# One Eye, Two Views: Resolving Monocular Diplopia in Keratoconus with Custom HOA-Correcting Scleral Lenses

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*Pending USED and accreditor approvals.

## BACKGROUND

Higher-order aberrations (HOAs) are irregularities in the eye's optical system that can result in visual disturbances like blurred vision, diplopia, halos and glare. Vertical coma is a specific type of HOA that disrupts how light is focused within the eye, leading to distortions along the vertical axis. Managing this aberration is crucial for achieving clear, comfortable vision, especially in patients with conditions that predispose them to higher-order aberrations, such as keratoconus. HOA-correcting scleral lenses utilize wavefront technology to identify and map higher-order aberrations in the eye. This detailed mapping informs the custom design of the lenses, which are engineered to counteract specific distortions and improve overall visual quality. The purpose of this case report is to describe the successful management of monocular diplopia in a patient with keratoconus, primarily attributed to higher-order aberrations (HOAs), using custom scleral lenses designed to correct these aberrations.

## CASE DESCRIPTION

A 47-year-old male presented with monocular diplopia OD, which was impacting his quality of vision. He had keratoconus in both eyes (Fig 1), contributing to his diplopia through higher-order aberrations (Fig 2). Although the patient achieved 20/20 VA in both eyes with optimally fit scleral lenses, he still experienced diplopia due to these aberrations. Wavefront aberration data was collected using an aberrometer to create a detailed map of the patient's HOAs over dotted lenses. This map was then used to design a custom HOA-correcting scleral lens with specific optical adjustments to address the vertical coma identified in the Zernike Plot. The dots helped outline the lens optic zone position and rotation (Fig 3). The patient was monitored through multiple visits over 5 months to assess lens comfort, visual acuity, and the effectiveness of HOA correction.

## LENS PARAMETERS

| | Sagittal Depth (µm) | Base Curve (mm) | Diameter (mm) | Power (D) | Edge (µm) |
|---|---|---|---|---|---|
| OD | 4564 | 7.85 | 15.8 | -1.50 | 90 flat/150 steep |
| OS | 4540 | 7.85 | 15.8 | -2.25-1.00x67 | 90 flat/180 steep |

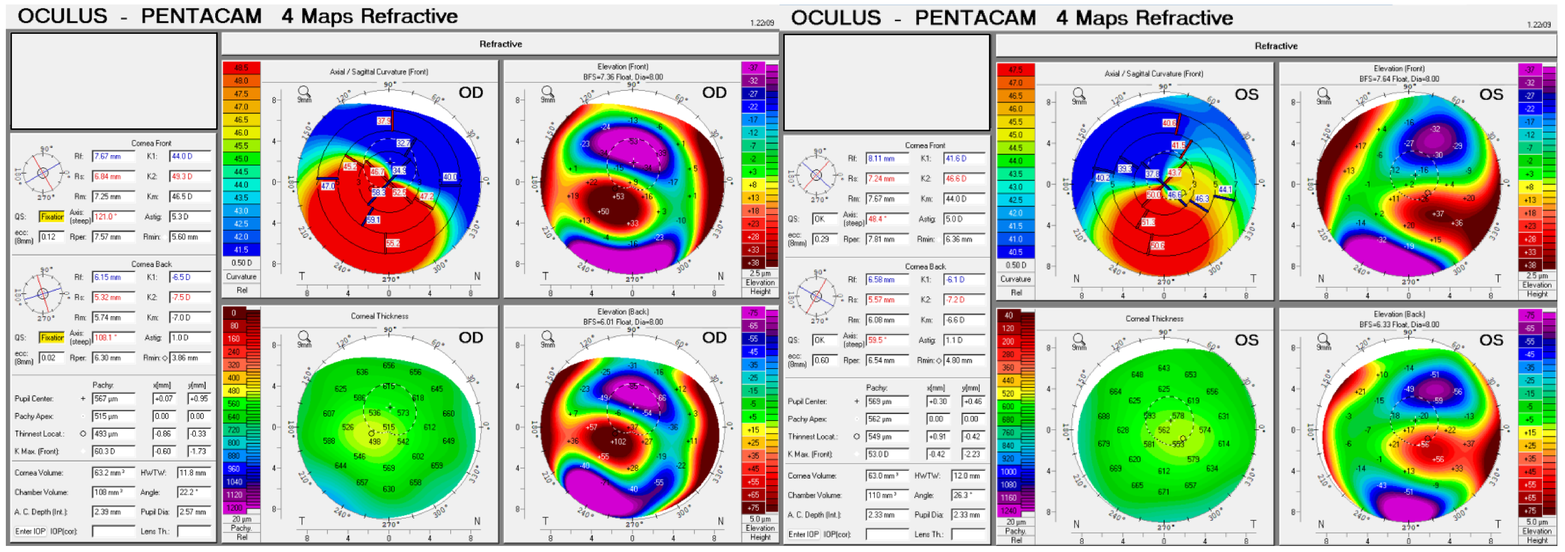


Figure 1: Corneal topography data for OD and OS. This shows the location of the corneal ectasia which is inferior/temporal in both eyes with significant posterior elevation OD>OS.

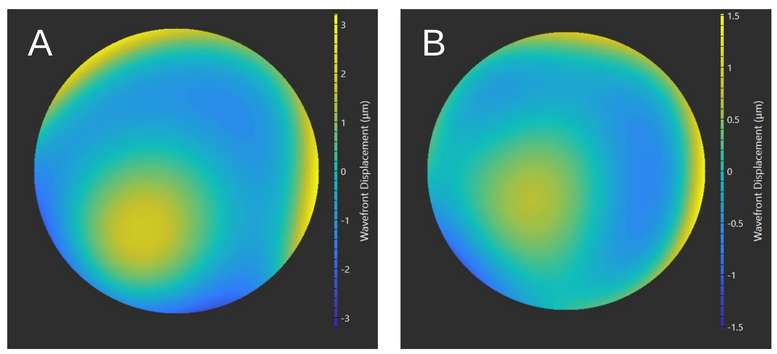


Figure 2: Initial wavefront map dot images showing high aberrations OD (A) prior to correction. Decrease in aberration seen in wavefront map with final correction OD (B).

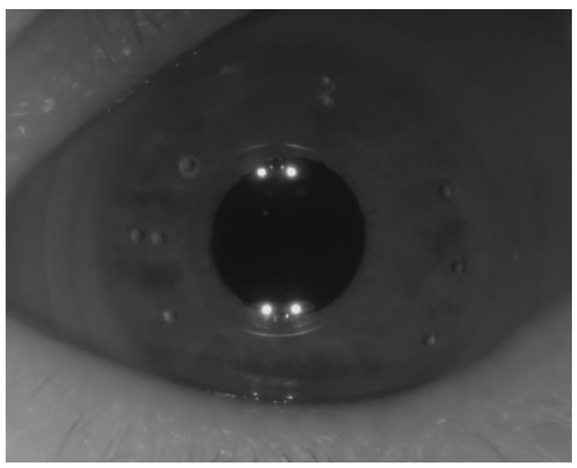

Figure 3 (left): Dotted trial lens used to detect optical zone decentration and rotation of the lens after the lens is fully settled for several hours.


Figure 4: Zernike Plot data for base lens from 04/26/24 (blue) and final HOA lens from 09/06/24 (orange). This identifies the magnitude of vertical coma OD with the base lens that is above the red line which categorizes it as severe HOA. The final HOA-correcting scleral lens corrected majority of the vertical coma along with other HOAs improving visual symptoms, including monocular diplopia.

## DISCUSSION

This case highlights the complex interplay between corneal irregularities, such as keratoconus, and higher-order aberrations (HOAs) in the development of monocular diplopia. While a rigid lens offers a tear lens to correct anterior corneal irregularity, some patients, like in this case, have more posterior corneal irregularity. With this, the tear lens can't correct aberrations from posterior irregularity such as vertical coma which can cause streaky images and diplopia like this case. Assessment of the posterior elevation map and aberrometry screening can identify patients who may have visual symptoms that are not improved by standard scleral lenses alone. Both eyes showed visually significant HOAs so he was deemed a good candidate for these lenses. The HOA correcting sclerals reduced these aberrations and his symptoms resolved even though he was already seeing 20/20.

## CONCLUSION

The use of custom HOA-correcting scleral lenses effectively addressed the vertical coma and other higher-order aberrations contributing to monocular diplopia in a patient with keratoconus. By integrating detailed wavefront aberration mapping into the lens design, significant improvements in visual clarity and reduction in double vision were achieved. This case highlights the efficacy of personalized scleral lenses in managing complex visual issues related to keratoconus and higher-order aberrations, ultimately leading to enhanced visual outcomes and improved quality of life for the patient.

## ACKNOWLEDGEMENTS

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