Management of Extreme Corneal Ectasia with a Virtually-Designed Scleral Lens

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Background

Toric haptic scleral lens designs are prescribed more often than in previous years. Recent interest in mapping the sclera and conjunctiva is proving that scleral shape is highly variable and may explain the difficulty in fitting some patients with scleral lenses. Scleral lens fitting is also complicated by scleral irregularities such as blebs, nodules, and pingueculae. Designing a lens to fit over and around irregularities in addition to having a highly irregular corneal and scleral shape can pose especially difficult fitting situations. A corneo-scleral topographical system was utilized to evaluate ocular shape of a patient with extreme cornea ectasia following radial keratometry and LASIK surgery. Highly customized back surface scleral lenses with front toric optics were empirically designed to address the unusual scleral shape, which significantly deviated from a toric curve with 180 degrees of symmetry.

Case Description

A 60 year old Hispanic male presented to clinic with progressive vision loss over the past year. He had been noticing gradual deterioration of his vision as well as glare and halos when driving at night. Ocular history was significant for corneal ectasia status post RK with LASIK enhancement OU. Entering vision was 20/250 OD, 20/200 OS with spectacles, pinhole acuities improved to 20/80-1 OD, 20/60-1 OS. Corneal topography of both eyes demonstrated an area of supero-nasal flattening with infero-temporal steepening/ectasia. Refraction OD: -5.25+6.00x137 20/200, OS: -5.25+4.75x023 20/125. Intraocular pressure by Icare tonometry was 15mmHg OU. Slit lamp examination revealed 8 RK and 2 AK scars OD, 8 RK scars OS with faint LASIK scars, elevated pingueculae OD>OS, and 1+ cortical cataracts OU. Moderate inferior and infero-temporal corneal thinning was present OD>>OS which coincided with the area of steepening on corneal topography. Dilated examination was unremarkable OU. He was referred for scleral lens fitting in hopes of avoiding a bilateral cornea transplant coupled with cataract surgery. An in office scleral lens trial was performed on both eyes using the Zenlens diagnostic lens 8.50BC/16.0/oblate/-2.00/5000 sag/std APS. Over-refraction OD -3.00+2.00x180 yielded 20/50-1 BCVA, OS -1.00+1.00x160 yielded 20/40-1 BCVA. After settling, there was central clearance but faint touch over the infero-temporal displaced ectatic area of the cornea with excessive limbal clearance inferior OU. The haptics showed moderate blanching temporal>nasal overlying the pingueculae OD>OS with subsequent areas of lift off surrounding the pingueculae as well as at the superior haptic due to inferior decentration. It was evident that although BCVA could greatly be improved, toric haptics, front-toric optics, and lifts would be needed both nasally and temporally to accommodate the pingueculae OU. Given the complexity of the fit coupled with large pingueculae and the limitations of diagnostic scleral lens designs, a custom impression based scleral lens was recommended. However, after discussion of costs, the patient was unable to afford such unique technology. He was then fit with a 16mm Latitude custom designed scleral lens (Visionary Optics, Front Royal, VA) in both eyes. Data from over 1 million data points was collected using the sMap3D corneo-scleral topographer and data was sampled for manufacturing of over 96 individual meridians; a standard toric lens uses 2 meridians.

Right Eye (OD)

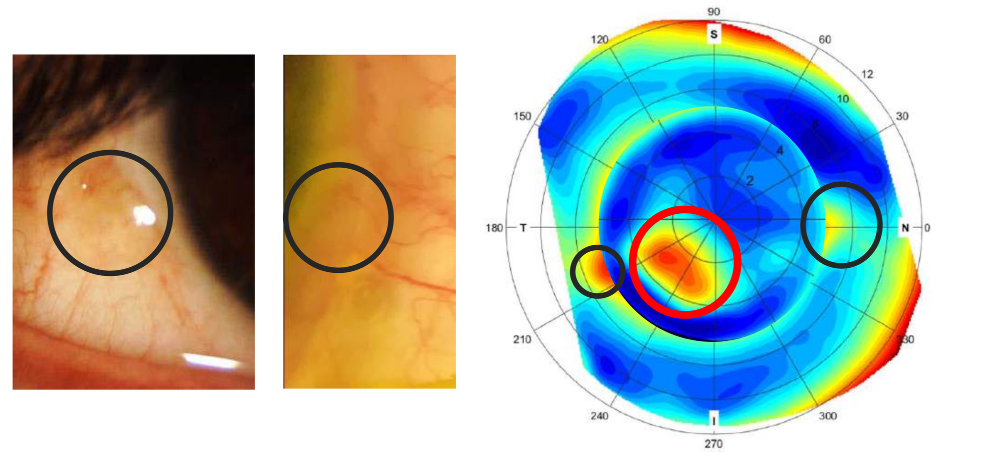

Figure 1
Slit lamp imaging of the right eye (left) demonstrated the presence of pingueculae at 0˚ and 200˚ (**black circles**). This is also visualized on the composite corneal scleral elevation map (right). An infero-temporal ectasia was also seen from 2-4 mm from the corneal center (**red circle**).

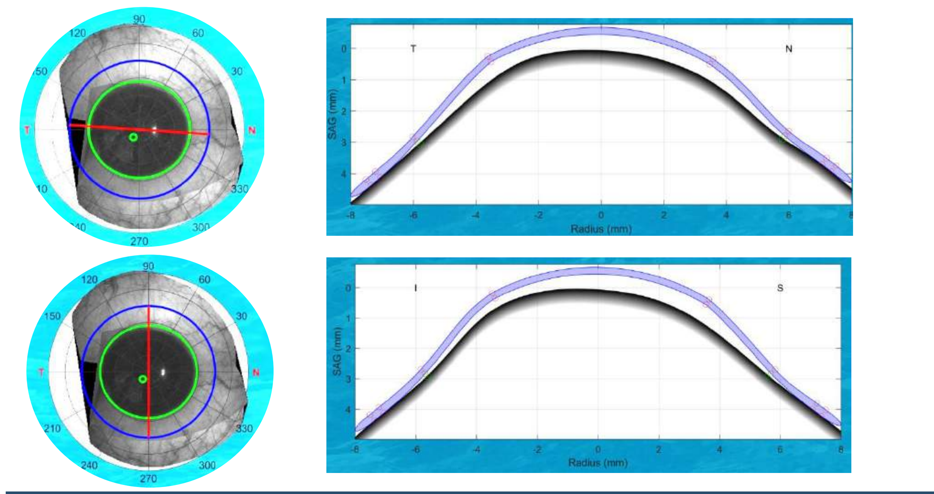

Figure 2
A 16mm customized Latitude lens was designed to fit this highly irregular eye. Over 1 million data points at intervals of less than 2°, 360° around were collected from the corneal scleral topography examination. The red lines in the polar graphs on the left define the meridians shown as computer generated sagittal images on the right; the purple object is the scleral lens drawn to scale above the shaded-grey ocular surface.

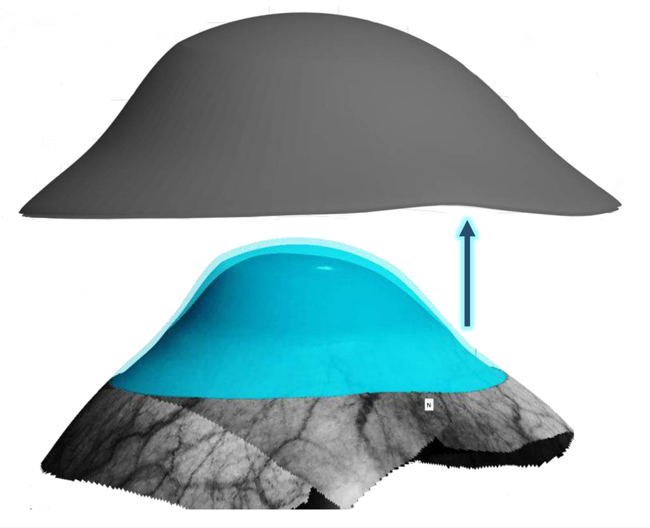

Figure 3
The top image shows 3D imaging of the lens design which demonstrates the highly irregular shape of the Latitude lens necessary to fit the ocular surface. Note the elevated area of one of the pinguecula (**blue arrow**). The bottom image shows the lens design superimposed on an ocular surface map derived from the sMap3D corneo-scleral topographer.

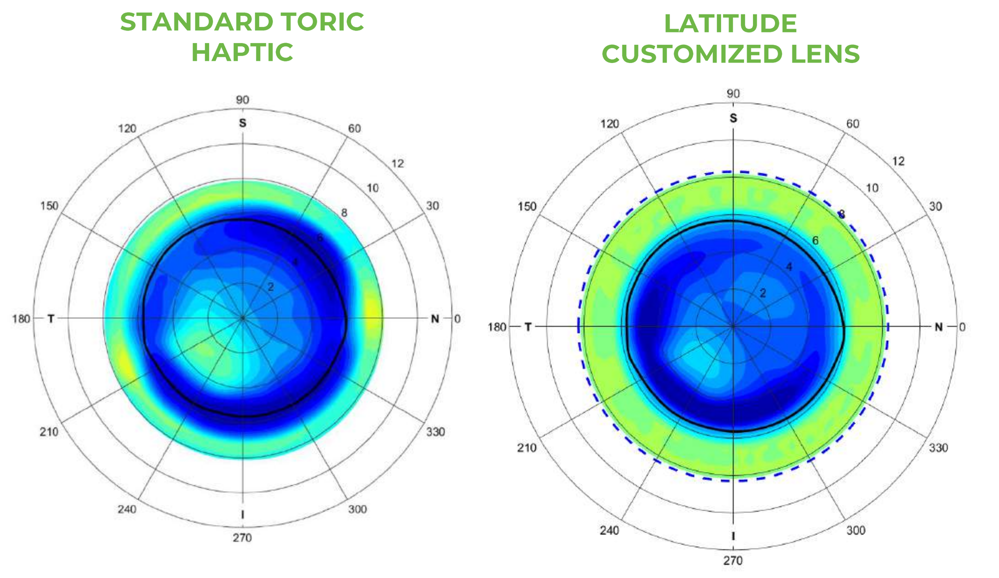

Figure 4
Figure 4 demonstrates the anterior polar lens elevation maps comparing the fit of a standard toric haptic scleral lens (left) and the Latitude customized lens (right). Various shades of blue demonstrate clearance of the lens over the ocular surface, shades of green show mild touch and yellows show areas of compression. The image on the left of a fit to a standard toric haptic lens with compression over the 2 pingueculae. The image on the right shows the fit of the Latitude custom lens a broad haptic zone of a uniformly green color indicating a well fitting lens just touching the surface.

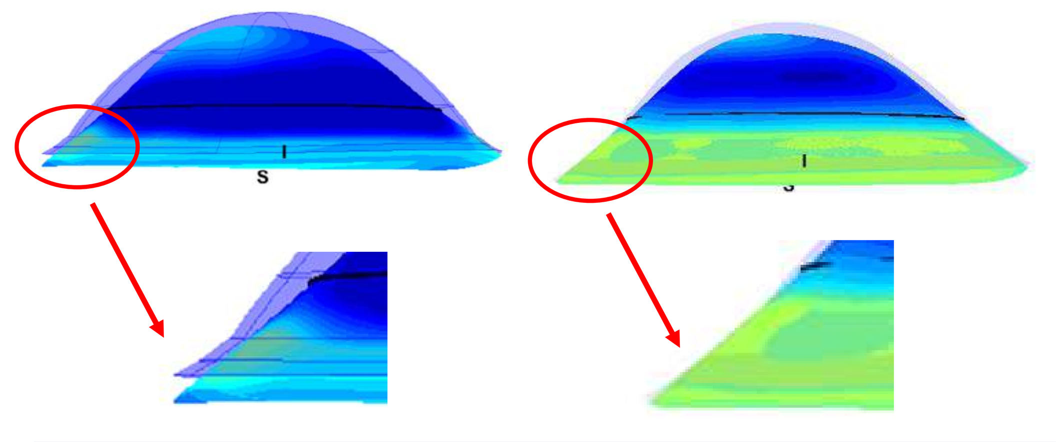

Figure 5
Here are sagittal lens elevation maps demonstrating the fit of a standard toric haptic scleral lens (left) and the Latitude customized lens (right). The **red circles** show the area of the fit temporally just superior to the pinguecula. The fit with a standard toric haptic predicts an area of edge lift while the Latitude lens fits the surface well.

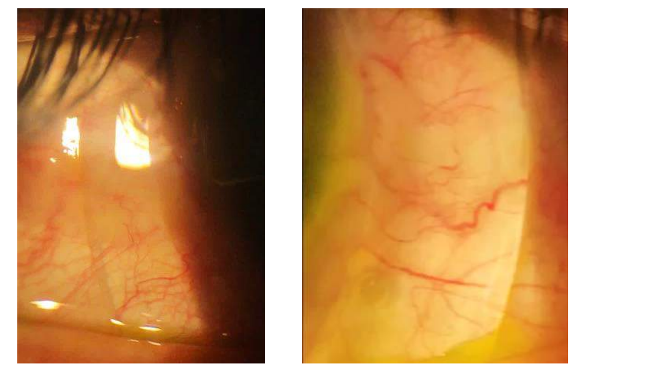

Figure 6
The Latitude lens was well fitting 360°; as demonstrated by the lens fit over the pigueculae temporally (left) and nasally (right). The lens was comfortable and final BCVA OD was 20/40-2.

Left Eye (OS)

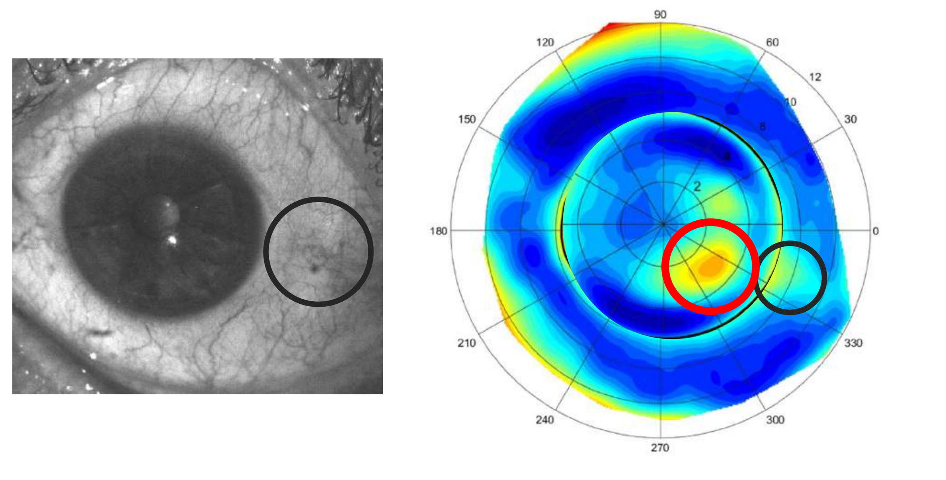

Figure 7
Eye imaging from the sMap3D of the left eye (left) demonstrates the presence of pinguecula at 340˚(**black circles**). This is also visualized on the composite corneal scleral elevation map (right). An infero-temporal ectasia is also seen from 2-4 mm from the corneal center (**red circle**).

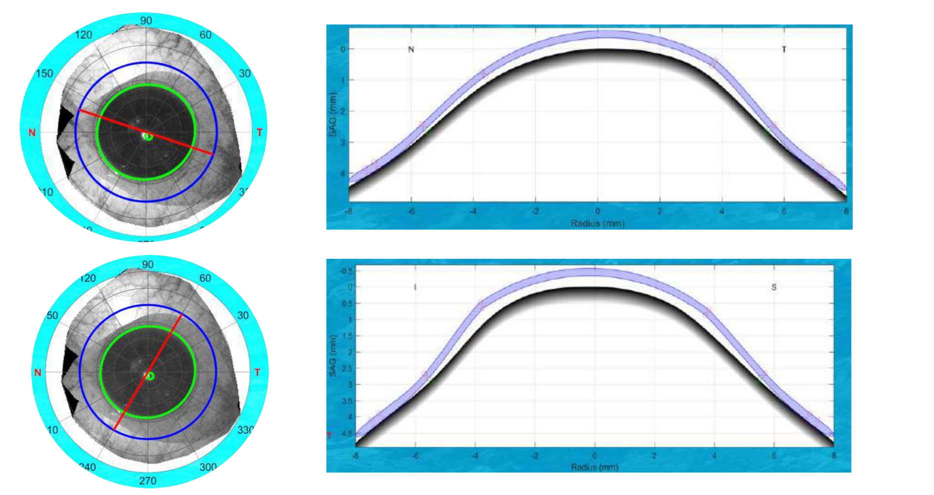

Figure 8
A 16mm customized Latitude lens was designed to fit this highly irregular eye. Over 1 million data points at intervals of less than 2°, 360° around were collected from the corneal scleral topography examination. The red lines in the polar graphs on the left define the meridians shown as computer generated sagittal images on the right; the purple object is the scleral lens drawn to scale above the shaded-grey ocular surface.

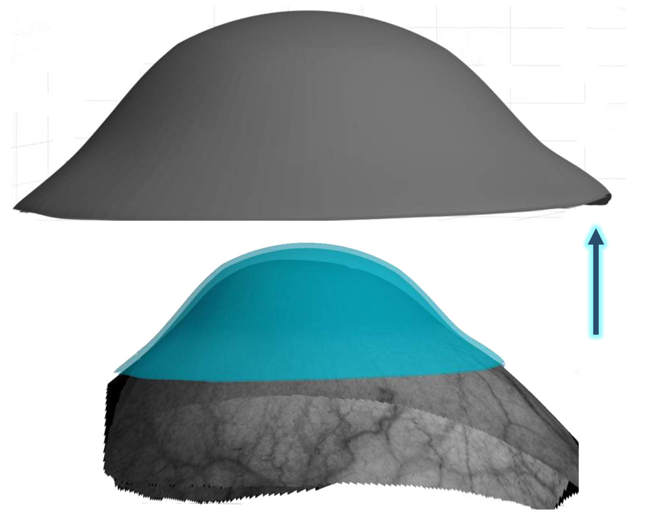

Figure 9
The top image shows 3D imaging of the lens design which demonstrates the highly irregular shape of the Latitude lens necessary to fit the ocular surface. Note the elevated area of one of the pinguecula (**blue arrow**). The bottom image shows the lens design superimposed on an ocular surface map derived from the sMap3D corneo-scleral topographer.

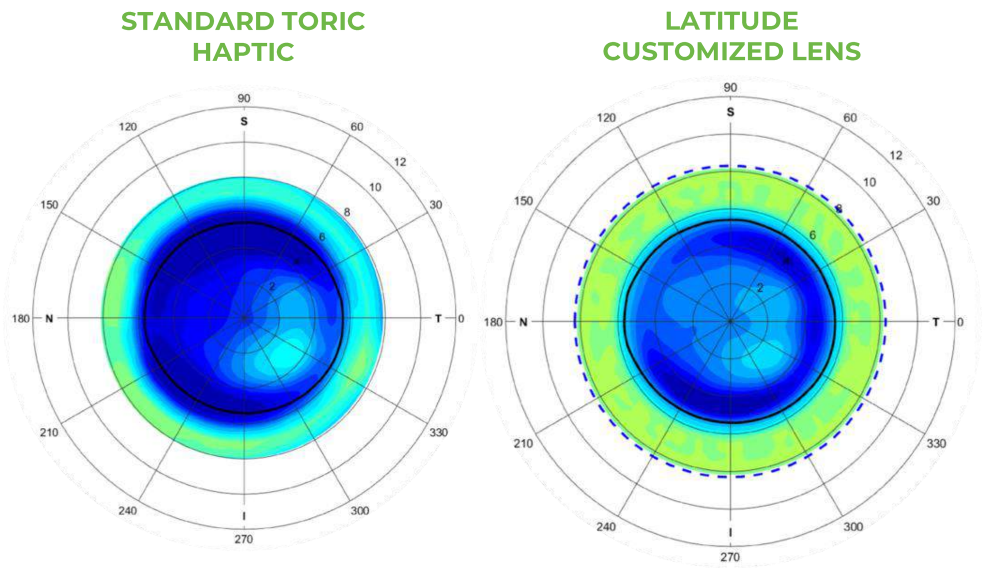

Figure 10
Figure 10 demonstrates the anterior polar lens elevation maps comparing the fit of a standard toric haptic scleral lens (left) and the Latitude customized lens (right). Note the thinner peripheral haptic with more color variations in the left image as compared to the broad haptic zone of a uniformly green color indicating a well-fitting Latitude lens just touching the surface.

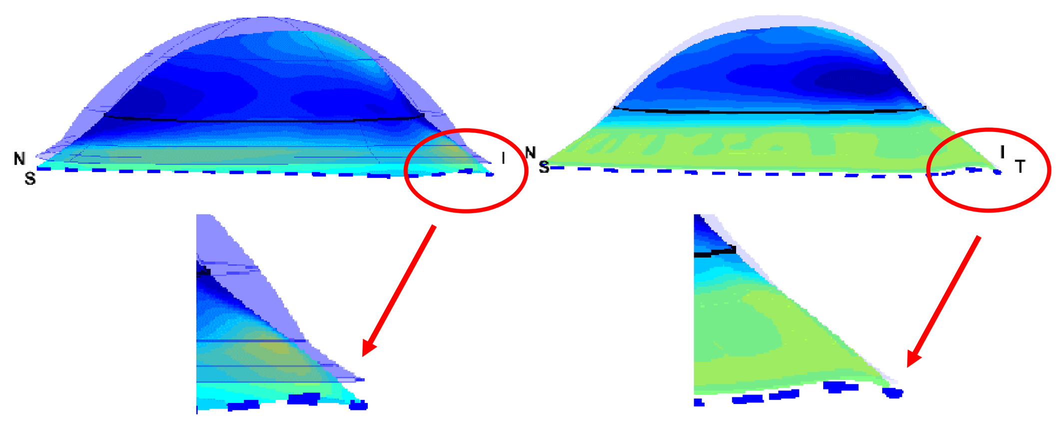

Figure 11
Here are sagittal lens elevation maps demonstrating the fit of a standard toric haptic scleral lens (left) and the Latitude customized lens (right). The red circles show the area of the fit infero-temporally adjacent to the pinguecula. The fit with a standard toric haptic predicts an area of edge lift while the Latitude lens fits the surface well.

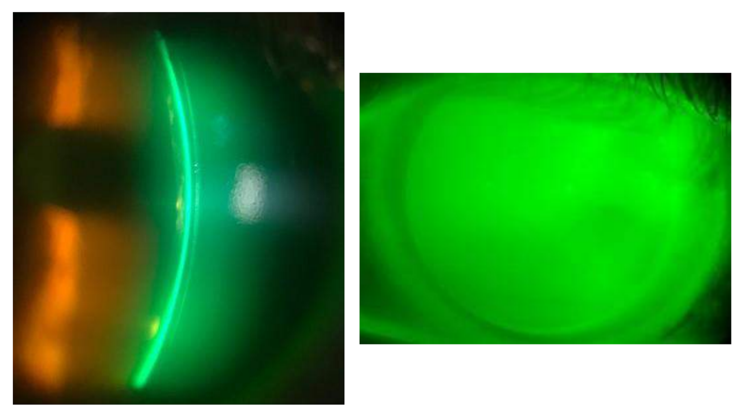

Figure 12
The Latitude lens was well fitting 360˚; the lens was comfortable and final BCVA OS was 20/30-2. The patient was able to avoid the immediate need for cornea transplantation OU.

Conclusion

Results of the Scleral Shape Study Group indicate that the majority of eyes present some sort of scleral asymmetry versus spherical or regular toric patterns. Using a corneo-scleral topographer, it is possible to identify and quantify size, shape and location of scleral obstacles including filtering blebs and pingeculae. In complex cases, such as the one described, a highly customized peripheral haptic scleral design can allow a close match of the haptic to the unique scleral shape avoiding adverse events and improving lens comfort compared to standard spherical and regular toric designs. The sMap3D corneo-scleral topography is highly repeatable in regard to sagittal height and scleral toricity measurements. This novel corneo-scleral device and innovative software technology accurately mapped both corneal and scleral irregularities and empirically designed scleral lenses dramatically simplified the fitting process and improved the odds of success. These virtually fit scleral lenses provided the patient with good comfort and vision and helped him avoid a cornea transplant.

References

1. DeNaeyer G, Sanders DR, Van Der Worp E, Jedlicka J, Michaud L, and Morrison S. Qualitative assessment of scleral shape patterns using a new wide field ocular surface elevation topographer: the SSSG study. J Cont Lens Res Sci. 2017, Nov 1(1): 12-22.
2. Achenbach P, DeNaeyer G, Sanders DR. Simplifying Scleral Lens Fitting in the Presence of Localized Elevations with a new Corneo-Scleral Topography System: Notches & Lifts. Poster American Academy of Optometry, Chicago. October 12-13, 2017.
3. DeNaeyer G, Sanders DR. sMap3D Corneo-Scleral Topography Repeatability in Scleral Lens Patients. Eye Contact Lens. 2017 Jul 21; [Epub ahead of print].