Article ▸ Essentially Monocular Patient Achieves Binocularity with Scleral Contact Lens Fit After Overcoming Initial Diplopia

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ABSTRACT

Background: Several case reports have demonstrated the benefits of a scleral lens fit, especially in patients with corneal irregularity, anisometropia, or severe dry eye. This case report focuses on a scleral lens fit in a patient with unilateral aphakia as well as corneal irregularity.

Case Report: A 60-year-old African-American male presented following an ocular trauma requiring crystalline lens extraction in his left eye only. This patient was left unilaterally aphakic and with a large corneal scar within the visual axis. His left eye had been uncorrected for 37 years due to a number of factors including high irregular astigmatism, anisometropia, and resulting aniseikonia. After unsuccessful attempts by other eye care providers at vision correction with glasses and various contact lenses, the patient was fit in a scleral lens. Once successfully fit, with resulting great vision, the patient had difficulty adapting to his newly acquired binocularity.

Conclusion: This case report clearly demonstrates the benefit of a scleral contact lens fit as well as the importance of considering how binocularity will be affected. It is evident in this case report how a scleral lens fit improved the quality of life for the patient.

Keywords: anisometropia, contact lens, mini-scleral lens, scleral lens, unilateral aphakia

Introduction

Contact lens correction has been the preferred method of vision correction for patients with aphakia, especially when only one eye is aphakic. A contact lens will reduce or even eliminate aniseikonia, allowing equal image sizes between the two eyes, as opposed to wearing a high-plus glasses prescription. Scleral lenses in particular have become a popular treatment option for vision correction in patients with corneal irregularities, including trauma. As the scleral lens vaults over the entire cornea, it creates a smooth optical surface for light to pass into the retina.

Case Report

A 60-year-old African-American male initially presented to the WJB Dorn VA Medical Center optometry clinic with complaints of longstanding blurred vision in his left eye only on May 14, 2013.

In 1976, a Coke bottle exploded and hit the patient in the eye during factory work. His job was to oversee the bottles after they were pressurized. In the words of the patient, "I was looking down and saw the head of the bottle come straight up into my eye."

Due to the laceration from the glass bottle, the patient developed a large corneal scar extending from the inferior nasal to superior temporal cornea. The patient also had to have his left crystalline lens removed without an implant after the trauma due to formation of a traumatic cataract.

Glasses resulted in great vision in his right eye but under-corrected vision in his left eye. Due to anisometropia and resulting aniseikonia, the power in the left lens had to be decreased, thus resulting in poor vision. Corneal gas permeable (GP) lenses were previously tried but were unsuccessful because a high-powered small lens, which is needed for vision correction in aphakia, tends to drop on the cornea. In addition, high irregularity of the cornea made fitting a small lens more problematic. They were also uncomfortable and too difficult for the patient to remove. Hydrogel contact lenses were attempted but were also unsuccessful, providing poor vision and fit.

Review of the patient's medical history revealed hyperlipidemia, sleep apnea, type 2 diabetes mellitus, osteoarthritis, gastroesophageal reflux disease, and carpal tunnel syndrome. Current medications included Metformin, Doxepin HCl, Aspirin, Baclofen, Docusate, Fluoxetine, Lisinopril, and Omeprazole. Family ocular history was unremarkable.

Upon ocular examination, entering acuities were 20/20-1 OD (right eye) and 3/200 OS (left eye) through the patient's habitual glasses, in which the left lens was balanced. Habitual glasses were as follows: OD +0.25-0.50x030, OS balance lens, ADD: +2.50. The best corrected visual acuities were 20/20 OD and 20/30 OS, attained with a subjective prescription as follows: OD +0.25-0.50x030, OS +11.75-4.00x135. Keratometry readings were measured with an autokeratometer and recorded as OD: 41.00/42.00 x 018 and OS: 40.00/43.25 x 128. Pupils were equal, round, and reactive to light with no afferent pupillary defect in either eye. Extraocular muscles showed full range of motion in both eyes. Visual fields were full to finger counting in all quadrants in both eyes.

Slit lamp biomicroscopy examination of the anterior segment was unremarkable except for the left cornea. There was a large, full-thickness linear scar from the inferior-nasal to superior-temporal cornea of the left eye, with inferior pannus extending 1 millimeter onto the cornea. Goldmann

applanation tonometry was measured as OD: 12mmHg, OS: 14mmHg at 3:55pm. The patient was dilated with tropicamide 1% and phenylephrine 2.5% combination drop. The right lens had 1+ nuclear sclerosis cataract, and the left eye was aphakic. The rest of the posterior segment was unremarkable with a healthy appearance.

Scleral Lens Fit

After a thorough eye examination and discussion of options for vision correction, it was decided to try a scleral lens fit on the patient's left eye. A lens with a diameter of 16.6mm was selected. This lens, accurately classified as a "mini-scleral" lens, was chosen because it was adequate to clear the cornea completely and not so large that the patient would have difficulty with insertion. Furthermore, the Jupiter lens was chosen in particular because the medical center already had an account with Essilor, and the optometrists involved in the case were familiar with the lenses, having already experienced success when fitting them. The initial trial lens had the following parameters:

Trial lens #1 (OS only)

Lens: Jupiter by Essilor, Power: -6.00, Base curve: 45.98/7.34, Diameter: 16.6

Subjectively, the patient reported that the lens was uncomfortable and that he could feel the lens edge around his eye. Objectively, the fit was very steep with a central clearance of 500-600 microns and a large, central insertion bubble.

A second, flatter lens from the fit set was tried on the patient's left eye with the following parameters:

Trial lens #2 (OS only)

Lens: Jupiter, Power: -4.00, Base curve: 44.00/7.67, Diameter: 16.6

The patient subjectively reported great comfort with only a mild foreign body sensation. When describing his vision, the patient declared, "Thank you, Jesus, I can see!" Upon objective assessment, there was trace blanching of vessels nasally. The vault was acceptable limbus to limbus with a central clearance of 250-300 microns. There was also acceptable movement of the lens with blinking. An over-refraction of +10.25 DS yielded a visual acuity of 20/20-1.

The Essilor lab was consulted for fitting suggestions. The scleral zone was flattened to eliminate vessel blanching at the lens edge. The edge lift was also flattened to reduce conjunctival redundancy and allow proper tear exchange. Lens power was adjusted after accounting for the over-refraction. The SAMFAP principle did not have to be used since the base curve radius of the second trial lens provided acceptable vault over the cornea. This third lens was ordered with changes made for a better fit and vision with the following parameters:

Trial lens #3 (OS only)

Lens: Jupiter, Power: +7.75, Base curve: 44.00/7.67, Diameter: 16.6

The patient reported that he was very happy with comfort and vision through the lens.

Objectively through the slit lamp, the lens provided good coverage and movement. There was 300-350 microns of central clearance, with more clearance inferiorly than superiorly. There was also slight touch near the limbus superior nasally. There was no obvious blanching of conjunctival vessels with good edge lift of the lens. An over-refraction of -0.50 DS provided visual acuity in the left eye of 20/20-1.

The final ordered scleral lens to account for the small change in power is as follows:

Final Lens (OS only)

Lens: Jupiter, Power: +7.25, Base curve: 44.00/7.67, Diameter: 16.6

The subjective and objective assessment of lens fit was the same as trial lens #3 above. However, the patient had a visual acuity of 20/20-1 with an over-refraction of plano.

There were some concerns after completion of the scleral lens fit. The patient reported clear vision monocularly but experienced diplopia after the lens fit was concluded. The diplopia was both horizontal and vertical. However, the double vision was not seen at near distances closer than about 65 cm from his eyes.

Additional binocular vision testing was performed on July 30, 2013, the same day the scleral lens was finalized. A cover test with the patient wearing the scleral lens on his left eye revealed 8-10 prism diopters left exotropia at distance. Loose prism lenses of 4 BI (base in) OS and 2 BD (base down) OD was deemed best subjectively by the patient, but he could not fuse images. Various combinations of prism correction, both in the phoropter and using loose lenses, did not allow single vision.

At this time, the possibility of aniseikonia causing the lack of binocular fusion could not be eliminated. The patient was taught how to insert and remove his lens. His lens was not released until he was proficient. Proper care, storage, and hygiene instructions were provided. The patient was sent home with his left lens along with a patch to wear while driving or doing other activities where diplopia would be dangerous. He was instructed to wear the scleral lens while at home to train his brain to begin using both eyes together. The patient was educated that it would take time to regain fusional ability.

The patient returned for his 1-month follow-up on diplopia and scleral lens wear on August 27, 2013. He had been wearing the lens almost every day since his last exam. He reported that the diplopia had significantly improved and vision was more clear with less sensitivity to light. Even with slight diplopia, the patient reported great improvement in vision and quality of life. A cover test at distance was done and revealed 4-6 prism diopters exophoria, a significant improvement from the initial

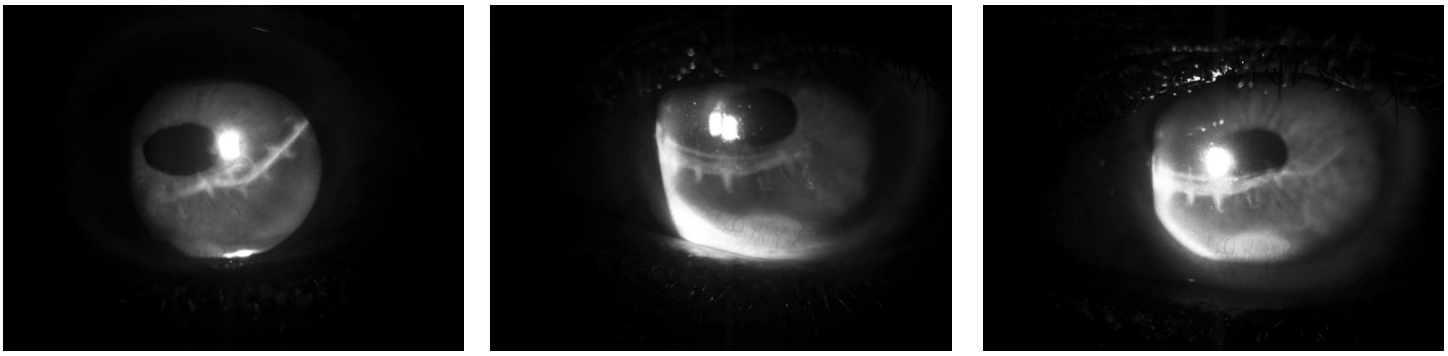

Figure 1. *Scleral lens on left eye vaulting over corneal scar from bottle top trauma*

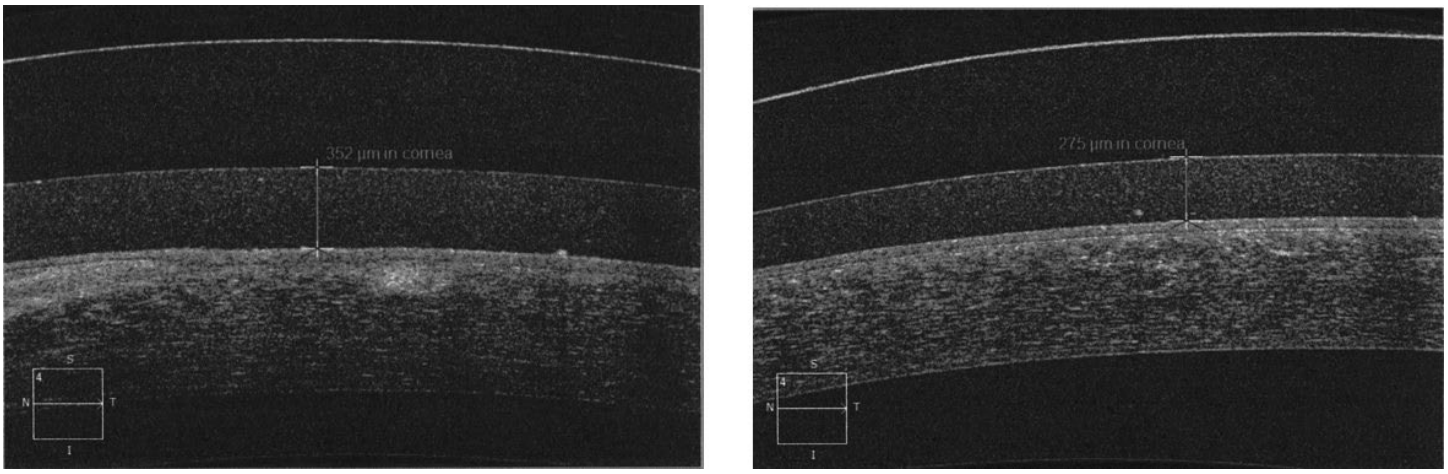

Figure 2. *Anterior Segment 5 Line Raster showing scleral lens clearance on central cornea*

cover test. The subjective glasses prescription was updated for wearing over the scleral lens and made of polycarbonate material to provide eye protection.

The patient returned for his 2-month follow-up on diplopia and scleral lens wear on September 24, 2013. He had been wearing the lens almost every day since his last exam. He reported that the diplopia had significantly improved even since his last exam. Most of the time his vision was single in the distance and all the time at near. Only occasionally in the far distance or with fine details did the patient notice diplopia.

The patient was still very happy with increased vision, improved depth perception, and reduced light sensitivity. He was pleased with his updated glasses prescription for wearing over his scleral lens. He was instructed to return to clinic in 3 months for follow-up on diplopia or as needed.

This patient returned 6 months later, instead of 3, due to clinic cancellations and patient conflicts that did not allow him to come in sooner. He was doing great with the scleral lens on his left eye. He reported successful all-day lens wear 4-5 days per week. The patient did not like to wear the lenses outside due to severe allergies to pollen. He noted very rare diplopia that lasted a second, being able to bring the two images together very quickly. He reported significant improvement in vision and depth perception. He also noted a huge increase in peripheral vision on his left field of view and felt safer while driving a car. No diplopia was reported during testing throughout the follow-up exam. A cover test at distance measured 2 prism diopters right hyperphoria and 4 prism diopters exophoria. The fit of the scleral lens was assessed with anterior segment OCT. Photos were also taken with the anterior segment camera to document the scleral lens on the left eye and to show the appearance of the corneal scar (Figures 1 and 2).

Discussion

Injury Prevalence

Eye injury has been found to be the most common reason for emergency intervention in ophthalmology departments throughout the world, with most injuries occurring in males between ages 30 to 35 years old. These ocular injuries represent the second greatest cause of vision loss.[1] Traumatic lens injury in patients with penetrating eye trauma has been reported to be as high as 65%.[2]

Ocular trauma caused by exploding carbonated beverage glass bottles has also been previously reported. It has been estimated that the incidence of ocular injury from carbonated beverage bottles is 1.2 per 100,000 population. Another study in Israel found that 2% of all ocular injuries requiring hospitalization were due to exploding carbonated beverage glass bottles.[3]

Visual Disability Without Binocularity

Reduced or absent binocularity can have a major impact on a person's activities of daily life. Stereopsis and contrast sensitivity

are two areas most affected in a monocular patient.[4] In patients with unilateral aphakia with no associated strabismus or vision correction, like the patient in this case report, there is binocular confusion, which is when two different objects are seen in the same location or visual direction. In this case, it is the same object, just very different sizes. This results from significantly different refractive errors and visual acuity in each eye.[5,6]

Any patient with reduced binocularity may have an impairment when doing tasks that involve depth perception or sensorimotor control. Even simple tasks such as walking are significantly impacted without binocular vision.[7] Speed, accuracy, and end-point precision when walking have been found to be reduced in monocular patients.[8,9] Furthermore, "lack of stereopsis has been associated with an increased risk of falls in the elderly and a lower quality of life."[10]

Scleral Lenses for Treatment of Corneal Irregularity

The cornea is very important in focusing light to make a clear image on the retina, contributing 60% of the total refractive power of the eye.[11] A clear image can only be produced if all of the structures through which light passes to get to the retina are transparent and free of distortion.

With the use of a scleral lens, more clear and comfortable vision can be obtained than with the use of spectacle lenses or corneal contact lenses. A scleral lens vaults over the cornea, providing a fluid reservoir behind the lens upon insertion and creating a smooth front surface for light to pass through. Furthermore, the lens does not have to rest on an irregular corneal surface but instead on the conjunctiva/sclera, creating a better fit in patients with corneal scarring or distortion.[12-15]

Scleral Lenses for Vision Correction in Aphakic Patients

Contact lenses are the preferred method of vision correction in aphakic patients. Contact lenses work better than glasses because aphakic spectacle prescription lenses are thick and reduce peripheral vision. Scleral lenses are great for aphakic prescriptions because high plus lenses are heavy, and with scleral lenses this total weight is distributed over a larger area, resulting in less droppage of the lens.

Furthermore, it is especially important for patients with unilateral aphakia to wear contact lenses to allow fusion of images. Anisometropia, where the eyes have significantly unequal refractive powers, is created in unilateral aphakia and makes binocular vision a challenge. Spectacles can be worn, but the differences in magnification of images will make fusion nearly impossible. Aniseikonia, or difference in perceived image size between the two eyes, is induced with spectacle correction of unequal refractive error. Use of contact lenses will allow more equal image sizes, minimizing aniseikonia, and thus allow binocular vision.[16,17] Scleral lenses are just one of the lens options that should be highly considered in aphakic patients.

Why Did This Patient Have Difficulty Regaining Fusion?

Diplopia and loss of fusion have been shown to occur in patients with a unilateral traumatic cataract followed by a period of uncorrected aphakia.[18] The phakic eye takes over due to having a clear image, while the uncorrected aphakic eye develops a strabismus and/or suppression occurs. A sensory exotropia can develop in the eye with poor vision. Since the eyes cannot work together to produce a clear image, the eye with poor vision will drift outward to allow the other eye to take over. This is likely what happened to the patient in the above case presentation. When vision in the left eye was finally corrected with a scleral lens, both eyes gained a clear image. Diplopia was initially seen in the distance while his brain and visual system adjusted to the change. Diplopia was not seen at close range possibly because the patient was still suppressing at near or because his convergence system helped align his eyes at near, eliminating diplopia.

Case studies have shown that binocular vision can be regained in some patients after optimal vision correction.[18] Furthermore, studies have revealed that "cortical plasticity is preserved in the aging visual cortex and may be triggered by restoring impaired vision."[19] The patient was old enough in this case report where vision was fully developed at the time of the trauma and subsequent removal of the traumatic cataract. There was no risk of deprivational amblyopia. Therefore, with correction of anisometropia and vaulting over the visually obstructing scar, there was a possibility of binocularity.[20] The patient had to overcome suppression of his left eye due to 37 years of being under-corrected, which proved to be a challenge, as evidenced by the resultant diplopia.

Conclusion

Clearly, scleral lenses should be a consideration when looking at viable options for vision correction in a patient with corneal irregularity, aphakia, or a combination of both. Scleral lenses are able to vault over corneal irregularities to create a smooth optical surface for improved vision that other spectacle or contact lens options cannot provide.

Furthermore, scleral contact lenses can provide a better fit due to the landing zone of the lens being on the sclera and not the cornea, where the irregularities are located. A scleral lens is also a great option for aphakic patients. The optics of scleral lens parameters are able to provide vision correction for large refractive errors while eliminating the need for thick and heavy spectacle lenses.

They reduce aniseikonia to allow more equal image sizes and thus increase the likelihood of fusion in unilateral aphakia. The patient in this case report is just one example of how to utilize scleral lenses. While the diplopia was profound at the beginning of the scleral lens trial due to previous suppression, complete resolution is expected after extended adaptation.

With the high likeliness of monocular ocular injury, a similar case could present in your clinic next week. Consider using a similar treatment plan to the case report above to assist

your patient. The patient described above was ecstatic about the outcome.

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Henry JJ. Essentially monocular patient achieves binocularity with scleral contact lens fit after overcoming initial diplopia. Optom Vis Perf 2015;3(5):260-4.

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