Comparing scleral contact lenses generated by impression technology vs Scheimpflug images

Bruno Laÿ[1], Christine Sindt[2], Ronan Danno[1]

(1) ADCIS SA, Saint-Contest, France – (2) Department of ophthalmology, University of Iowa, Iowa City, IA

EYEPRINT PROSTHETICS

PURPOSE

The purpose of this project is to evaluate ocular surface elevation data generated by impression technology (EyePrint EPD software) vs rotating Scheimpflug imagery. The elevation data between the data collection techniques is compared and then evaluated to the alignment on the ocular surface with an elevation specific contact lens.

METHODS

The elevation specific lens design software (EPD) was modified to import either:

- A digitized impression (DI) as an STL file that has been generated by a 3D scanner taking as input an impression and generating a 3D mesh file made of about 100,000 points. The optic center is designated manually.
- A Corneo-Scleral Profile (CSP) as a CSV file, generated by the Scheimpflug imagery. The size of the file is 22,000 points. EPD automatically positions the optic center at the CSP apex (Vertex Normal) location as defined by the Scheimpflug system. CSP data sets were generated at 2 different time points (T1 and T2).

In both cases, limbal detection was done manually by an expert grader.

The DI and CSP datasets are defined with two different coordinate systems, therefore an automatic registration step is necessary. This outputs a Root Mean Square (RMS) distance value which indicates the correlation between the two surfaces.

Contact lenses were designed with the EPD software using the DI and CSP datasets.

The contact lenses were placed on the eye and evaluated with anterior segment ocular coherence tomography (OCT) to assess lens to ocular surface relationships.

METHODS (CONTINUED)

14 eyes without pathology were evaluated with impression technology and Scheimpflug imagery. 2 lenses per eye were generated with both the DI and the CSP data sets. Lenses were made based on the maximum diameter of the scleral data available on the scans.

The following parameters were then assessed:

- RMS distance value between DI and CSP after automatic registration between both 3D surfaces.

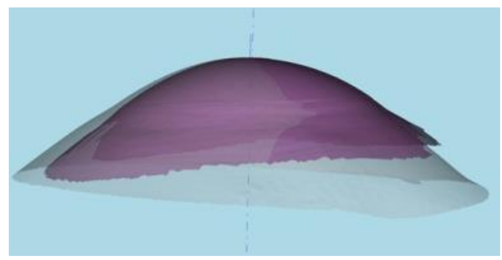
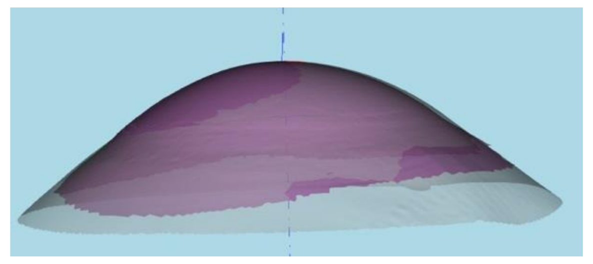



Figure 1: Before and after registration. DI in gray, CSP in purple

- Maximum (i.e. ellipse major axis) limbal diameters were compared between the DI and CSP datasets.

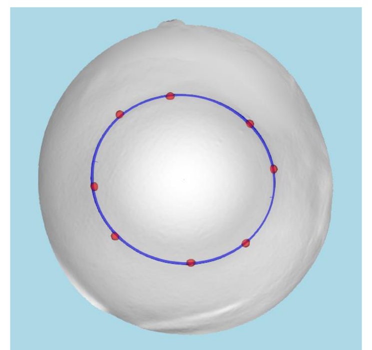
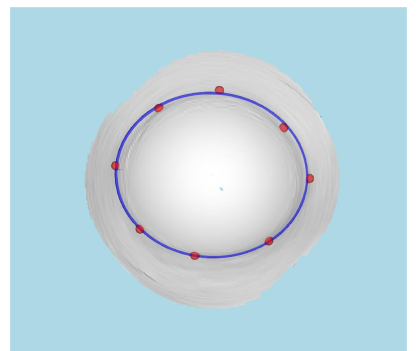


Figure 2: Limbal detection on DI



Limbal detection on CSP

- Central vault and peripheral landing using Optovue OCT scans (on a subset of 4 eyes).

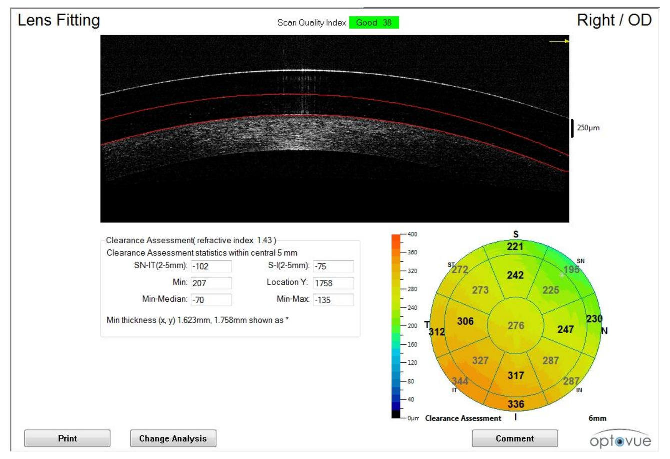
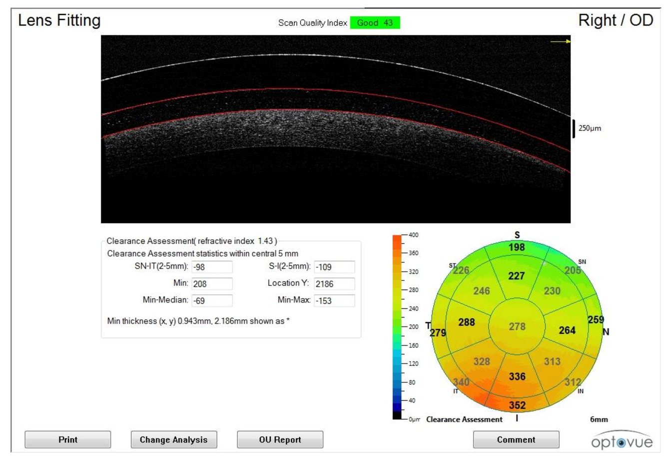


Figure 3: Central vault on DI



Central vault on CSP

Figure 4: Peripheral landing on DI

Peripheral landing on CSP

RESULTS

	RMS CSP Time 1 vs DI	RMS CSP Time 2 vs DI	Maximum Limbal Diameter CSP (mm)	Maximum Limbal Diameter DI (mm)	Central Vault DI	Central Vault CSP
Eye #1	0.0644	0.0647	12.09	12.33	209	251
Eye #2	0.0940	0.0988	12.1	12.53		
Eye #3	0.0943	0.0902	11.72	11.95		
Eye #4	0.0723	0.0880	11.74	11.83		
Eye #5	0.0688	0.0868	12.87	13.56		
Eye #6	0.0622	0.0703	12.41	13.14		
Eye #7	0.0788	0.0842	12.38	12.85	258	286
Eye #8	0.1050	0.1035	12.99	13.39		
Eye #9	0.1330	0.1265	12.63	12.76		
Eye #10	0.1900	0.1893	12.14	12.84		
Eye #11	0.0583	0.0627	12.17	12.84	324	334
Eye #12	0.0848	0.0692	11.97	13.05	278	276
Eye #13	0.0555	0.0568	12.05	12.76		
Eye #14	0.0834	0.0897	12.17	13.28		

Figure 5: RMS distance, max limbal diameter and central vault values

- CSP compared to DI among all subjects and time-points has an average RMS distance of 0.0902 mm. This shows consistency between the DI and the CSP data.
- CSP vs DI RMS distances at T1 and T2 differ with an SD of 0.0083 mm. This shows consistency between scans.
- Maximum limbal diameter is larger on the DI than on the CSP, showing an average difference of 0.43 mm. This shows the curvature change in the limbus area is measured differently in both techniques.
- Central vault between DI and CSP yields an average difference of 19.5 µm (with an SD of 16.8 µm).

CONCLUSIONS

Impression technology has been validated over many years and contact lenses up to 26 mm have been successfully fit with this data.

Rotating Scheimpflug cameras give similar data up to 16 mm and can successfully generate mini scleral contact lenses. The Scheimpflug imagery can give additional data such as pupil center, visual axis, automated limbal detection and posterior cornea higher order aberrations (HOA). Scheimpflug imagery opens the market for not only elevation specific mini scleral lens design, but also advanced optics including visual axis aligned multifocal and HOA correction.