Elevating to the next level: A case series of dual sag scleral lens empirical design based on digital mapping

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Introduction

Scleral contact lenses are indubitably a great correction option for patients with irregular corneas; however, the unique shape and elevation differences across the cornea can present fitting challenges. Historically, toric or quadrant-specific peripheral curves were the only manipulable adjustments available to troubleshoot lens alignment issues which did not address corneal toricity, leading to either excessive or inadequate clearance.

Inferotemporal lens decentration is commonly related to a flatter horizontal white to white compared to the vertical white to white causing more clearance superior and inferior, hence the lens to fall with gravity. Dual sagittal height is an additional customization option for scleral lenses which allows both major corneal meridians to be aligned independently thus a more cohesive, 'lock and key' fit. By incorporating toricity inside the vaulting chamber, fitting concerns such as air bubble formation, midday fogging, blanching, impingement, conjunctival prolapse, and lens decentration can be improved, resulting in increased comfort, wear time, and visual quality with scleral lens wear.

Digital Imaging

The Challenge…

- Scleral shape is most likely **asymmetric** & usually irregular – quadrant specific or toric – but rarely spherical
- We **cannot** predict the scleral shape by assessing the cornea

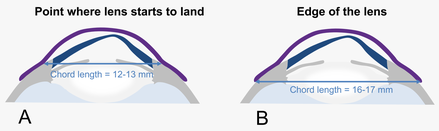
Digital imaging of comprehensive eye shape is an advantageous tool when designing all specialty contact lenses; designing a scleral lens with consideration for dual sagittal height may be conceptualized as follows:

Check sagittal height difference at different chord lengths.

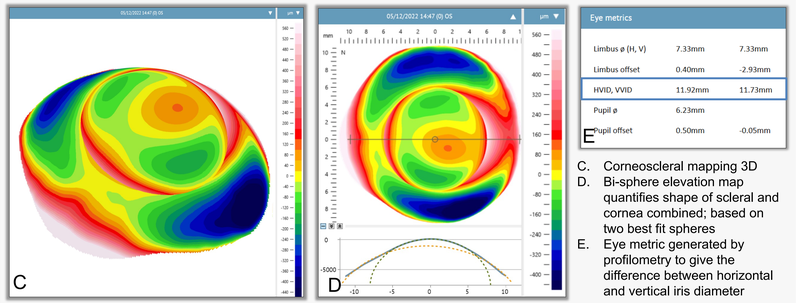
A. Toricity at first landing point
B. Toricity at edge of the lens

Consider applying toric sag inside lens at beginning of landing rather than all at the edge, for best fit.

Figure 1: Clinical image of profilometry measurement taken to measure sagittal height of eye at different chords.



Digital Output: the Basis for Empirical Lens Design



C. Corneoscleral mapping 3D
D. Bi-sphere elevation map quantifies shape of scleral and cornea combined; based on two best fit spheres
E. Eye metric generated by profilometry to give the difference between horizontal and vertical iris diameter

Cases: Empirical Lens Design

Patient A: Empirically designed QUAD haptic versus DUAL-SAG
- 30yo female, autoimmune related dry eye
- Regular cornea; 150um toricity in cornea; 200um toricity at the sclera (edge)
- Dual sag performed best b/c toricity starts at cornea (provides best centration)

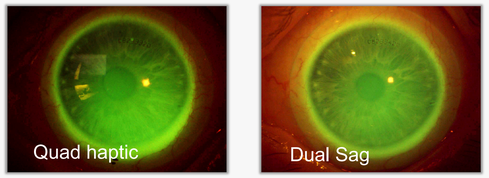
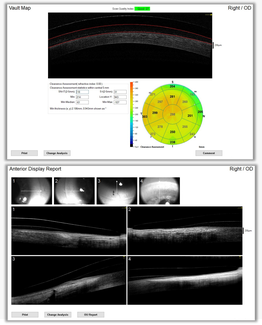


Figure 2: Anterior segment photography imaging best centration fit with dual sag scleral (right) over quad haptic (left).

Patient B: ONE and DONE first lens fit based on empirical profilometry data
- 38yo female
- Mild keratoconus; 240um toricity in cornea; 470um toricity at the sclera (edge)
- Lens parameters: 7.80/17.0/-2.25 4750/5200 sag/std LC/stp4H;stp2V



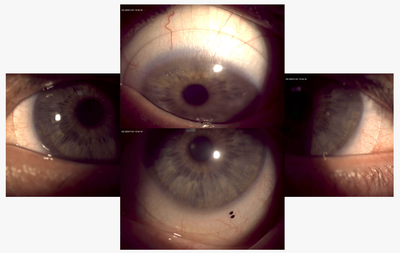


Figure 3: Optical Coherence Tomography (left) imaging central clearance (top left) and landing (bottom left), with corresponding anterior segment photography (right); all display success with the fit.

Patient C: Decreased post lens reservoir fogging with DUAL-SAG
- 36yo male, ocular rosacea
- Advanced keratoconus: 200um toricity in cornea; 200um toricity at the sclera (edge)

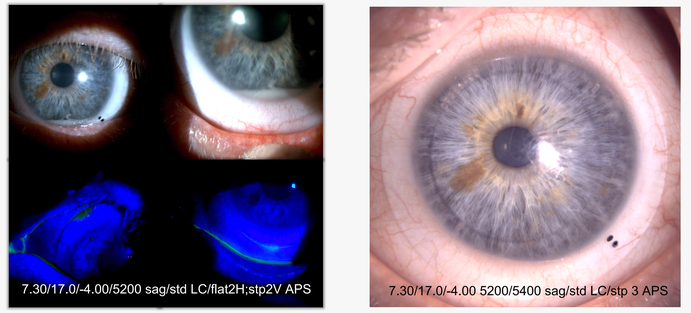


Figure 4: Anterior segment photography demonstrating that with majority of lens parameters being the same, the lens fit is more optimal by placing toricity in the sag over peripheral corneal shape (right) than solely at the haptic (left, white fog settled inferior).

Discussion

Free form lens design effectively accommodates irregular corneal and scleral shape. It also is be capable of providing dual sag shape on appropriate eyes. Quadrant specific sag will further narrow the gap in customization of scleral lens curves between free form and non-free form scleral designs.

In any evaluation of digital lens design efficacy (all specialty lens modalities) that the quality of data into a system will determine the quality of lenses produced.

Conclusions

Scleral lens fitting is influenced by several factors, including corneal sagittal height, limbal profile, and scleral shape. Corneoscleral topography can highlight these findings and help guide when dual sagittal height can be implemented to obtain the optimal lens fit and enhance patient satisfaction. Digital design is the way of the present and future, though currently trial lens fitting with dual sagittal height designs is relevant and useful in clinical practice and often necessary for power.

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