Utilizing swept-source optical coherence tomography (SS-OCT) to visualize the peripheral landing system of different orthokeratology designs

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Introduction

Orthokeratology (OrthoK) lenses are used to correct refractive error by temporarily reshaping the cornea overnight.

The proper **lens-to-cornea fitting relationship** of the peripheral landing system is imperative for a successful fit and plays an integral role in lens centration, stabilization, and long-term safety.

Traditional dynamic observation of OrthoK lenses utilizing sodium fluorescein (NaFl) can be confounded by irritative tearing and may not be entirely representative of a lens fit.

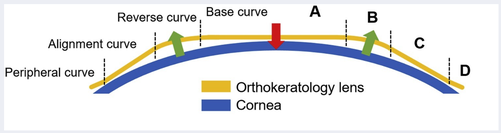

Image 1. Schematic of orthokeratology lens[1]

Purpose

This study utilizes **anterior segment swept-source optical coherence tomography (SS-OCT)** to acquire high-resolution, cross-sectional images of the OrthoK lens-to-cornea fitting relationship, to observe its potential value in understanding the subtle relationship between the weight-bearing region of the lens and mid-peripheral cornea.

Methods

Two commercially available OrthoK designs were fit onto a subject with ideal fit, movement, and centration.

- One lens had **tangential** peripheral curve design, and the other lens had **alignment** peripheral curve design
- **Landing** parameters were varied within the same lens design and imaged

The peripheral landing system of OrthoK lens over cornea was imaged with anterior segment SS-OCT (Topcon Triton).

Static photos using NaFl were taken for comparison.

Results

Comparison #1
Can you tell which lens design?

Simply looking at the bullseye fluorescein pattern, it is almost impossible to differentiate manufacturer-specific designs. SS-OCT captures a high-resolution sagittal view and allows for visualization of tangential landing design (Figure 1) versus alignment curve landing design (Figure 2) of peripheral curves.

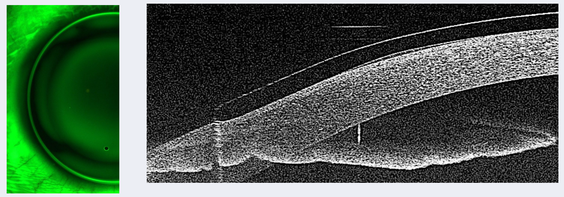

Figure 1. Ideal tangential landing

Figure 2. Ideal alignment curve landing

Comparison #2
Is the fit too tight?

When analyzing edge lift, the difference in fluorescein pattern may be too subtle to distinguish. Figure 2 depicts ideal edge lift, whereas Figure 3 depicts insufficient edge lift, which may not allow adequate tear exchange and may lead to discomfort, lens binding, or corneal injury.

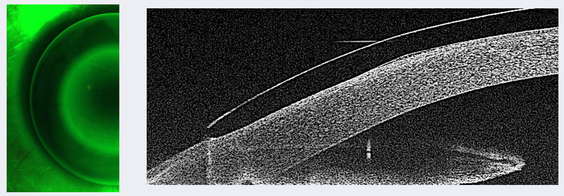

Figure 3. Tight alignment curve landing

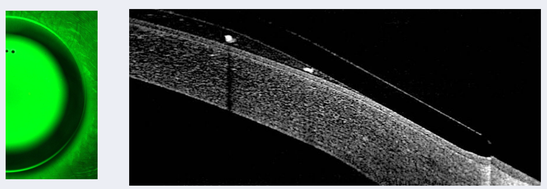

Figure 4. Tight tangential landing

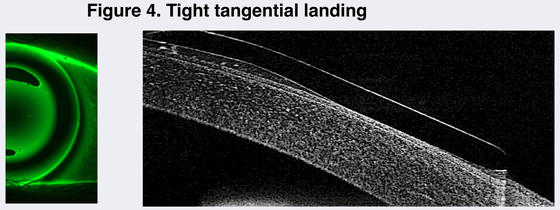

Figure 5. Loose tangential landing

Comparison #3
Is it not obvious?

For the purpose of demonstration, Figure 4 shows an extremely tight fit that fluorescein is trapped under the base curve. In contrast, Figure 5 shows excessive edge lift that is greatest inferiorly. Looking at the SS-OCT images, Figure 4 shows the OrthoK lens landing harshly against the mid-peripheral cornea and Figure 5 shows acceptable mid-peripheral corneal touch but excessive edge lift.

Conclusions

- High resolution SS-OCT images of OrthoK lenses over cornea increase sensitivity and specificity of identifying lens-specific design compared to NaFl analysis.
- High resolution images obtained using SS-OCT allow the ability to capture the appearance of different lens designs which would otherwise be indistinguishable.
- These preliminary results show the capability of SS-OCT as an excellent supplementary tool at observing the lens-cornea fitting relationship and provide guidance on design improvements to achieve better initial comfort, long-term safety and efficacy of OrthoK treatment.

Future Considerations

SD-OCT has been used in investigating the lens-tear-cornea relationship in both soft lenses and scleral lenses[(2)]. However, to our knowledge, this is **one of the first studies that utilized SS-OCT** in analyzing lens-tear-cornea relationship in OrthoK treatment. The better resolution offered by SS-OCT provides great potential in both qualitative and quantitative analysis of the central and peripheral lens system and its dynamics on corneal surface.

For adaptation into clinical practice and to aid R&D in design optimization, a larger database of images need to be compiled so practitioners can properly identify and evaluate OrthoK fitting using SS-OCT.

References

1. Vincent, Stephen J., et al. "CLEAR-orthokeratology." *Contact Lens Anterior Eye* 44.2 (2021): 240-269.
2. Tom, Lisa M. MD; Jacobs, Deborah S. MD Advances in Anterior Segment OCT For the Design and Fit of Scleral Lenses, International Ophthalmology Clinics: Fall 2019 - Volume 59 - Issue 4 - p 31-40 doi: 10.1097/IIO.0000000000000284