Redesign of ortho-k lenses using computerised simulation to resolve the corneal indentation rings

Singson Chi Keong KWAN BSc(Hons)Optom, MOptom, FBCLA[1,2], **Lachlan HOY** BAppSc(Optom)Hons, GCOT, FIAO, FCCLSA[3,4]

[1]University of New South Wales, [2]Ng Teng Fong General Hospital, [3]Innovative Eye Care, [4]EyeSpace

Background

Corneal indentation ring is associated with orthokeratology corneal reshaping and excessive localised mechanical pressure on the cornea during overnight rigid lens wear. A previous study found that corneal indentation ring appeared in 4% of the children after the first night of Ortho-K lens wear though they disappeared in the subsequent visits (Chan et al. 2012). Another study reported that among those Ortho-K wearers who had corneal indentation rings, the location of the rings corresponded to the bearing zone of the Ortho-K lenses. Therefore, it was suggestive of lens adherence and excessive pressure on the cornea during the closed eye environment (Lui and Edwards 2000). Although epithelial indentation is not a true staining, its existence indicates mechanical disruption to the corneal epithelium. A case report showed that for an asymptomatic extended RGP wearer with corneal indentation ring and corresponding corneal staining subsequently developed corneal ulcers in both eyes (Levy 1985). As persistent corneal indentation suggests chronic and constant disruption to the cornea, intervention is required. The aim of this case report is to demonstrate how computerised contact lens fitting simulation can resolve the corneal indentation rings in an Ortho-K wearer.

Case description

A 12-year-old Caucasian female was referred for myopia control advice in Orthokeratology in Oct 2015. Her visual acuities were 6/6 in each eye after two weeks of overnight Ortho-K lens wear. Lens care with hydrogen peroxide and non- preserved lubricant in the back on the lens on insertion was prescribed. She had continuously worn the lenses each night since the initial lens fit and returned for regular aftercare visits. During the visit in May 2017, corneal indentation rings of approximately 7mm in diameter were seen in the mid-peripheral corneas of both eyes, with the use of sodium fluorescein. Corneal topography also showed distorted mires with crooked and uneven spacing of Placido rings in both eyes. The topographic mire distortion corresponded to the location of the corneal indentation marks, which coincided with the transition interface between reverse curve zone and alignment zone when the lenses were on the eyes.

The patient was asked to stop the lens wear and another pair of Forge Ortho-K lenses with blended curve design were ordered using EyeSpace, with a slight decrease in back optic zone diameter and a decrease in the junctional angle at the reverse and alignment curve. At 2-month post new lens wear, indentation marks with sodium fluorescein were no longer present in both eyes. Corneal topography showed improved corneal mires.

	Before lens re-fit	2 months after lens re-fit
Unaided VA	R: 6/6 L: 6/6	R: 6/6 L: 6/6
Cornea indentation	R & L: Yes	R & L: No
Corneal mire distortion at Mid-periphery	R & L: More obvious	R & L: Less obvious
Corneal staining	No	No

Before lens re-fit

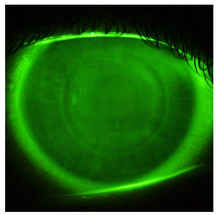


Figure 1. Corneal indentation ring with sodium fluorescein in the Right eye

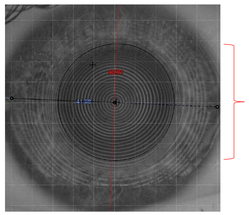
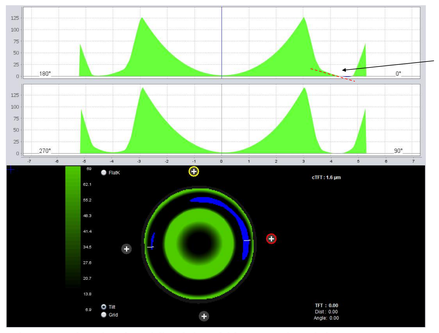


Figure 2. Corneal mire of the Right eye

The distance between concentric rings uneven and distorted around the clock hours



The lens-corneal angle of bearing, indicating steep alignment curve fit

Figure 3: The simulated fit of the old lens on the Right eye

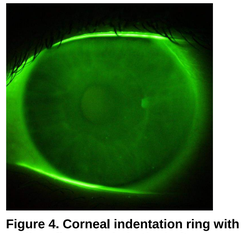


Figure 4. Corneal indentation ring with sodium fluorescein in the Left eye

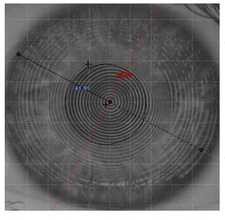
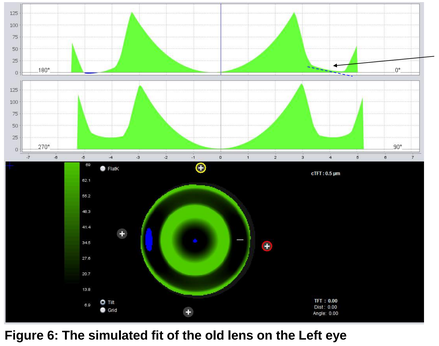


Figure 5. Corneal mire of the Left eye

The distance between concentric rings uneven and distorted around the clock hours



The lens-corneal angle of bearing, indicating steep alignment curve fit

Figure 6: The simulated fit of the old lens on the Left eye

2 months after lens re-fit

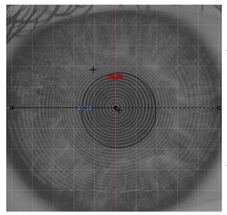
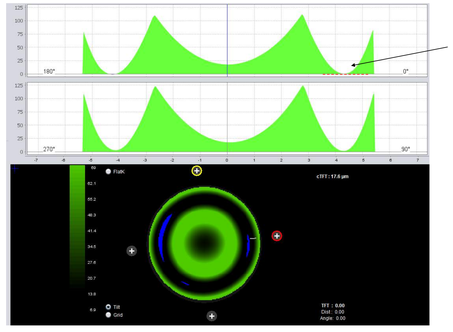


Figure 7. Corneal mire of the Right eye

The distance between concentric rings became more even and less distorted



The lens-corneal angle of bearing, indicating ideal alignment curve fit

Figure 8: The simulated fit of the old lens on the Right eye

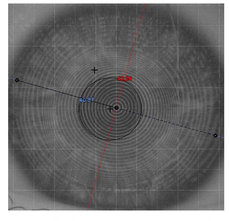
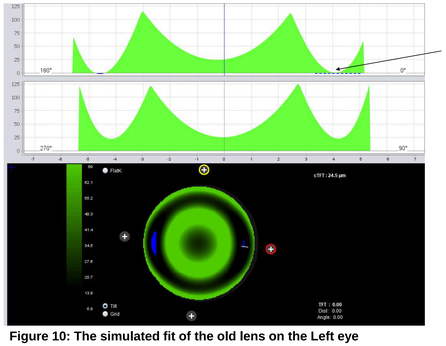


Figure 9. Corneal mire of the Left eye

The distance between concentric rings became more even and less distorted



The lens-corneal angle of bearing, indicating ideal alignment curve fit

Figure 10: The simulated fit of the old lens on the Left eye

Discussion

- This case describes the occurrence of corneal indentation rings with orthokeratology and corneal reshaping, and the lens modification to resolve the indentation while maintaining the corneal reshaping required for optimal unaided vision.
- Corneal indentation ring diameters were approximately 7 mm in both eyes with mire distortion measured by corneal topography. The location of the marks corresponded to the junction between the reverse curve and alignment curve.
- The indentation rings were believed to be caused by the localised mechanical pressure exerted on the cornea due to large junctional angle between the reverse curve and alignment curve. Re-design of the lens profile was made to reduce and or eliminate the landing angle between the reverse and alignment curve.
- The epithelial disruption was alleviated after the lens modification. Indentation marks were no longer present in both eyes, with improved corneal mires in topography maps.
- Although flattening of the base curve optic zone radius, use of lubricant and encouraged conscious blinking have been reported to help with corneal indentations, redesign of lens serves as another effective way to resolve the issue.

Conclusion

- Corneal indentation rings were resolved by redesigning of the lens profile aiming to improve the corneal-lens angle at alignment curve zones. Localised pressures were alleviated which prevented corneal disruption in the mid-peripheral corneas of both eyes.

References

- Chan, K. Y., Cheung, S. W., & Cho, P. (2012). Clinical performance of an orthokeratology lens fitted with the aid of a computer software in Chinese children. Contact Lens and Anterior Eye, 35(4), 180-184.
- Levy, B. (1985). Rigid gas-permeable lenses for extended wear--a 1-year clinical evaluation. American journal of optometry and physiological optics, 62(12), 889-894.
- Lui, W. O., & Edwards, M. H. (2000). Orthokeratology in low myopia. Part 2: corneal topographic changes and safety over 100 days. Contact Lens and Anterior Eye, 23(3), 90-99.