Management of Post-Refractive Oblate Corneal Shape and Myopic Regression with a Novel Custom-Soft Dual Base Curve Design

Vanessa Lin, OD; Sheila Morrison, OD, MSc, FAAO, FSLS

Mission Eye Care (Calgary, AB, Canada)

Northeastern State University Oklahoma College of Optometry

Cornea and Contact Lens Resident

Background

Laser-assisted in situ keratomieulusis (LASIK) is a commonly performed corneal refractive surgery. Despite surgical advances, many patients still experience sub-optimal vision correction or post-surgical complications. In the field of contact lenses, it is often discussed on how to manage cases of post-LASIK ectasia and the need for specialty lenses in an irregular, diseased eye. What's often overlooked are the many visual challenges that are faced by patients who've undergone a refractive surgery with no complications. Refractive regression and over- or under-correction are common in such procedures yet have limitations to how vision correction can be achieved.

Patients may be reluctant to return to spectacle or contact lens wear post-surgery because this is often the motivation to undergo the procedure in the first place. Myopic post-surgical corneas usually have a flatter central curvature relative to peripheral curvature. This difference increases with higher baseline refractive error correction. For this reason, oblate RGP and scleral lenses were introduced for post-LASIK fits. These lenses are designed with a reserve curve that's steeper than the central BOZR to better accommodate this corneal shape. Despite this, RGP and scleral lenses require adaptation to comfort and handling. Patients may prefer their habitual vision correction modality which is often soft lenses. Commercial soft contact lenses have a constant base curve that doesn't match the shape of the post-surgical cornea. In a steep base curve, the lens will fit the peripheral cornea with excessive central clearance. In a flat base curve, the central cornea will fit but move excessively due to poor peripheral fit. Ideally, an oblate lens design will be able to fit the central cornea without excessive clearance and land adequately in the periphery that allows for acceptable lens movement and therefore stable vision correction *(Fig 1)*.

Fig 1. Diagram depicting an oblate, post-refractive cornea fit with a prolate lens with a steep base curve, a flat base curve, and an oblate base curve.

Case Description

Case History

- 35yo female
- **CC**: Gradual decrease in distance vision OU after LASIK surgery, strong preference to return to contact lens wear
- **POH**: LPI OU (2010), myopic LASIK surgery OU (2017)
- **PMH**: none
- **Meds**: none

Exam Findings

- **Pre-surgical spectacle refraction**: approximately -6.50 DS OU
- **Post-surgical spectacle refraction:**
  - OD -0.75/-0.25x024 20/20
  - OS -1.00/-0.25x075 20/20
- **HVID**: ~12.0mm OU
- **Topographies:** See *Fig 2.*

Contact Lens History

Conventional soft lenses (BC 8.4, 8.6, 9.0)	• Not stable on-eye • Fluctuating vision with blink
Hybrids	• Difficulty with application and removal • Non-tolerant to comfort with optimal fitting hybrid compared to soft lenses
Scleral lenses	• Unable to tolerate comfort • Difficult with application and removal
Custom soft prolate for irregular cornea	• Better than prior lenses • Vision still fluctuating on blink

Case Description - continued

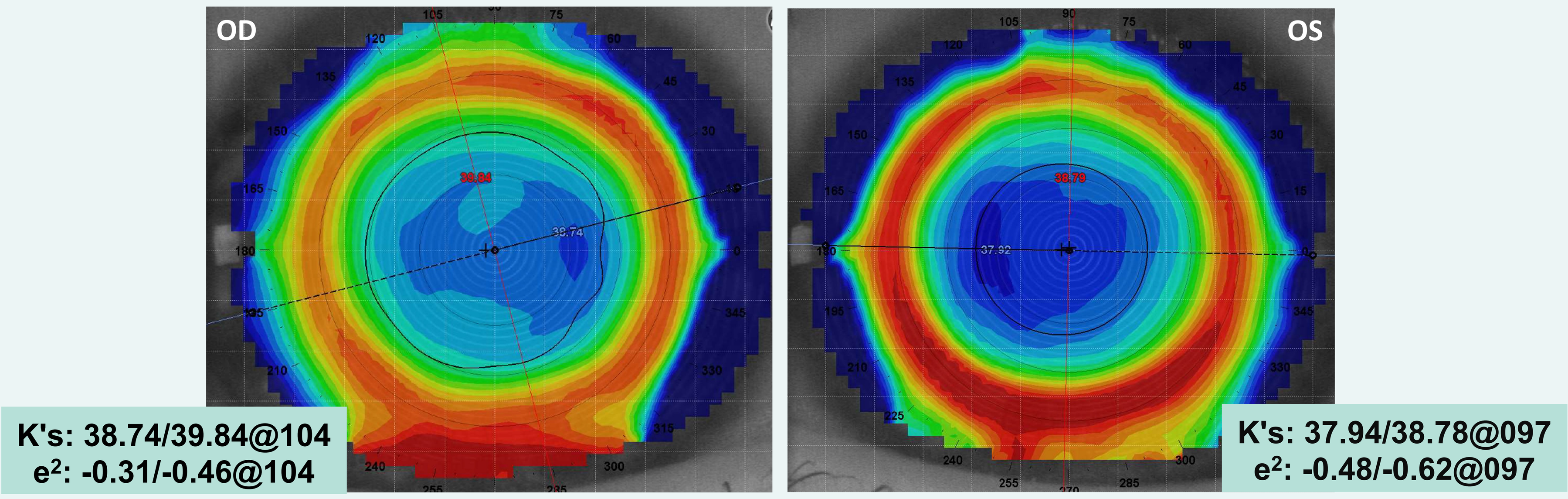

Fig 2. Topography tangential power maps of OD and OS, depicting an oblate, post-refractive corneal shape.

Treatment and Management

To better accommodate the post-surgical oblate corneal shape, custom-soft dual base curve lenses were ordered through Art Optical. Multiple lenses were trialed with various central and peripheral base curves. The goal was to achieve a centered lens, movement of ~1mm in primary gaze and ~1.5mm in up gaze, and good conformation to the corneal shape. This would mean good peripheral alignment without excessive central clearance or good central alignment without edge fluting. The ideal performance would be similar to a prolate soft lens on a prolate cornea. The initial central base curve was selected from the previous best-fitting lens with a steeper peripheral base curve. Adjustments were made to increase the difference between central and peripheral case curves until the ideal lens fit was achieved.

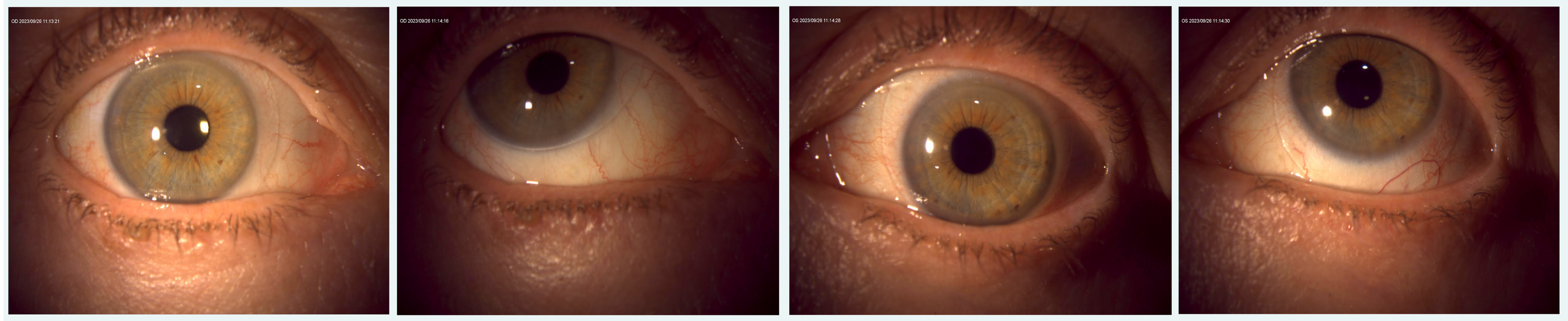

Fig 3. Initial custom-soft oblate lens designs on-eye that showed lens decentration with eye movement and inability to re-center when returning to primary gaze.

Best-Fitting Lens Parameters

OD

Central BC 9.20; Peripheral BC 8.5; Pwr -0.75; Dia 15.0; Ct 0.13; 8.00 OZ; 0.20 EL

OS

Central BC 9.20; Peripheral BC 8.5; Pwr -1.00; Dia 15.0; Ct 0.13; 8.00 OZ; 0.20 EL

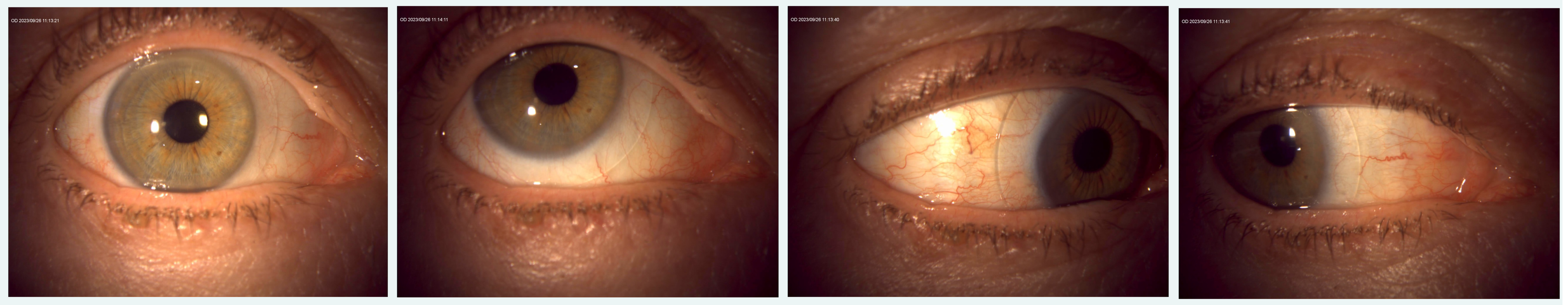

Fig 4. Final custom-soft oblate lens designs on-eye with adequate lens centration and appropriate lens position on eye movements.

These lenses provided the ideal lens centration and movement *(Fig 4)*. With improved stability, the patient was able to achieve VA 20/20 OD, OS, OU without visual fluctuations between blinks.

Discussion and Conclusion

In post-LASIK patients seeking vision correction with a soft contact lens, a custom oblate lens design is proposed to best match the post-surgical corneal shape.

The process of designing the lenses in this case was to select an initial central base curve from a previous best-fitting lens, and a steeper peripheral base curve. The difference was increased between the dual base curves by flattening the central curve and steepening the peripheral curve until lens stability was achieved. Alternatively, optic zone diameter could also be adjusted to affect the fit. A smaller diameter would transition into a peripheral curve that steepens sooner, resulting in a tighter and more stable peripheral fit.

There is also a thought of using imaging-driven data for oblate lens design. Topography data could be helpful in determining the optic zone diameter based off ablation zone and keratometry values in determining starting base curves. Alternatively, there has been reports of significant sagittal height differences between soft contact lenses of the same base curve, which can affect on-eye behavior of the lens. The impact that diameter variability has on sagittal height relative to curvature changes is much more significant. Profilometry data at a certain chord length may be beneficial in determining lens parameters, especially in patients with a larger HVID such as this case *(Fig 5)*.

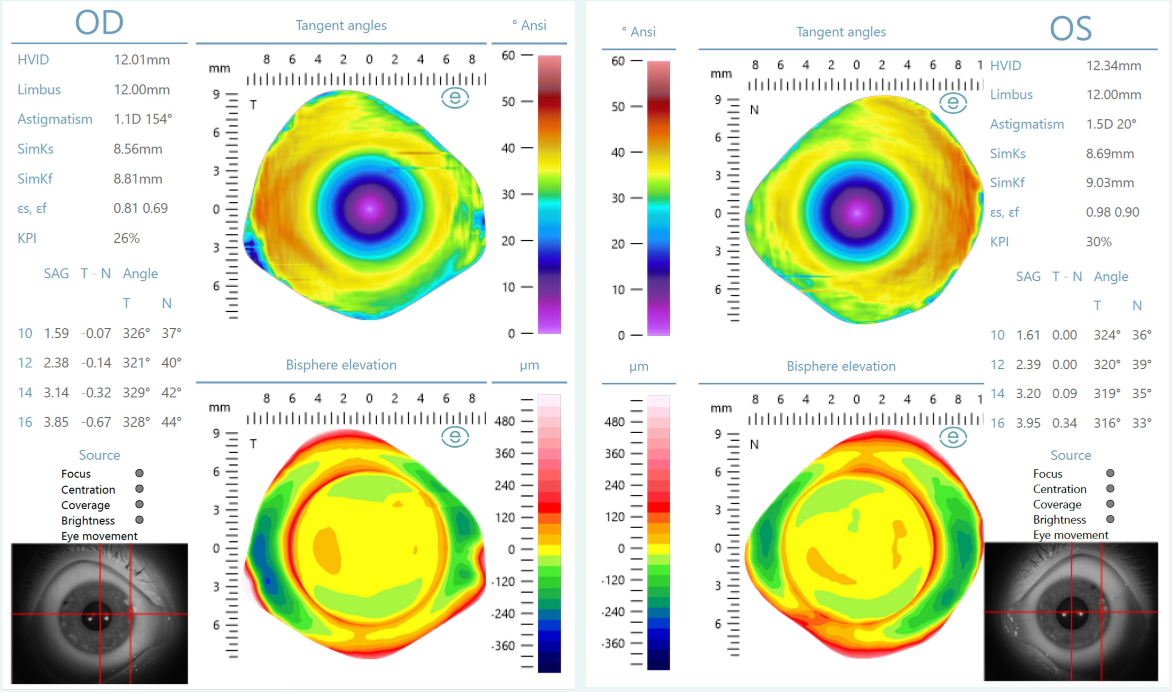

Fig 5. Profilometry data depicting range in elevation and sagittal height in a cornea of larger HVID.

Using soft oblate lenses in post-refractive corneas has its limitations. In this case, there was minimal refractive astigmatism which made lens stability easier to achieve as there was no need for rotational stability. Methods for toric stabilization that are utilized in other soft lens designs could be incorporated. Unfortunately, it is not uncommon for post-refractive astigmatism to be irregular and would still require a rigid contact lens to achieve best-corrected vision. Another consideration is any decentration of the ablation zone, which could affect lens stability due to mismatch between location of the oblate shape between lens and cornea.

Vision challenges that are faced by patients who have undergone a refractive surgery with no complications are often overlooked. Many patients that undergo refractive surgeries are seeking freedom from spectacles. If contact lens wear is necessary, patients deserve a modality they are comfortable and familiar with which is often soft lenses. Custom oblate, dual base curve soft lenses are a novel design and should be considered in post-refractive contact lens fittings.

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