Surface Coverage with Single vs. Multiple Gaze Surface Topography to Fit Scleral Lenses
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Introduction
Until very recently, scleral lens fitting has depended upon the use of a diagnostic fitting set utilizing a trial-and-error process. The measurement of the anterior ocular surface is necessary to measure two critical parameters key to scleral lens fitting: the sagittal height of the eye (SAG) at the diameter of the scleral lens and the shape of the eye. There are currently 2 corneoscleral elevation topography systems commercially available:

Eye Surface Profiler (Eaglet Vision, Roemond, Netherlands) Relies on a single straight-gaze view to obtain surface topography
sMap3D® (Precision Ocular Metrology LLC, Cedar Crest, NM) Takes three images of the anterior ocular surface and stitches them together to produce a single wide field topographic image

Both of these systems measure corneal and scleral SAG and choroid. Unlike placido-based (reflection) corneal topography systems, both of these systems are based upon the fluorescence (fluorescein) detection of the ocular surface abnormalities, or corneal scarring or irregularity; virtually any surface can be scanned.

Objective
To determine if data obtained from a single straight-gaze examination provides a sufficient area of measurable scleral coverage within a given diameter to provide accurate data for mini-scleral and full scleral lens fitting.

Methods
Twenty-five eyes of 23 patients that presented for scleral lens fitting were retrospectively analyzed. All patients were measured with the sMap3D instrument using recommended exam procedure: three image acquisitions (up, straight and down gaze) with the application of a fluorescein and anesthetic solution. Examinations were performed by a scleral lens fitter who had experience using the instrument on a routine basis. All patients were examined for 10 months before the patients in this study were examined. Acquisition time for all 3 images was usually less than 2 minutes. The extent of readable sclera and cornea and the limbal outline were identified for each image. The 3 images were aligned using a proprietary stitching algorithm.

Results
Figure 1 presents the coverage graph for the entire series of 25 eyes. Both the straight-gaze and stitched image provided 100% ocular surface coverage at a 10mm diameter circle from the corneal center. At the 14, 15, 16, 18 and 20mm diameter circles the straight-gaze image only covered 68%, 53%, 39%, 18%, and 6% of the ocular surface respectively while the stitched image covered 98%, 96%, 93%, 75%, and 32% respectively. Only 12% of cases in the straight-gaze group had >70% coverage at a 16mm diameter compared to 92% in the stitched group; 72% had greater than 90% coverage in the latter group (Figure 2).

Average Case
Most similar coverage in the straight gaze image (16mm) to the average of the series

Best Case: Most amount of coverage in the straight gaze

Worst Case: Least amount of coverage in the straight gaze

The Average Case to the left shows the appearance of the case in the series with the most similar coverage at 16mm in the straight gaze image to the average of the series. The Best Case (below, left) shows the appearance of the case in the series with the most coverage in the straight-gaze image and the Worst Case (below, right) shows the appearance of the case in the series with the least coverage. No case in the stitched group had less than 65% coverage at the 16mm diameter circle, however 68% of cases in the straight-gaze group had <50% coverage (Figure 2). The 95% limits of agreement between the 50% and 100% coverage scleral toricity was between -1.4D (50% coverage value larger) and 1.0D (100% coverage larger), a 2.6D spread. The absolute difference between 50% to 100% coverage scleral toricity was ±0.50D in 28% and ±1.00D in 16% of cases.

Discussion
The decreased coverage using the single gaze approach makes calculation of back surface power unreliable since, due to the shape of the lens, surface, fitting, and/or sclera are the areas usually unreadable at 16mm making either the steep or flat meridian unmeasurable depending upon whether with- or against-the-rule scleral toricity is present. Since the two commercially available corneo-scleral topography systems are both based upon the fluorescence detection of the ocular surface, the single (primary) gaze image from both instruments should give the same amount of coverage and based upon the data presented, the stitched image provided by the sMap3D instrument should give substantially more coverage. It appears that a single straight-gaze image would introduce significant measurement inaccuracy in fitting scleral lenses while a 3-gaze stitched image would not.

Conclusions
• 3-gaze stitched image averaged 96% and 93% coverage at 15mm and 16mm diameters
• A straight-gaze image averaged 53% and 39% coverage at 15mm and 16mm diameters
• The 95% limit of agreement for scleral toricity between 50% and 100% coverage had a 2.6D range
• A 3-gaze stitched image was more accurate than a straight gaze to fit scleral lenses

References

Disclosures
Drs. DeNaeyer and Sanders and Mr. Farajian are shareholders in Precision Ocular Metrology, the manufacturer of the sMap3D® instrument. Dr. Sanders is a shareholder of Visionary Optics and Dr. DeNaeyer is a consultant to Visionary Optics. Visionary Optics distributes the sMap3D® and helped fund this research.