NCC 2018
making a difference

Toric soft contact lens design considerations for wearer experience

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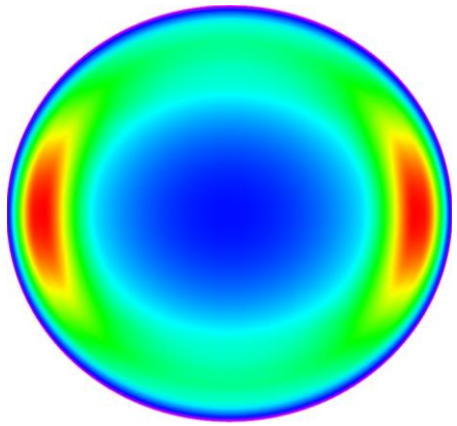
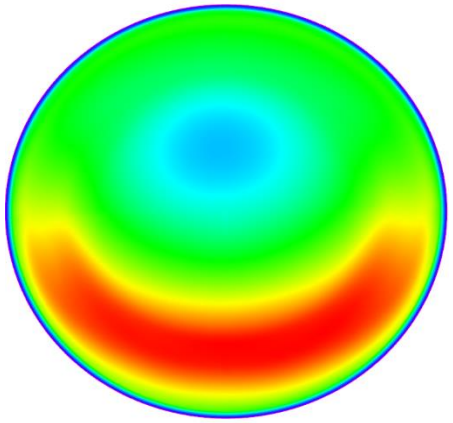
Motivation & Background

- Optimal on-eye rotational stability and alignment are major design considerations for contact lenses that correct for astigmatism. Eyelid Stabilized (ES) and Prism or Peri-Ballasted designs (PB) are the major stabilization design types.



ES



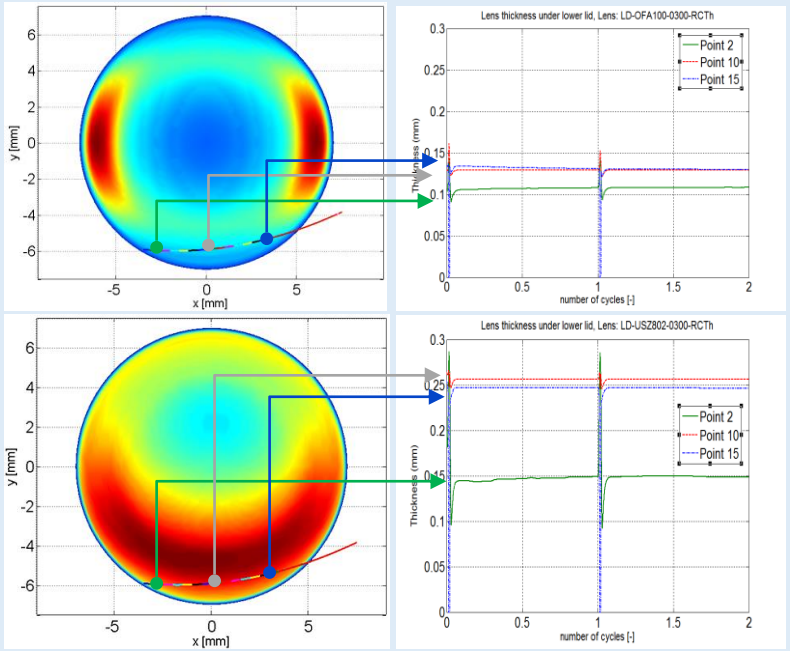
PB

- Toric soft contact lens (TSCL) wearers sometimes report a “heavy” feeling or difficulty with lens removal. To help understand these symptoms, computer-based analytical tools were used to calculate design metrics and differentiate between ES and PB designs.

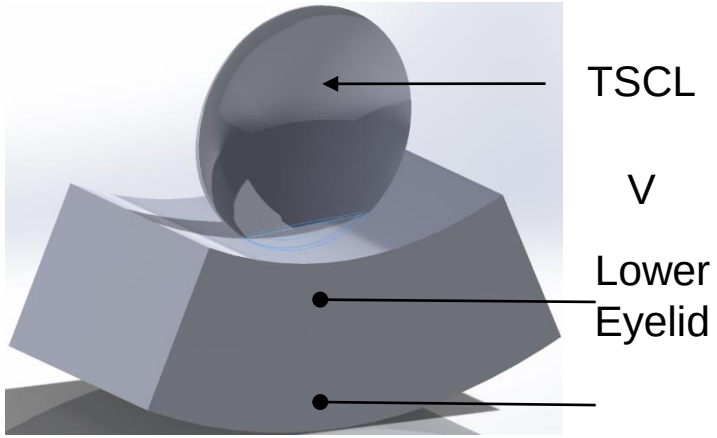
- Design metrics are proposed that may help understand wearer experience.

Methods

- Rotation-Centration Modeling

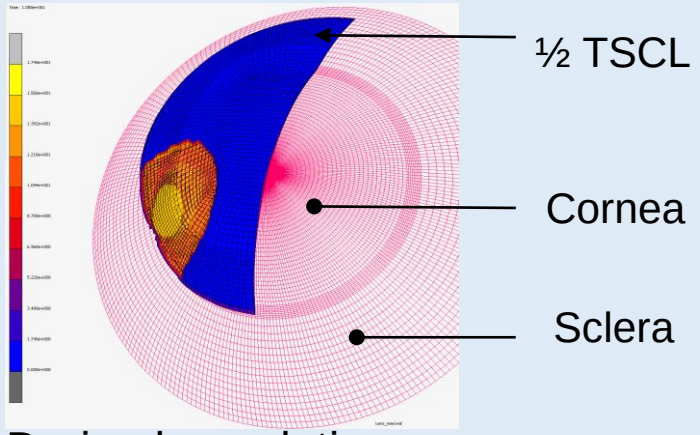


- Derived population average eyelid geometries.
- Tracked transient thickness under eyelid margin at multiple locations during & in-between blinks.



- Derived population average eyelid geometries [1]
- Used 3D CAD modeling tools and mathematical operations to calculate the volume (V) of the Toric Soft Contact Lens (TSCL) under the lower eyelid for both types of lenses in primary gaze.

- Finite Elements Analysis



- Derived population average eye shape [2]
- Used Finite Element Analysis (MSC.Marc) to calculate the pinching force necessary to remove the lens after settling.
- Force was measured when seal at lens edge was first broken.

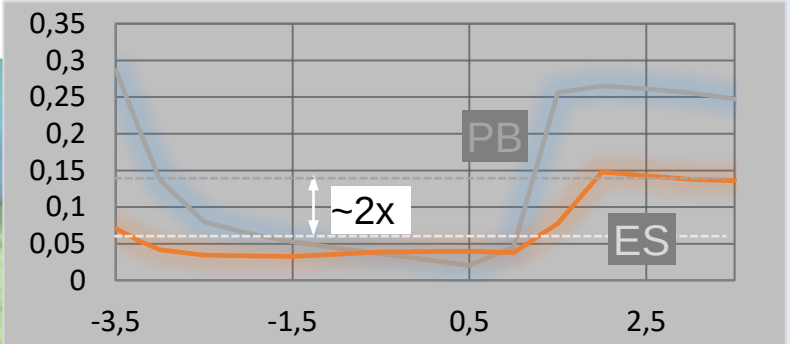
Results

ES→Eyelid Stabilized
PB→Peri/Prism Ballasted

- Eyelid margin/Lens interactions

➢ The average local lens thickness change experienced by the lower lid margin during a blink cycle is about twice as much for PB lenses as compared to an ES design lens.

Thickness change (*) (mm)



(*) Experienced by the eyelid during a blink cycle

➢ In primary gaze, the amount of material under the lower eyelid is about twice as much for PB as compared to ES.

Volume under lower eyelid (ul)

	PB		ES	
	CA*	CH*	CA*	CH*
V (ul)	2.53	2.84	1.08	1.19

~2x

(*) CA: Caucasian; CH: Chinese

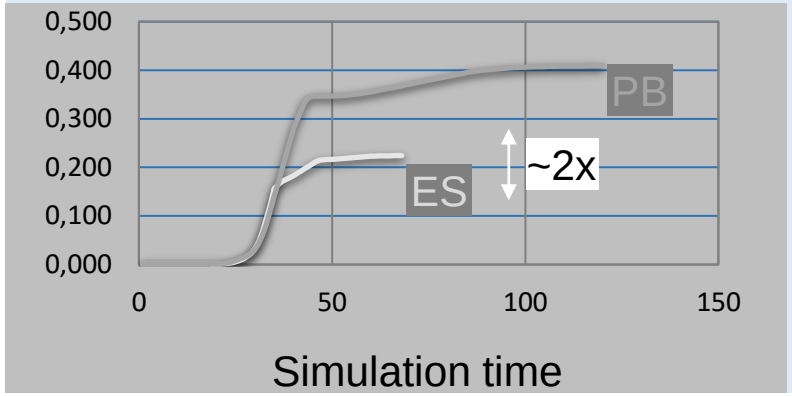
- Lens Removal

➢ The pinching force applied by fingers necessary to remove the lens and the resulting pressure on the eye are about twice as large for PB as compared to ES.

Max Finger Pressure (kPa)

ES: 8.4 —~2x→ PB: 17.4

Removal Force (N)



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Results - Summary

ES→Eyelid Stabilized
PB→Peri/Prism Ballasted

Design Metric	ES	PB
Average thickness under eyelid margin in-between blinks (mm)	0.12	0.23
Average thickness under eyelid margin during blink (mm)	0.07	0.15
Lens volume underneath lower eyelid (ul)	1.08 (Caucasian) 1.19 (Chinese)	2.53 (Caucasian) 2.84 (Chinese)
Removal force (N)	0.22	0.41

- All four design metrics point to about a two fold increase in eye/lens interactions when wearing PB design type as compared to ES design type.

Conclusion

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- The lower eyelid margin on average experienced more transient interactions with Peri/Prism Ballasted compared to Eyelid Stabilized design.
- The increased thickness on the lower half of the Peri/Prism Ballasted design also contributed to larger finger forces required to remove the lens.
- These findings using geometrical and simulation design analysis suggest potential differences between designs in wearer experience including lens awareness, feeling of heaviness on the lower lid and ease of lens removal. Further clinical studies are needed to verify these findings.

REFERENCES

[1]- Hickson-Curran S, Brennan NA, Igarashi Y, Young G. Comparative evaluation of Asian and white ocular topography. Optom Vis Sci. Dec 2014;91(12):1396-405.

[2] Atchison DA, Smith G. Optics of the human eye. Butterworth-Heinemann, Oxford (2000)