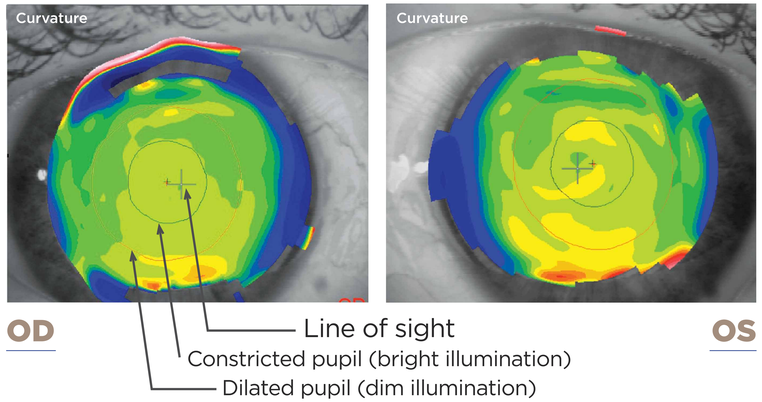

Figure 3a Right eye topography performed over multifocal lens with 0.30 mm de-centered optics. Notice the approximate 0.30 mm mismatch between the center of the near optics and the patient's line of sight.
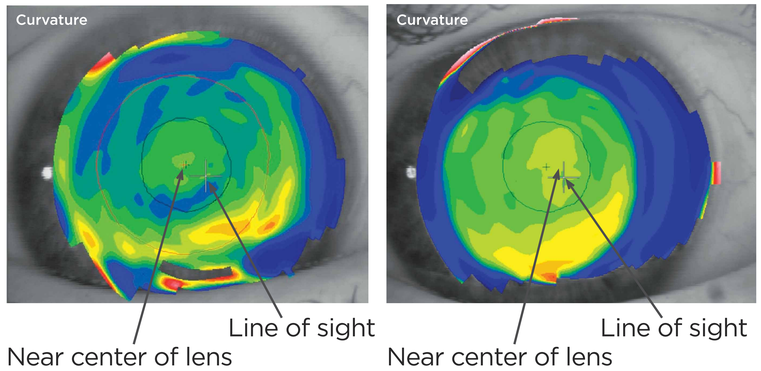
Figure 3b Right eye topography performed over multifocal lens with 0.60 mm de-centered optics. The increase in the amount of de-centering in the multifocal optics more closely aligned the center of the near optics with the patient's line of sight.