When Sclerals Fail: Getting Creative Within Your Limitations for Post-Traumatic Corneal Grafts

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Background

Injury to the cornea can cause various structural changes and any trauma beyond the epithelium can lead to permanent vision loss. The sequela of deep corneal injury includes corneal distortion, scarring and edema. Beyond the cornea, penetrating injuries can result in hyphema, iris defects/misshapen pupils, retinal detachment and more[1]. In some cases, vision potential can only be restored with a penetrating keratolasty (PKP).

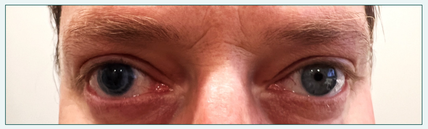
Contact lens fitting post-keratoplasty has its challenges, most of which stem from an oblate corneal shape and highly irregular astigmatism. Modern scleral contact lenses have become a popular option for various corneal and ocular surface diseases. Specifically, for corneal grafts, these lenses serve as an excellent option due to its complete corneal clearance and improved stability compared to corneal rigid gas permeable (RGP) lenses. Although many PKP patients have successful scleral wear, complications still exist that require careful lens fitting and monitoring. The major complication of concern is corneal graft rejection, which can result from chronic insults associated with lens wear. It is important to consider factors such as corneal hypoxia, microtrauma, epithelial erosions and toxicity effects. A scleral contact lens may aggravate these factors in the following ways. Firstly, oxygen transmissibility occurs through the scleral lens and then tear reservoir to become available to the cornea. To avoid hypoxic-related complications, scleral lenses could be designed with minimal lens thickness, a high Dk material and a minimal post-lens vault. Some oxygen is available from tear exchange, although this variable is dependent on the individual fit and is minimal compared to other contact lens such as RGPs[3]. Tear exchange could also be impacted by conjunctival prolapse, where the pliable conjunctival is suctioned into the limbal clearance zone, a common scleral lens complication. To avoid this, limbal clearance should be kept minimal during lens design[2]. Secondly, lens-eye suction or “seal-off” could create microtraumas and a toxic environment for the eye. A lens that has a strong adhesion result in more difficult removal, therefore inducing chronic trauma to the globe. This risk is exacerbated in PKP patients where there is an increased suction force from oblate corneal shape and the corneal stroma is already weakened post-surgery. Seal-off also creates a stagnant tear reservoir which decreases oxygen transmission and accumulates in toxic metabolic waste[3]. Lastly, epithelial erosions could occur due to lens bearing and is especially worrisome along the graft/host interface. The extreme corneal irregularity in some PKP patients creates difficulties in traditional scleral lens fits. The philosophy is to avoid excess clearance as this could induce hypoxia and avoid too little clearance as this could result in corneal touch. This balance may be best alleviated with an impression-based or freeform design. Although scleral contact lenses may be a great option for many PKP patients, there are complications that can cause these high-risk patients to fail out of these lenses.

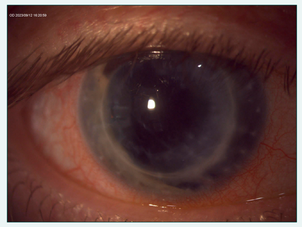
When scleral lenses fail, more traditional contact lens modalities must be explored. RGP lenses have limitations on such an irregular PKP cornea as the lenses have poor stability which leads to lens decentration and ejection out of the eye. Traditional soft contact lenses often provide poor visual outcomes since the irregular astigmatism cannot be neutralized[2]. A combination of the two would be a piggyback system, placing a soft lens underneath the RGP. The soft lens acts to roughly smooth the corneal shape, acts as a protective barrier, and improve centration of the RGP. With a normalized surface to land on, the RGP acts to correct vision. With this two-lens system, oxygen transmissibility should be optimized, especially in a PKP patient[4].

Another aspect to managing a patient post-penetrating injury is the management of misshaped pupils. In these cases, a prosthetic tinted contact lens could be utilized. These lenses are used for various iris defects such as aniridia, ocular albinism and iris atrophies. Commercially available cosmetic contact lenses are translucent with a predefined, colored iris. Custom prosthetic contact lenses have a much greater range of design options including pupil or iris occlusion, clear pupil or iris, personalized iris pigments, various pupil sizes and more[5]. The use of these lenses is individualized to each clinical case and can offer great visual and cosmetic outcomes.

Case History

- 45yo male
- **POH**: Primary injury OD (2008)
  Penetrating keratoplasty OD (2008)
  Secondary injury with corneal rupture OD (2022)
  Corneal repair OD (2022)
  Second penetrating keratoplasty OD (2023)





Solution #1: Scleral Lens

The patient was initially fit in a scleral lens with minimal central thickness, minimal post-lens reservoir and adequate tear exchange to maximize oxygen permeability.

Lens Parameters
16.0 / 4550 / 6.95 / +8.50 / Std limbal clearance / Edges-F3/S3
VA 20/150

Corneal pachymetry was measured before/after 4 hours of wear-time. Significant corneal edema was observed and the patient was failed out of scleral lenses.

Solution #2: Corneal GP Lens

The patient was then fit in a corneal GP lens to maximize oxygen permeability.

Lens Parameters
9.40 / 7.5 / +12.25
VA 20/125

The best-fit lens still had poor stability that often ejected out of the patient’s eye with great discomfort.

Solution #3: Traditional Piggyback System

To improve fit and comfort, a piggyback system was trialed over a small-diameter, steep conventional soft lens.

GP Lens Parameters
9.40 / 7.5 / +12.25
Soft Lens Parameters
13.8 / 7.9 / PLANO / Dk/t 121
VA 20/125

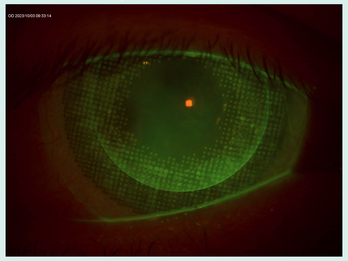
The lens had greater centration and improved patient comfort. The patient did not experience significant corneal edema after 4 hours of wear-time in this system. However, photophobia and cosmesis was still a concern.

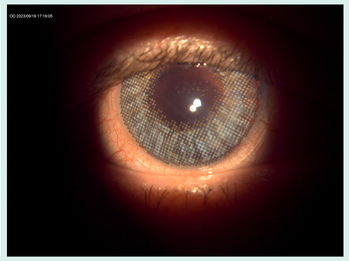
Solution #3: Piggyback: Corneal GP over Commercially-Available Colored Soft Lens

To address patient’s concerns, a commercially-available colored soft contact lens was trialed under the corneal GP.

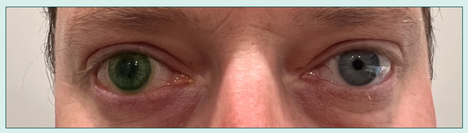
GP Lens Parameters
9.40 / 7.5 / +12.25
Soft Lens Parameters
14.2 / 8.6 / PLANO / Dk/t 138 / Pupil 6mm / Color Grey / Silicone Hydrogel
VA 20/50

CONT - Solution #3: Piggyback: Corneal GP over Commercially-Available Colored Soft Lens





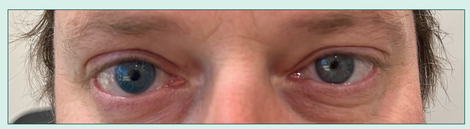
This system successfully provided greater centration of the GP lens and a slight pinhole effect. The patient did not experience significant corneal edema after 4 hours of wear-time in this system. Unfortunately, the patient would like to further improve vision, photophobia and cosmesis with a smaller pupil size.



Solution #4: Piggyback: Corneal GP over Custom Prosthetic

To address patient’s concerns, a custom prosthetic was trialed under the corneal GP.

GP Lens Parameters
9.40 / 7.5 / +12.25
Soft Lens Parameters
14.5 / 8.6 / PLANO / Dk 7.9x10^{-11} / Pupil 3.50mm, Open Pupil / Hydrogel
VA 20/40



The patient was able to achieve his BCVA in this system with improved cosmesis and reduced photophobia. He did not experience significant corneal edema after 4 hours of wear-time in this system, despite switching to a hydrogel material.

Conclusion

Scleral contact lenses have become a revolutionized option for the management of many corneal and ocular surface diseases. It is important to recognize the benefits and limitations to its use, especially in high-risk patients. PKP corneas, although more reliant on a specialty lens for vision, are more vulnerable to injury associated with contact lens-wear. There is still a place for more traditional contact lens fitting, even in complex cases. The innovation comes from finding more creative solutions such as combining a piggyback system with a prosthetic contact lens. Despite limitations due to ocular health concerns or lens availabilities, there is value in thinking outside the box to helping patients achieve the best vision and quality of life that they deserve.

References

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