Clinical Application of a Bitoric Lens Design

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BACKGROUND

A bitoric design refers to one with toric front and back surfaces. When utilized in rigid gas permeable (GP) lenses, it provides both neutralization of corneal cylinder and lens stability. The back surface toricity enhances lens stability over the highly toric cornea with a corneal cylinder of approximately 2.50D, and the front surface toricity neutralizes residual cylinder. Despite the existing popularity of hybrids, scleral lenses and other GPs such as spherical and aspheric designs, the bitoric design effectively manages moderate to high amounts of astigmatism in an economical way.

CASE DESCRIPTION

- **Demographics:** 44 y/o AA M
- **Chief Complaint:** blurry vision with soft contact lenses.
- **Ocular History:** Previous wearer of GP and soft contact lenses (SCL). The patient dropped out of SCL secondary to inadequate vision and expressed an interest in bitoric GP.
- **Medical History:** Unremarkable.
- **Medications:** One A Day® Vitamins

CLINICAL

VAcc	OD: 20/20-3, OS: 20/40-3, OU: 20/25+1
Keratometry	OD: 42.50D/46.00D @ 096° OS: 44.00D/47.00D @ 083°
Corneal topography Medmont E350 (Nidek, US)	Limbus-to-limbus, with-the-rule (WTR) astigmatism OD, OS
Refraction	OD: -5.00-3.75x010 / 0.75 add, VA 20/20-1 OS: -6.50-3.25x175 / 0.75 add, VA 20/25+1
HVID	11.4 mm OD, OS
Anterior/posterior segment	Unremarkable OD, OS

FINAL CONTACT LENSES

Brand	X-cel™ Bitoric
Material	Optimum Comfort™
Parameters	OD: -3.75D/-8.50D, BCR 8.04/7.50, 9.5 mm OAD, PC 0.40/12.25, IC 0.35/9.34. OS: -5.00D/-8.00D, BCR 7.76/7.42, 9.5 mm OAD, PC 0.40/11.50, IC 0.35/9.06.
VAcc	OD: 20/15-2, OS: 20/20-2, OU: 20/15-1

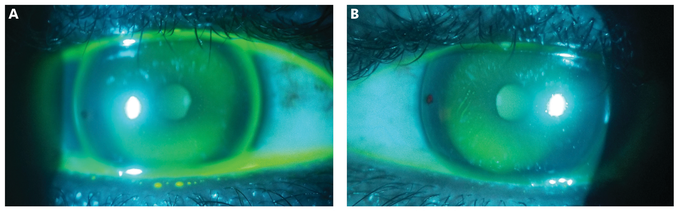

FIGURE 1. *Fluorescein Pattern of Final Bitoric Lenses. (A) OD. (B) OS.*

COMPARISON OF LENS DESIGNS

METHOD

Two other lens designs (Valley Contax™ spherical BCR and Pinnacle™ spherical BCR with aspheric BCR) were selected by selecting a base curve (BCR) for spherical GPs; BCR of 1.00D flatter than flat K was selected for each eye. Optical path difference (OPD), high-order aberrations (HOA), and over-refraction (OR) were measured utilizing OPD-Scan III (Nidek, US) with each design applied to the patient's eyes.

	Valley Contax™ Spherical BCR, PCR	Pinnacle™ Aspheric BCR, PCR
Lens Parameters	OD: -3.00Sph/BCR 7.76/OAD 9.4 OS: -3.00Sph/BCR 7.50/OAD 9.4	OD: -3.00Sph/BCR 7.76/OAD 9.2/Medium edge lift OS: -3.00Sph/BCR 7.50/OAD 8.9/Medium edge lift
Autorefraction/OPD	OD: -2.25-1.00x015 OS: -3.75-0.50x160* *Repeated errors secondary to excess lens movement with blinks	OD: -1.75-1.50x010 OS: -2.00-2.50x031
Total Sphere (µm)	OD: 0.044 OS: 1.544	OD: 0.037 OS: 0.819
Total Coma (µm)	OD: 0.039 OS: 0.809	OD: 0.040 OS: 1.617
Total High Order (µm)	OD: 0.189 OS: 11.397	OD: 0.183 OS: 4.379
Over-refraction	OD: -2.00-1.25x015 OS: -4.00-0.25x035	OD: -1.75-0.75 x 005 OS: -2.75-2.75x180
BCVA	OD: 20/15-1 OS: 20/25-2	OD: 20/20+2 OS: 20/25+2

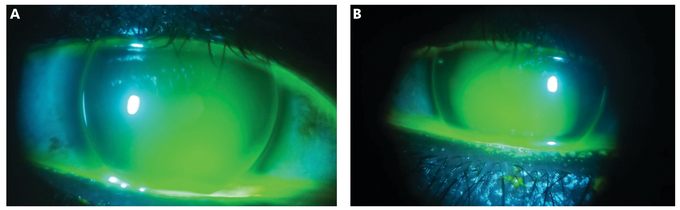

FIGURE 2. *Fluorescein Pattern of Spherical. (A) OD. (B) OS.*

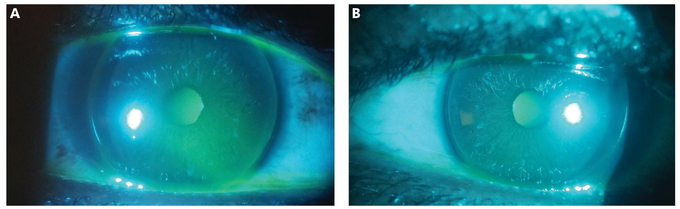

FIGURE 3. *Fluorescein Pattern of Pinnacle™ Aspheric. (A) OD. (B) OS.*

DISCUSSION

Among the three different lens designs, the bitoric design provided the best-corrected visual acuity (BCVA) as well as the most stable fit over the highly toric cornea. In our patient, BCRs of the bitoric lenses were selected utilizing the two-thirds principle, where the amount of back surface toricity equals to two-thirds of the corneal astigmatism.[1] This principle accounts for refractive change driven by a difference in index of air (n = 1.00) and index of tear film (n = 1.337) on the cornea.[1] Where corneal astigmatism matches with refractive astigmatism, spherical power effect (SPE) design can adequately neutralize all the corneal astigmatism. In a case where both values do not match, cylinder power effect (CPE) is used to neutralize both the corneal and internal astigmatisms; in our patient, finalized OD lens was CPE whereas OS lens was SPE. Front surface toric design was excluded as such design is more appropriate for fitting against-the-rule astigmatism with minimal corneal astigmatism.

OR results of spherical and aspheric designs indicated the presence of lens flexure whereas bitoric design did not. Bitoric design minimized excess fluid behind the lens, which is one of factors determining lens flexure.[2]

Spherical lenses resulted in higher total spherical aberration (SA) and total HOA over aspheric design with comparable BCVAs. Also, spherical design induced excess fluorescein pooling along the vertical meridian and resulting vertical movement with blinks, demonstrating unstable fit. The aspheric design showed better centration but higher total coma than the spherical design. Optical performance improved over the spherical design by reducing total HOA and SA serving as an incentive for its clinical application.[3] However, a limitation exists when interpreting the data for the aspheric design because the BCR was selected in a similar manner to the spherical design. Aspheric lens designs should be fit steeper than flat K to avoid lens seal-off caused by matching the prolate corneal shape too closely.[1] This should result in more central clearance than a spherical design, observed clinically as more intense fluorescence of the central tear lens. Selection of the same BCRs for both lenses resulted in minimal central clearance in the aspheric design in this case ***(Figure 3)***.

CONCLUSIONS

This case report presents a successful optical correction of high corneal astigmatism using a bitoric lens design. It demonstrates better visual performance and fit over spherical or aspheric designs. Its clinical application has been long-established for cases of high regular corneal cylinder and mild corneal ectasia.[4] Its popularity has declined after the applications of scleral lenses have become more acceptable in managing comfort and vision.[5,6] Nevertheless, GP fitting is deemed a first-line therapy secondary to higher costs involved with hybrid and scleral lens fitting. Aspheric design of GPs is commonly utilized in management of high corneal cylinder and keratoconus.[7] When such designs are used over the normal cornea, HOAs induced by their optics decrease the overall quality of vision. For our patient with highly astigmatic corneas, a bitoric lens design successfully provided better visual outcomes at an affordable cost.

DISCLOSURES

Conflict of interest: All authors declare that they have no conflict of interest.

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