Distribution of power

Dr Alexis KS Vogt, **Kirk Bateman**, **Tim Green** and **Bill Reindel**

describe the use of power maps to evaluate aspheric multifocal contact lenses

The demand for multifocal contact lenses continues to increase with an ageing population. Although aspheric optics are commonly used to provide simultaneous vision correction for presbyopes, limited optical design information is available to assist practitioners in lens selection.

Historically, Hartmann-Shack instruments have been used to create wavefront maps of second order aberrations associated with contact lenses. Colour maps that highlighted change in aberrations provided some information associated with the optical design, Figure 1. This colour map of a traditional spherical lens highlighted that the design was rotationally symmetric, and the colour scale provided insight into the optical quality of the lens, but did not intuitively provide information on the refractive characteristics of the lens. A new generation of Hartmann-Shack wavefront-sensing instruments which apply high lateral resolution are now available for evaluation of mapping lens power across a contact lens. These instruments record more than 2,800 unique measurements over the central 6mm of the lens.

This new generation of Hartmann-Shack instruments displays data as a plot of the local power measurement as a function of radial distance from the centre of the lens. Figure 2 illustrates the resulting power profile from this same spherical contact lens, where each point represents the measured power over a narrow annular zone. This plot shows the power of the lens from the centre (on the left side) out to the periphery of the optical zone (on the right side). With the traditional spherical contact lens, the power profile remains relatively uniform across the optic zone.

A power profile resulting from the measurement of an aspheric multifocal contact lens is illustrated in Figure 3. The aspheric optical design results in the local power changing across the optic zone of the lens, becoming more negative toward the periphery. In contrast to the spherical lens with a uniform power profile, the power of the

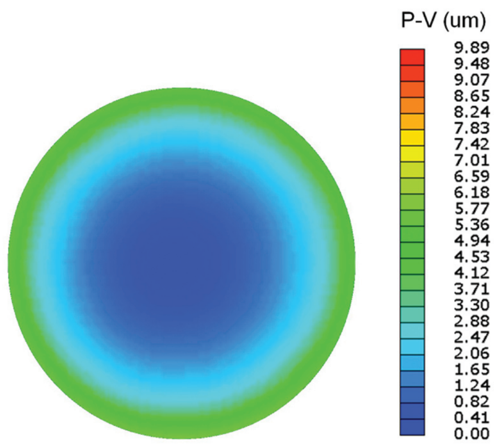

Figure 1 Wavefront map of a -3.00D traditional spherical contact lens

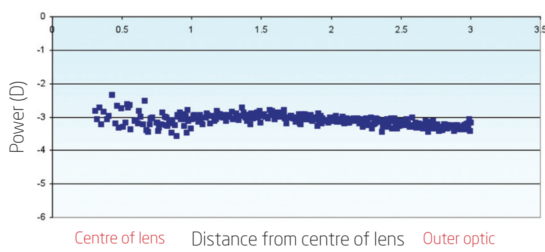

Figure 2 Power profile of a -3.00D traditional spherical lens

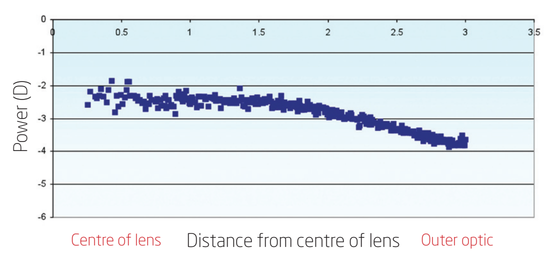

Figure 3 Power profile of a -3.00D aspheric multifocal contact lens

aspheric multifocal contact lens shows greater difference in the measurements between the centre and the periphery of the optic zone.

These power maps can be a useful tool to compare multifocal contact lenses that integrate aspheric optical designs. Both the Bausch+Lomb PureVision Multi-Focal and CIBA Air Optix Aqua Multifocal lenses use aspheric optical designs to create centre-near adds. The PureVision design addresses the needs of emerging, functional, and absolute presbyopes with two different add powers, while the Air Optix Aqua design offers three add powers. To compare similarities and differences between designs, high resolution Hartmann-Shack wavefront measurements were gathered for PureVision Multi-Focal Low Add (PVMF LA), PureVision Multi-Focal High Add (PVMF HA), CIBA Air Optix Aqua Lo Add, Med Add and Hi Add lenses. For reference purposes, single-vision PureVision and CIBA Air Optix Aqua lenses were also measured.

For each design, three -3.00D lenses were measured and the median of the three measurements was plotted. Figure 4 shows the resultant power profiles for the three Air Optix Aqua multifocal designs. These results highlight similar power profiles for the Air Optix Aqua Med Add and Hi Add lenses, and a distinct Air Optix Lo Add profile.

To compare add powers associated with these three designs, a representative add power was calculated, averaging the power measurements over the central 1mm radius (2mm diameter) of the lenses. Add differences within 0.25D were considered to represent the same add from a clinical perspective. Analysis determined the mean lens powers over the central 2mm diameter for the centre-near Med Add and Hi Add Air Optix Aqua multifocals were -1.70D and -1.59D, respectively. The difference in add powers of 0.11D (95 per cent CI: 0.02, 0.20D) did not meet the criterion of being different by 0.25D and hence the Med Add and Hi Add multifocals could be considered as having a similar add. The mean central lens power for the Lo Add Air Optix multifocal was -2.75D and was considered distinct from the Med and Hi Add lenses.

Figure 5 illustrates the power profiles of Air Optix Lo Add and CIBA Air Optix single-vision spherical lenses. The spherical lens power profile was relatively flat, and the mean power in the central portion of the lens was -3.01D. The profiles illustrate the aspheric nature of the Lo Add design as indicated by the changing slope of the power profile. The difference in means between the spherical lens and the Lo Add Air Optix lens was 0.26 D (95 per cent CI: 0.18D, 0.35D).

Similar Hartmann-Shack wavefront measurements were obtained for PureVision Multi-Focal Low Add and PureVision Multi-Focal High Add lenses. Figure 6 illustrates the power profiles of the PureVision Multi-Focal Low and High Add centre-near aspheric

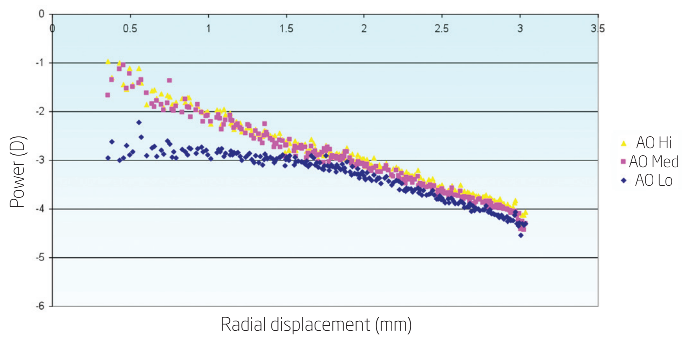

Figure 4 Power profiles of CIBA Air Optix Aqua Lo, Med and Hi Add lenses

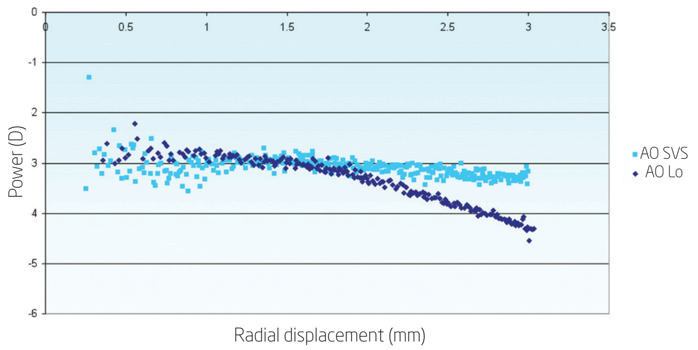

Figure 5 Power profiles of CIBA Air Optix Aqua Lo Add and CIBA single-vision lenses

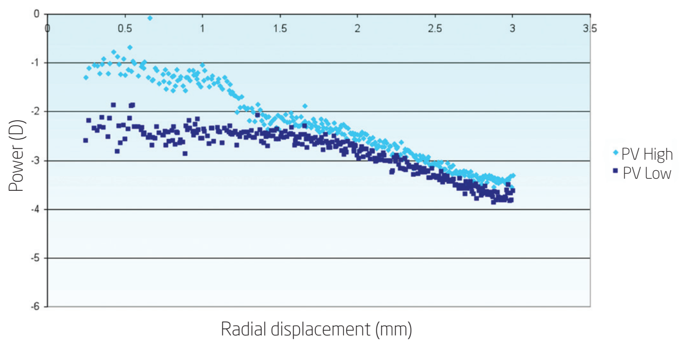

Figure 6 Power profiles of PureVision Multi-Focal Low Add and High Add lenses

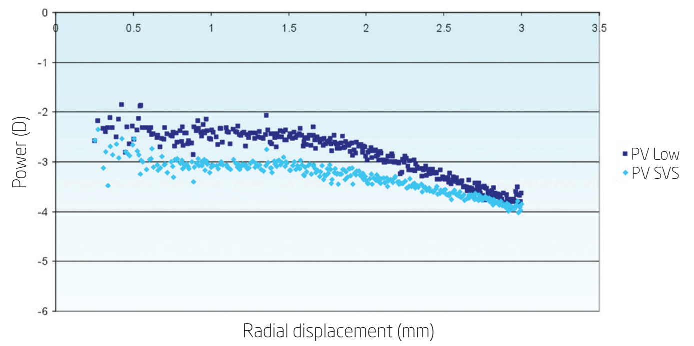

Figure 7 Power profiles of PureVision Multi-Focal Low Add and PureVision single-vision lenses

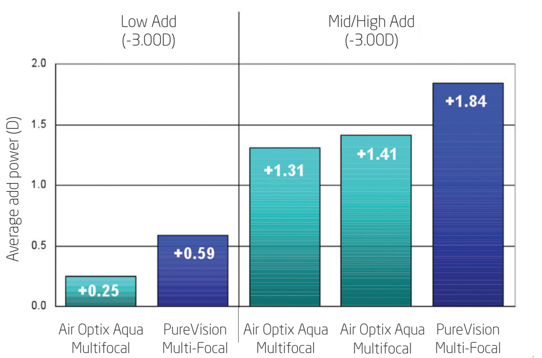

Figure 8 Add power of PureVision Multi-Focal and Air Optix Aqua Multifocal lenses

design lenses. Mean lens powers over the central 2mm diameter for the PureVision Multi-Focal Low Add and PureVision Multi-Focal High Add were -2.41D and -1.16D, respectively. With a difference in central powers of 1.25D (95 per cent CI: 1.18D, 1.31D), the power maps reveal two distinct design profiles, as confirmed by confidence interval analysis.

Figure 7 illustrates the power profiles of PureVision Multi-Focal Low Add and PureVision single-vision aspheric lenses. The power changes from the centre of the single-vision lens toward the periphery of the optic zone highlight the aspheric profile of the lens. The mean power in the central portion of the lens was -2.97D. The difference in means between the single-vision lens and the Low Add PureVision lens was 0.57 D (95 per cent CI: 0.50D, 0.64D).

The mean lens powers over the central 2mm diameter for the centre-near multifocal lenses provide the information needed to estimate add powers of the various designs. The add of each multifocal lens was calculated as the difference between the labeled power, in this case -3.00D, and the power of the central portion of the lens, Figure 8. The results indicate the Air Optix Aqua Lo Add offers +0.25D, while the PureVision Multi-Focal Low Add offers more than twice the add, +0.59D. The difference between add powers was statistically significant. The Air Optix Aqua Med and Hi Add designs have very similar amounts of add, + 1.31D and +1.41D, respectively. In comparison, the PureVision Multi-Focal High Add offers +1.84D of add. The add difference between the PureVision High Add Multi-Focal lens was significantly greater than the Air Optix High Add.

Conclusion

Power mapping is a useful tool to evaluate relative similarities and differences in power profiles of aspheric multifocal contact lenses. The add powers calculated from the power profiles can help provide insight into fitting these lenses. Analysis of power profiles of the three CIBA Air Optix Aqua multifocal products showed that there are effectively just two distinct designs. The power profile for the Lo Add estimated the add to be 0.25D. With an add of this magnitude, practitioners may find a need to adjust the distance power to increase the effective add. With the Med Add and Hi Add lenses having similar adds, the practitioner may find a limited use for the Med Add as the patient requires a greater need for add. Measurements of the two Bausch+Lomb PureVision Multi-Focal lenses confirmed two distinct designs. The PureVision Multi-Focal Low Add and PureVision Multi-Focal High Add offered more add when compared to the Air Optix Multifocal Lo and Air Optix Multifocal Hi Add lenses. With only two add powers, PureVision Multi-Focal lenses make the fitting process simple. Greater add power helps reduce inconvenience of changing lens powers as reading needs increase.

● **Dr Alexis Vogt** is a product designer for Bausch+Lomb, Rochester, where **Tim Green** is manager of product design, **Kirk Bateman** is manager, statistics and data management and **Bill Reindell** is global director of medical affairs