Instantaneous Power Profile vs Sagittal Power Profile of EDOF Multifocal Lens and Clinical Correlations

Peg Achenbach, OD, Rosa Lee, MS
Visioneering Technologies Inc., Alpharetta, GA

Introduction

Multifocal contact lenses vary, even within center-near and center-distance designs. Understanding the optical design of multifocal contact lenses may help predict how the lens will perform on the eye and clinically. This poster describes the power profile of an etafilcon A, extended depth of focus (EDOF) center-distance design that has a highly aspheric optic zone, and how we believe it correlates to clinical performance. Utilizing differential geometry, a mathematical discipline that describes the shapes of curved surfaces, a custom algorithm was developed with Lambda X to describe the instantaneous power profile of contact lenses. This description helps us understand the optical characteristics of this EDOF multifocal design, and supports the hypothesis that the uninterrupted plus power of this design contributes to the clinical outcomes.

The objective of this study was to use a custom algorithm to analyze the power profile of a commercially available multifocal contact lens and hypothesize a correlation to the clinical performance.

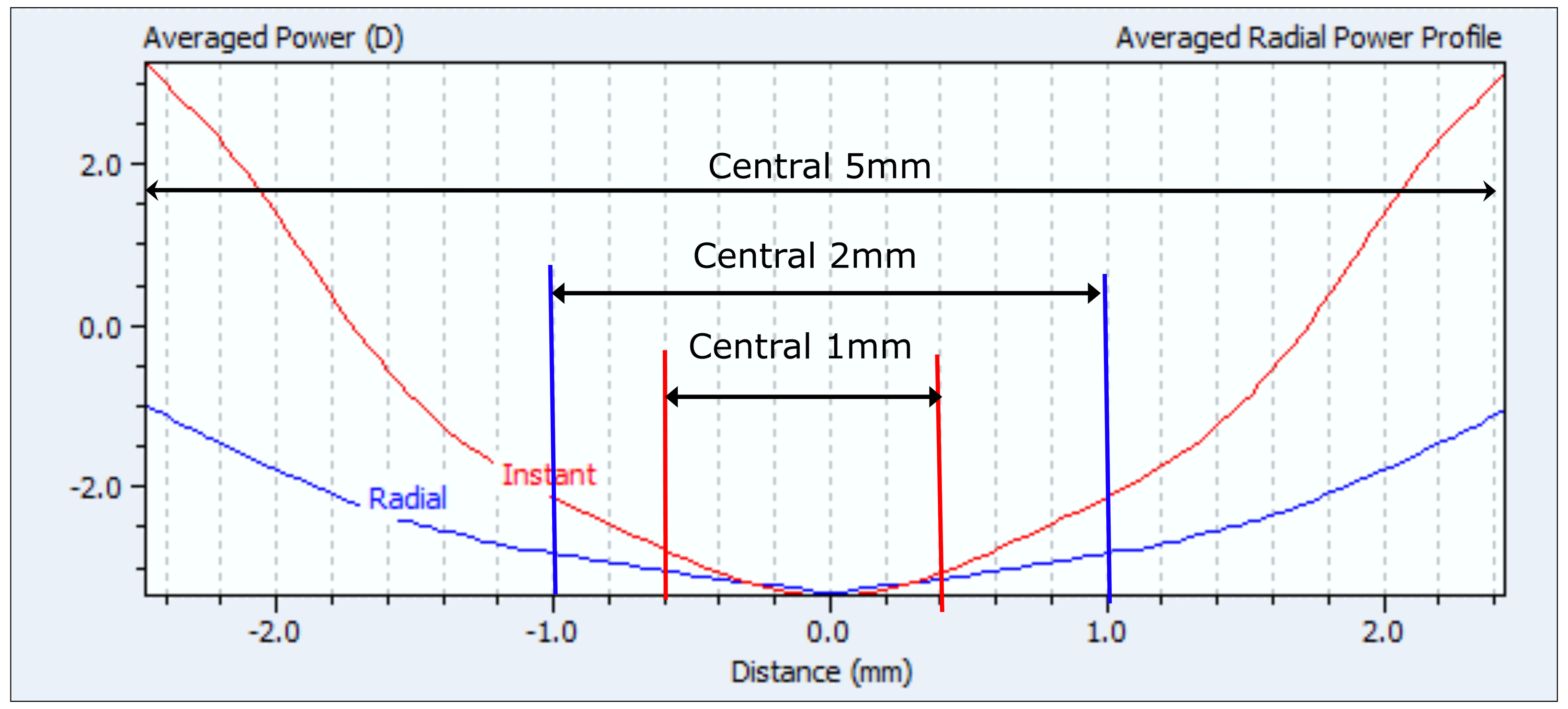
Methods

-3.00D power lenses of etafilcon A, EDOF were analyzed on a Phase Shifting Schlieren wavefront sensor, NIMO TR1504 [Lambda-x]. The lenses were placed inside a cuvette, with it's own packaging solution. The material's refractive index of 1.402 was used in the measurements. Using the customized algorithm, both sagittal (traditional) and instantaneous (new) data was exported. Measurements were averaged to analyze the results. The average power was analyzed over multiple zones to understand the power progression of this design over the central 5mm pupil zone.

Additionally, objective and subjective visual results, including LogMar visual acuity, stereoacuity and depth of focus, or range of clear vision data were gathered using the etafilcon A, EDOF lens design in a prospective, single masked, one week clinical.[1] In this clinical of the etafilcon A lens, the age range of the subjects was 43-65 years old and the add power range was +1.00D to +2.75D.

- NIMO TR1504 (Lambda-X)
- Phase-shifting Schlieren measurement technology
- λ = 546 nm
- High resolution radial power maps and power profiles
  - Imaging device 1024 x 1024 pixels
  - Spatial resolution 18 x 18 μm^2
- Outputs: Sagittal and Instantaneous power maps and power profiles

Results

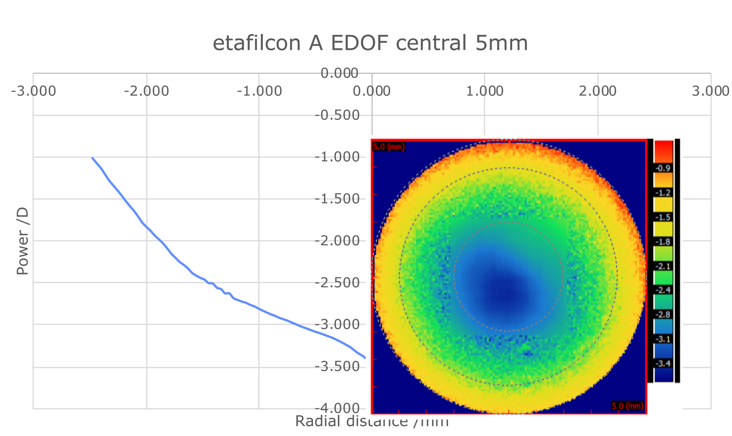


The first part of the analysis looked at the power difference between 5mm and the center of the lens, as this is often labeled the 'ADD' of the lens. The sagittal power difference for the etafilcon A, EDOF lenses was found to be 2.39D. The instantaneous power difference for the same lenses was found to be 6.44D. (Absolute power differences are reported)

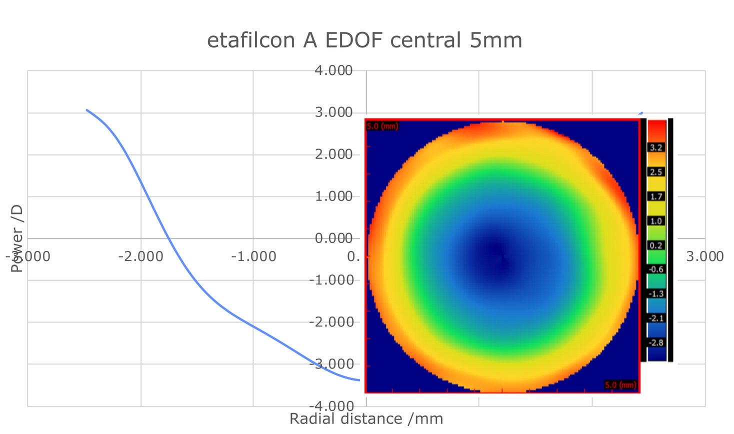
The absolute power difference between the edge of the optic zone and center doesn't tell the whole story, as evidenced by the graphs demonstrating the uninterrupted plus power profile of the etafilcon A, EDOF lens.

This power profile of an EDOF center distance design with a highly aspheric optic zone is unique in the smooth progression of plus power throughout the optic zone.

Sagittal Power profile

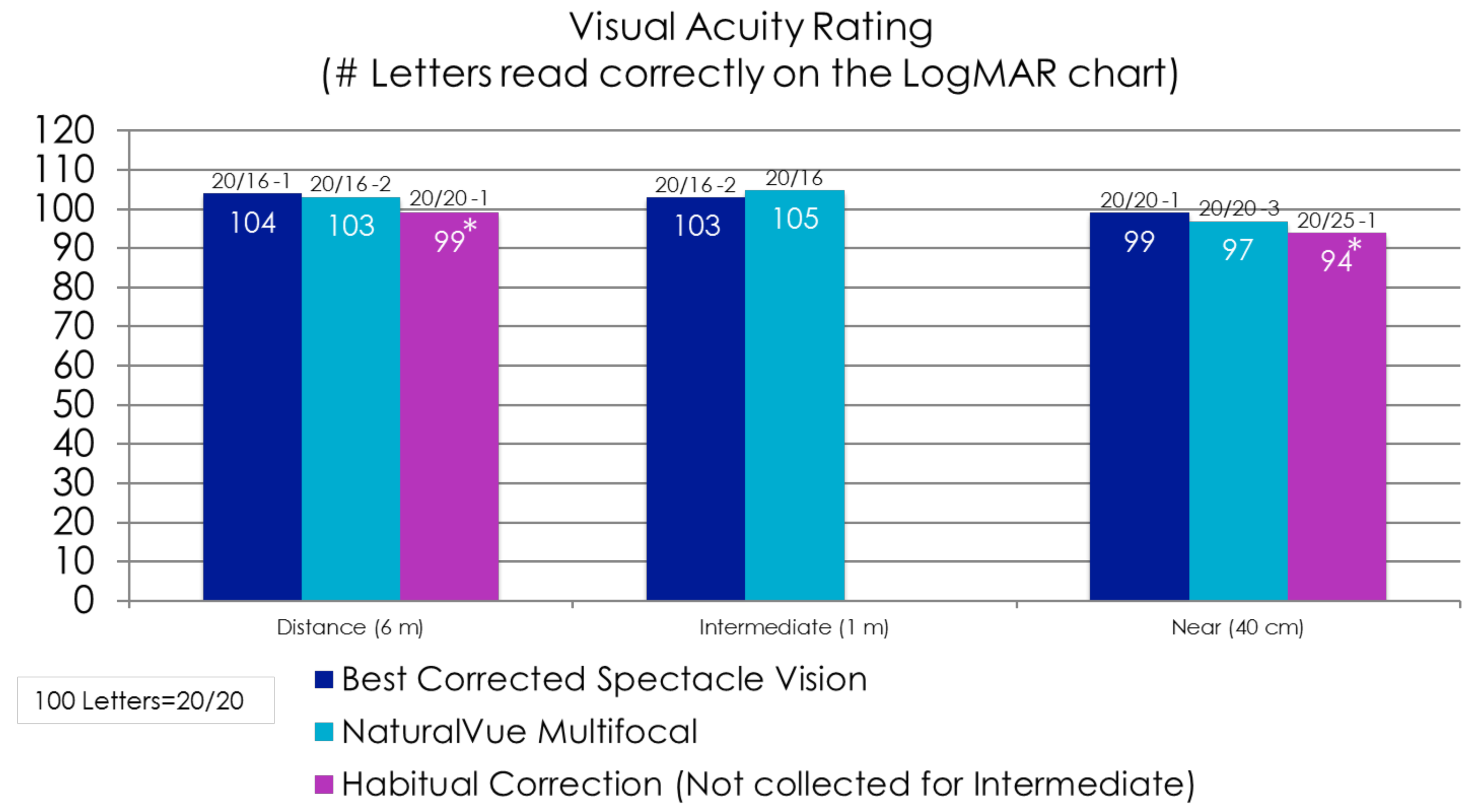


Instantaneous Power profile

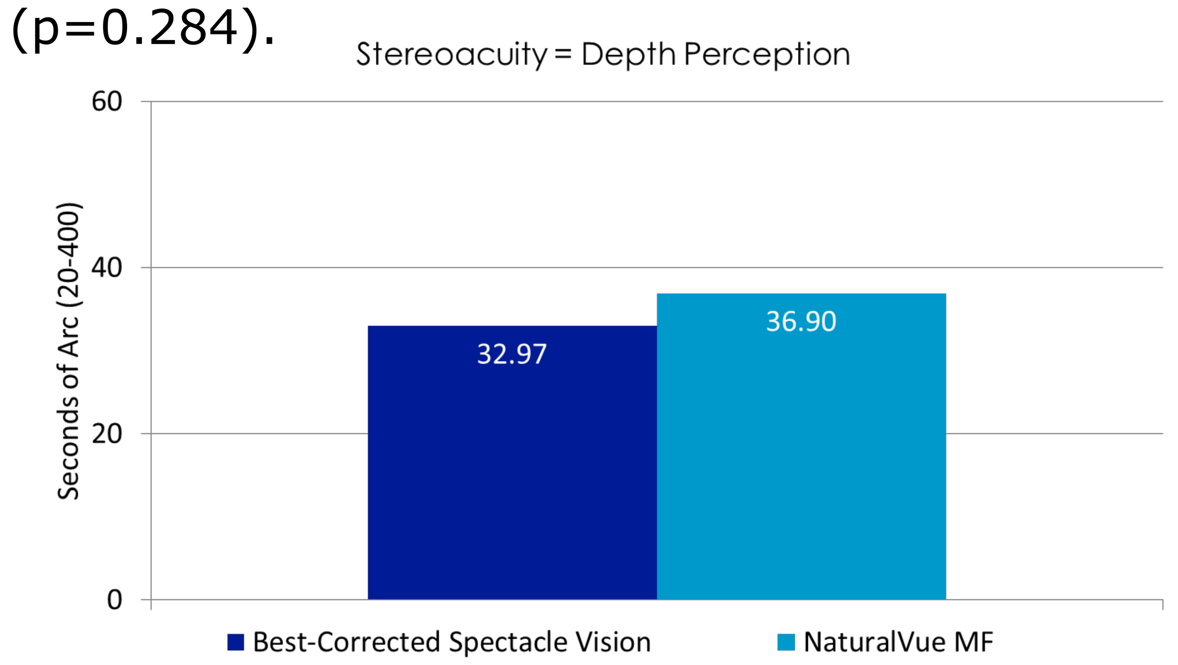


In the clinical[1], a visual acuity rating (VAR) was used to quantify the number of letters read correctly on a LogMAR chart, with 100 letters equal to 20/20 on the Snellen chart, 105 equal to 20/16, and so on. VAR for the EDOF lens was found to be within two letters of best corrected spectacle vision (BCSV), with a VAR score at distance (6m) of 103, intermediate (1m) 105, and near (40cm) 97. There was no statistically significant difference between BCSV and the EDOF lenses (p>0.05), yet there was a statistically significant difference between the habitual correction type as compared to both BCSV and the EDOF lens.

Results



Stereoacuity was measured at one week using the Randot E Stereotest, comparing the BCSV to the EDOF lens. The average stereoacuity score for BCSV was 32.97 ±17.6 seconds of arc and the test lens was 36.90 ± 21.6 seconds of arc. A two-sided t-test of unequal variance showed no statistically significant difference between the stereoacuity score for BCSV as compared to the EDOF lens (p=0.284).



For the EDOF lens, the average far point was 103 cm (0.97D) and the average near point at 27 cm (3.70D), versus at baseline with correction, the average far point was 68 cm (1.47D) and the average near point at 28 cm (3.57D). The average depth of focus was 76 cm for the EDOF lens as compared to 40 cm at baseline with correction.

Conclusion

There are different ways of interpreting the power profiles that best describe the design intent. Instantaneous power illustrates the power profile more accurately for progressive aspheric type designs. Regardless of the method used to describe the power profile, the smooth, uninterrupted progression of plus power throughout the optic zone is clearly demonstrated. We believe that this unique EDOF design, and the uninterrupted plus power profile, contribute to the excellent visual performance and positive clinical outcomes.

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1. VTI data on file 2015. n=59. Data assessed after 1 week of wear. At p<0.05. No statistically significant differences were obtained between BCSV and NaturalVue® Multifocal 1 Day contact lenses.

Contact information:
Peg Achenbach, OD
Visioneering Technologies, Inc
Email: pachenbach@vtivision.com