Enhancing Vision Through Innovation: Profilometry-Based Scleral Lens Design for Advanced Post-Surgical Glaucoma Patient

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Introduction

The successful use of scleral contact lenses for corneal surface rehabilitation and corneal epithelial defect resolution has been described in many peer-reviewed publications[1,2,3]. The scleral and conjunctiva shape of an individual patient is unique and can pose challenges in fitting scleral lenses when patients have undergone surgical procedures secondary to retinal or glaucomatous disease. The use of free-from scleral lens design in the form of profilometry or impression-based designs has been significant in allowing highly specific and customized designs. This technology is repeatable and reliable[(4,5)] when obtaining data on patients making it clinically relevant for challenging cases where diagnostic scleral lens design is not compatible.

Case Report

A 76-year-old female was referred for a scleral lens evaluation by her corneal specialist in a last-resort effort to improve the patient's ocular surface. The patient has a history of neurotrophic keratitis, worse in the right than the left, with a non-healing epithelial defect in the right eye.

The patient reported longstanding severely blurred vision with glaucomatous vision l3oss due to severe congenital open-angle glaucoma. She presented to the clinic with an epithelial defect in the right eye that was non-healing for 6 months. The corneal defect was treated with amniotic membranes, bandage contact lenses, topical cenegermin, and aggressive topical lubrication without complete resolution. The patient reports surgical history of cataract removal in both eyes and dual glaucoma tube shunts in each eye.

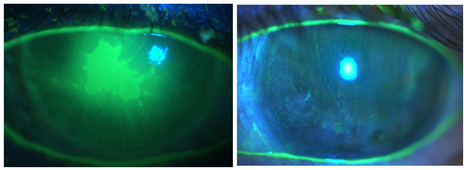
Entering spectacle visual acuity:

OD: 20/CF @5ft, PH: no improvement

OS: 20/400, PH: 20/200

Baseline Evaluation

Figure 1. Baseline corneal surface OD, OS



The patient presented with a persistent corneal epithelial defect in the right eye measuring 4mm x 4mm and a very desiccated and irregular corneal surface in the left eye (Figure 1).

Due to the presence of two glaucoma tube shunts (superior temporal and inferior nasal) in each eye and the corneal defect in the right eye, profilometry imaging was obtained using the sMap3D device (Visionary Optics), Figure 2,3.

Figure 2. Profilometry Scan OD

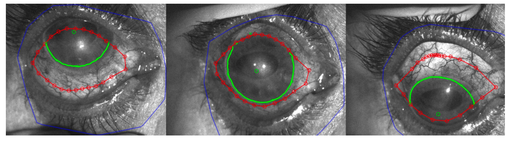
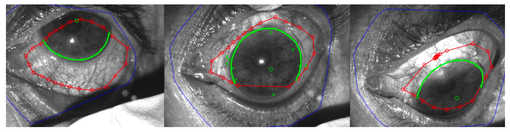


Figure 3. Profilometry Scan OS



The patient's scleral lenses were ordered based on the profilometry imaging scans. Standard diagnostic scleral lenses did not fit adequately to determine power due to the patient's unique conjunctival shape. A corneal gas permeable lens was not used for power determination to avoid mechanical interaction with the corneal defect. The power determination would be evaluated after the first pair of scleral lenses were dispensed.

The patient was instructed to continue all topical therapies until the dispense visit.

Initial Dispense

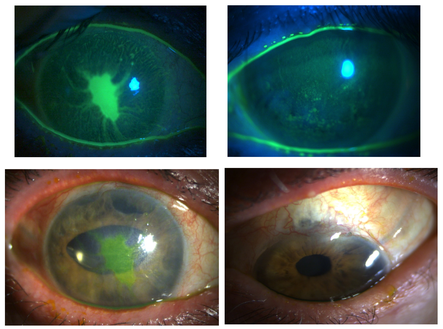
The patient returned for scleral lens dispense 1 week later with some improvement in her epithelial defect in the right eye and stable ocular surface in the left eye (Figure 4). The visual acuity recorded was the same as the previous visit.

The patient was taught how to apply, remove, care for, and clean scleral contact lenses successfully in office.

Visual acuity for the right eye improved to 20/400 with the scleral lens in place. Further power determination was planned for once the epithelial defect closed.

With the scleral lens in place in the left eye, vision improved to 20/40 with a -3.00 DS over-refraction.

Figure 4. Day 1 Scleral Lens Dispense - Corneal Surface OD,OS



The fit of both scleral lenses was adequate without blanching, compression, or lift off of the edge, including over the glaucoma tube shunts. The fluid reservoir was adequate throughout each eye, with 350 um centrally in the right (Figure 5), and 250 um centrally in the left (Figure 6).

Both lenses were dispensed with instructions for daily lens wear to accommodate the patient's significant topical therapies for glaucoma.

Figure 5. Scleral Lens Fit OD

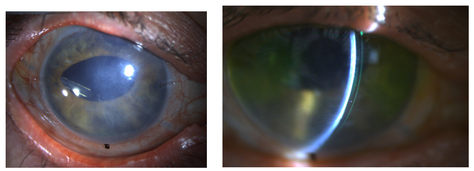
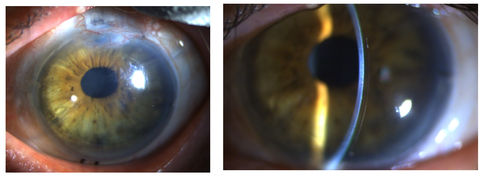


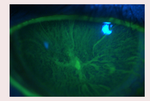
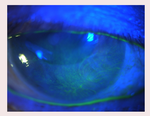
Figure 6. Scleral Lens Fit OS



Follow up

The patient was followed closely after initiating lens wear and continual communication was made with the patient's referring corneal and glaucoma specialists. The patient's corneal defect progress was photo documented at each visit (Table 1), with complete resolution of the corneal defect on day 10 of lens wear.

Table 1. OD Corneal Defect Progress

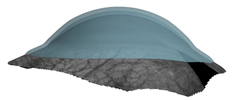
Right eye corneal epithelial defect after lens removal	Days of daily wear scleral lens wear	Visual acuity
	Day 3	20/400
	Day 7	20/80
	**Day 10 *Complete resolution of defect**	20/50
	Day 180 *no recurrences of epithelial breakdown	20/40

The patient was able to subjectively chose power as her corneal surface improved and subsequent scleral lenses were ordered to incorporate power improving vision to 20/40 in the right eye and 20/20 in the left eye. This visual improvement was significantly surprising to the patient as she was told her vision impairment was permanent starting 25 years prior due to glaucoma damage.

The patient's lens fit and ocular surface continues to be followed closely with no recurrences of corneal surface breakdown had been observed since initiating scleral lens wear. The patient's ocular surface was assessed by removing lenses at every visit, photo documenting findings, and checking intraocular pressure.

Final Scleral Lens Design

OD: Visionary Optics Latitude®
BC: 8.438 mm
Power: +2.00 DS
Diameter: 16.50 mm



OS: Visionary Optics Latitude®
BC: 7.856 mm
Power: -3.00 DS
Diameter: 16.50 mm

Discussion

Scleral lens technology has expanded significantly in recent years. With the implementation of free-form scleral lens design, either with impression mold or profilometry, practitioners now can design completely customizable scleral contact lenses. In this case, the patient had been treated with every medical therapy to resolve the epithelial defect without success. The patient's complicated glaucoma surgical history of dual tube shunts in each eye inhibited the use of traditional diagnostic scleral lenses due to the significantly asymmetrical and irregular conjunctival shape. The use of profilometry to create a highly specific scleral lens in each eye was successful in accurately fitting over the conjunctival obstacles allowing for complete resolution of a non-healing epithelial defect in the right eye. Subsequently, the patient experienced a profound improvement in visual acuity that was thought to be lost permanently due to glaucomatous disease. Communication between providers was paramount in the successful outcome of this case as the patient has a complex ocular history requiring frequent monitoring.

Conclusion

The use of profilometry to design customized scleral lenses was successful in this case in rehabilitating the ocular surface and resolving an epithelial defect that failed multiple traditional medical therapies. Traditional diagnostic or non-free-form based scleral lens designs would not have been successful in this case due to the presence of two glaucoma tube shunts in each eye causing significant conjunctival shape challenges. This case highlights the benefit of co-management with optometry and ophthalmology to provide the patient with access to all options for vision and corneal surface rehabilitation.

References

1. Lee SM, Kim YJ, Choi SH, Oh JY, Kim MK. Long-term effect of corneoscleral contact lenses on refractory ocular surface diseases. Cont Lens Anterior Eye. 2019 Aug;42(4):399-405. doi: 10.1016/j.clae.2018.10.011. Epub 2018 Oct 30. PMID: 30389416.
2. Paul S, Natarajan R, Iqbal A. Prosthetic Replacement of Ocular Surface Ecosystem Scleral Lens: Benefits of an In-Clinic Therapeutic Approach for Persistent Corneal Epithelial Defect. Eye Contact Lens. 2021 Oct 1;47(10):578-580. doi: 10.1097/ICL.0000000000000827. PMID: 34369409.
3. Vilares Morgado R, Moura R, Moreira R, Falcão-Reis F, Pinheiro-Costa J. New Promising Therapeutic Approach for Refractory Corneal Epithelial Defects. Cureus. 2023 May 22;15(5):e39324. doi: 10.7759/cureus.39324. PMID: 37351246; PMCID: PMC10283014.
4. Bandlitz S, Esper P, Stein M, Dautzenberg T, Wolffsohn JS. Corneoscleral Topography Measured with Fourier-based Profilometry and Scheimpflug Imaging. Optom Vis Sci. 2020 Sep;97(9):766-774. doi: 10.1097/OPX.0000000000001572. PMID: 32941338.
5. DeNaeyer G, Sanders DR. sMap3D Corneo-Scleral Topographer Repeatability in Scleral Lens Patients. Eye Contact Lens. 2018 Sep;44 Suppl 1:S259-S264. doi: 10.1097/ICL.0000000000000401. PMID: 28737664.

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