Abstract: Surgeons used radial keratotomy (RK) in the past as an attempt to flatten the corneal shape and reduce refractive myopia in a patient. In the present day, many post-RK patients suffer from poor, fluctuating vision due to an irregular corneal shape induced from this procedure. Rigid gas permeable lenses, such as scleral lenses, are an excellent solution to improve and stabilize vision. Scleral lenses help recreate an optimal refractive surface to enhance vision for the patient. Patients with specific dry eye symptoms can receive a therapeutic benefit from scleral lens use as the lens acts as a protective barrier for corneal hydration. This is a case report on a patient suffering from both ocular and systemic conditions resulting in decreased vision and discomfort from severe dry eye. She has been successfully fit with scleral lenses to improve signs and symptoms.

Key Words: Radial keratotomy (RK), dry eye, Sjogren's syndrome, scleral lens
Introduction: Patients may present to their eye care provider with multiple conditions impacting both their ocular and systemic health. Ocular comorbidities frequently lead to visual impairment and decreased quality of life. To suitably manage these coinciding ailments, it is essential to obtain an early and proper diagnosis. [1] In some instances, similar approaches can help alleviate patient symptoms in managing these comorbidities.

The goal of refractive surgery is to eliminate the dependency on glasses and contact lenses.

Radial keratotomy (RK) was a technique introduced to the United States in the 1980s. Multiple radial incisions were created on the cornea to flatten the corneal shape in an attempt to decrease the amount of refractive myopia in a patient.[2] In the present day, many patients suffer from side effects of RK, such as fluctuating diurnal vision, hyperopic shift, and irregular corneal astigmatism resulting in haloes, glare, and poor best-corrected visual acuity (BCVA) [3], [4]. Many post-RK patients are familiar with using multiple glasses to adjust for fluctuating visions throughout the day. Fitting post-RK patients in contact lenses can also pose challenges since the cornea takes on an altered oblate profile after surgery. Traditional contact lenses are designed for a prolate cornea and when placed on an oblate shape, leads to poor lens centration and excessive movement. Clinical research shows us that gas-permeable (GP) lenses are the best choice for patients post-refractive surgery in terms of visual acuity and tolerance. [5]

Scleral lenses have seen a resurgence in recent years due to high oxygen permeability in GP materials and modern lens designs to become a popular choice for the management of both irregular corneas and ocular surface disease.[6] Scleral lenses are designed to vault entirely over the cornea and limbus and to land on the sclera with its overlying conjunctiva. There is a fluid
reservoir between the posterior surface of the lens and the anterior surface of the cornea.[6] This fluid reservoir, along with the smooth front surface of the lens, helps to recreate an optimal refractive surface to provide improved vision for the patient as well as a protective barrier for corneal hydration.

Sjogren’s syndrome is an auto-immune disorder than affects exocrine glands in the mouth and eyes, such as the salivary and lacrimal glands. Patients present most commonly with dry eye and dry mouth symptoms in addition to systemic involvement. Dry eye symptoms affect over 16 million Americans, and approximately 10% of those symptomatic patients have underlying Sjogren's syndrome[7][8]. Out of the patients who are diagnosed with Sjogren’s, the average time of onset of dry eye symptoms to diagnosis of Sjogren’s is about 10 years[9]. Sadly, the majority (two-thirds) of those with dry eye from Sjogren's syndrome remain undiagnosed[10]. Diagnosis of Sjogren's syndrome is vital to differentiate the underlying mechanism and treatment between dry eye diseases such as meibomian gland dysfunction or an autoimmune condition causing an aqueous deficiency. [11]

This case report takes us through the journey in managing a patient with post-RK along with dry eye symptoms to be eventually diagnosed as Sjogren’s syndrome. After multiple surgical endeavors to improve visual acuity, the patient was referred to be fit in a scleral lens to improve visual acuity and comfort.
Case Report: A 66-year-old white female was referred to our clinic with the chief complaint of fluctuating, poor vision, with haloes and glare in both eyes. She did not currently wear any glasses or contacts as she stated they did not help improve her vision. Five months prior, in November 2014, she had cataract surgery in both eyes intending to improve her vision. She was unhappy that after cataract surgery, her vision has not improved and continued to fluctuate with halos and glare. She had decided that she needed LASIK to help improve her vision and unhappy with her visual outcome from her cataract surgery, went to another ophthalmologist asking for LASIK as a procedure to improve her vision. Instead of LASIK, she was referred to our clinic for a scleral lens fit.

Ocular & Medical History: The patient had worn corneal gas-permeable (GP) lenses in the 1980s before she elected to have RK surgery in 1984. Afterward, her vision was adequate to function without the use of contact lenses or glasses. In 2005, she had a retinal detachment with a laser repair in the right eye. Suffering from decreased vision, along with haloes and glare, in November 2014, she had cataract surgery with an intraocular lens (IOL) implant in both eyes. Noticing that her vision did not improve significantly, a few months later, she had a YAG Laser Capsulotomy. Her vision still did not improve. The patient also had long term, suffered from severe dry eye symptoms, and was prescribed autologous serum eye drops from her previous ophthalmologist for the use of one drop in each eye, once per day.

Her systemic medications include Allopurinol for management of gout, Lipitor for management of hypercholesterolemia, and Synthroid for hypothyroidism. The patient had no other known allergies other than to tetracycline.
Examination:

Initial Visit: The patient's unaided visual acuities were 20/70, measured in the right eye, left eye, and both eyes together. The patient's external examination noted normal ocular adnexa except some mild-moderate telangiectasia of the lower lid margin, clean eyelids, and lashes, full extraocular muscle motilities, and versions, and pupils 2.5mm each, equal, round and fully reactive to light. Slit-lamp examination displayed 8 radial corneal scars from RK, including subepithelial fibrosis and Vogt’s vertical striae in the endothelium. The vertical striae were more prominent in the right eye than the left eye. Her posterior capsule IOL was well centered and clear, in both eyes.

Subjective refraction was +1.25-3.00 x 090 in the right eye with visual acuity improving to 20/40-2 and +3.00-2.00x060 the left eye with visual acuity improving to 20/30-2. A +2.50 add improved near visual acuity to 20/40 in the right eye and 20/25 in the left eye.

Entrance testing included a dry eye questionnaire (TERTC-DEQ) in which the patient scored a 73 (range 0-100, Normal:<17, Dry Eye Suspect: 17-33, Dry Eye Syndrome: >33) demonstrating severe dry eye.

Corneal topography was performed with the Oculus Pentacam. The results (Figure 1) revealed irregular astigmatism with flattening within the central 3mm radius of the cornea in both eyes (OD: K1 = 35.2D, K2=36.0D, and OS: K1=36.6D, K2=37.2D). In both eyes, front and back elevation demonstrated a similar pattern with a significant area of a ring of mid-peripheral ectasia. The pachymetry map was decentered inferiorly, in both eyes, with the thinnest reading of
552um in the right eye and thicker reading in the left eye (576um in the thinnest area). The patient’s corneal diameter was 11.7mm in each eye. Baseline topographies are below in Figure 1.

Figure 1: 4 Maps Refractive, OD and OS. Both eyes demonstrate an oblate corneal profile with irregular astigmatism and mid-peripheral ectasia.
Contact Lens Evaluation & Examination: Diagnostic trial scleral lenses (Zenlens Oblate by Bausch + Lomb) were placed on the patient’s eye. The first lens was selected, taking into account both the patient's history of post-refractive corneal surgery and the size of her corneal diameter. The Pentacam measured corneal diameter as 11.7mm in each eye and so the smaller trial lens (16.0mm) was chosen.

Initial Trial Lens: Zenlens Oblate

<table>
<thead>
<tr>
<th></th>
<th>Trial</th>
<th>Sag (µm)</th>
<th>BC (mm)</th>
<th>Power (D)</th>
<th>Diameter (mm)</th>
<th>VA (distance)</th>
<th>Sph-Cyl OR (D)</th>
<th>OR VA (distance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD:</td>
<td>Z14</td>
<td>4400</td>
<td>9.5</td>
<td>-2.00</td>
<td>16.0</td>
<td>20/40</td>
<td>-1.00</td>
<td>20/25-2</td>
</tr>
<tr>
<td>OS:</td>
<td>Z14</td>
<td>4400</td>
<td>9.5</td>
<td>-2.00</td>
<td>16.0</td>
<td>20/200</td>
<td>+2.00</td>
<td>20/25+2</td>
</tr>
</tbody>
</table>

Both eyes’ parameters suggested the same trial lens. With two trial sets available, the same lens was placed on each eye. After 10 minutes of wear, the trial lens provided an initial central clearance of 350µm, approximately 200µm of mid-peripheral and 100µm of limbal clearance with mild conjunctival blanching, more concentrated in the horizontal meridian for both eyes. The 350µm central clearance was estimated as the amount of clearance equal to the thickness of the lens (350µm). The trial lens' peripheral haptics were evaluated as slightly tight 360°. Due to the mild blanching, a “Flat 2” was ordered in the peripheral landing zone, which indicated a flattening of approximately 60µm.

Lens Ordered: Zenlens Oblate with material Contamac Optimum Extreme

<table>
<thead>
<tr>
<th>Lens #1</th>
<th>Sag (µm)</th>
<th>BC (mm)</th>
<th>Power (D)</th>
<th>Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD:</td>
<td>4400</td>
<td>9.5</td>
<td>-3.00</td>
<td>16.0mm</td>
</tr>
<tr>
<td>OS:</td>
<td>4400</td>
<td>9.5</td>
<td>Plano</td>
<td>16.0mm</td>
</tr>
</tbody>
</table>
Diagnosis, Plan, Treatment: The patient was diagnosed with bilateral, central flattening with mid-peripheral ectasia secondary to RK. The patient was also diagnosed with dry eye syndrome (DES). Both conditions caused irregular astigmatism creating visual blur with conventional glasses or contacts.

The plan was to order the scleral lenses in the patients' specified parameters to improve visual acuity and to alleviate symptoms of dry eye. A glasses prescription was given to the patient to help improve visual acuity, yet it was cautioned to her that due to diurnal variations from RK, the prescription could change.

Visit #2: Scleral lens dispense (Lens #1)

The patient returned 2 weeks after for her scleral lens dispense. The parameters of the lenses ordered are listed below, along with Visual Acuity.

<table>
<thead>
<tr>
<th>Lens #1</th>
<th>Sag (µm)</th>
<th>BC</th>
<th>Power</th>
<th>Diameter</th>
<th>Subjective BCVA</th>
<th>Sph-Cyl OR</th>
<th>OR VA (distance)</th>
<th>Peripheral Haptics</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD:</td>
<td>4400</td>
<td>9.5</td>
<td>-3.00</td>
<td>16.0mm</td>
<td>20/25²</td>
<td>-0.25</td>
<td>20/25-2</td>
<td>Flat 2</td>
</tr>
<tr>
<td>OS:</td>
<td>4400</td>
<td>9.5</td>
<td>Plano</td>
<td>16.0mm</td>
<td>20/25²</td>
<td>Plano</td>
<td>20/25-2</td>
<td>Flat 2</td>
</tr>
</tbody>
</table>

After 10 minutes of wear, the right eye displayed 350µm of central apical clearance, 200µm of mid-peripheral clearance and 100µm of limbal clearance. The left eye displayed 450µm of central clearance with slightly higher mid-peripheral clearance at 300µm and 200µm of limbal clearance. For both eyes, there was no blanching 360 degrees around the lens edge, there appeared to have slight edge lift in the vertical meridian.
The patient was given a spectacle Rx for reading glasses of +2.50D to wear over her scleral lenses, which brought her reading vision to 20/20, OU.

At this time, the patient demonstrated proper application and removal of the scleral lens. The patient was prescribed to disinfect lenses with Unique pH and to use Unisol in the bowl of her scleral lens.

**Visit #3: 2 week follow up (with Lens #1, ordered Lens #2)**

At the patient’s follow up visit, she reported that she was overall pleased with her vision in her lenses. However, she noticed that she could only wear her scleral lenses for 8 hours a day, and then her eyes would feel dry and she would need to remove her lenses. She also reported that after 30 minutes of initial insertion, her vision would become foggy and that she would need to remove the lenses and replace with fresh solution. She would do this several times a day. After she replaced the solution, her vision would be clear again.

The patient arrived in the morning without wearing her scleral lenses. After application of lenses, the lenses were allowed 30 minutes to settle before evaluation. Her presenting scleral lenses had 350µm of central clearance in the right eye and 450µm of central clearance in the left eye, along with 200µm of limbal clearance, in both eyes. There was no blanching 360° around either lens and trace movement of both lenses. There was moderate amount of vertical edge lift in the both lenses. The patient’s vision was 20/30+2 in the right eye and 20/25−2 in the left eye. Binocularly, her vision was 20/25+2 at a distance and with her +2.50 readers, 20/20 at near.
At this time, due to the patient's complaints of severe dry eye and was already using autologous serum teardrops prescribed through her previous doctor. Temporary collagen punctal plugs were inserted into the patient's lower eyelids.

Due to the patient experiencing mid-day fogging (MDF) along with the excessive clearance between the cornea and lens, new lenses were re-ordered with a decrease in sagittal depth, and toric haptics (Steep 1 in the vertical meridian, an increase in 90µm) to help decrease MDF. The base curve in the left eye was also flattened to help decrease apical clearance.

<table>
<thead>
<tr>
<th>Lens #2</th>
<th>Sag (µm)</th>
<th>BC (mm)</th>
<th>Power (D)</th>
<th>Diameter (mm)</th>
<th>Peripheral Haptics</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD:</td>
<td>4250</td>
<td>9.5</td>
<td>-3.00</td>
<td>16.0mm</td>
<td>Flat 2/Steep 1</td>
</tr>
<tr>
<td>OS:</td>
<td>4150</td>
<td>9.76</td>
<td>Plano</td>
<td>16.0mm</td>
<td>Flat 2/Steep 1</td>
</tr>
</tbody>
</table>

**Diagnosis, Plan, Treatment**

The patient was diagnosed with MDF due to severe dry eye and lens fit. Current scleral lenses improved vision but caused an inconvenience with MDF. The patient's severe dry eye symptoms, even with her scleral lenses, led to the insertion of temporary collagen punctal plugs to help alleviate symptoms. At this time, the patient was also referred to the Dry Eye Clinic at the University of Houston for further testing due to severe dry eye symptoms.

The plan was to continue wearing current scleral lenses while new lenses were ordered. In the meantime, it was discussed with the patient to use Refresh Optive Preservative-Free tears or
Celluvisc inside the bowl of her scleral lenses in attempts to decrease MDF while waiting for new scleral lenses.

Visit #4: Secondary lens dispense (With Lens #2)

The patient returned for a secondary lens dispense. She reported that she had a follow up at the Dry Eye Clinic and was tested positive for Sjogren’s Syndrome using the Sjo test. The Dry Eye Clinic had started her on topical cyclosporine drops (Restasis) twice a day, and her rheumatologist prescribed Cevimeline to treat symptoms of dry mouth from Sjogren’s syndrome. No other additional medications were added. Her new lenses were dispensed.

<table>
<thead>
<tr>
<th>Lens #2</th>
<th>Sag (um)</th>
<th>BC (mm)</th>
<th>Power (D)</th>
<th>Diameter (mm)</th>
<th>VA (distance)</th>
<th>Sph-Cyl OR</th>
<th>OR VA (distance)</th>
<th>Peripheral Haptics</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD:</td>
<td>4250</td>
<td>9.50</td>
<td>-3.00</td>
<td>16.0mm</td>
<td>20/25</td>
<td>Plano</td>
<td>20/25</td>
<td>Flat2/Steep1</td>
</tr>
<tr>
<td>OS:</td>
<td>4150</td>
<td>9.76</td>
<td>Plano</td>
<td>16.0mm</td>
<td>20/25+</td>
<td>+0.50</td>
<td>20/25+</td>
<td>Flat2/Steep1</td>
</tr>
</tbody>
</table>

Visit #5: 1 week follow up (Lens #2)

The patient returned for her one week follow up with her new lenses. She reported that her vision was good out of her scleral lenses. She did not experience as much MDF with her new lenses. She was still using 1 drop of Celluvisc in the bowl of her scleral lens before insertion. She did not have as many issues with her new pair of lenses.

The patient arrived at the exam wearing the lenses, and the fit of the lenses was examined after wearing lenses for 5 hours. Her presenting scleral lenses had 250µm of central clearance in the right eye and 170µm of central clearance in the left eyes with 100 µm of mid-peripheral
clearance and 50µm of limbal clearance, in both eyes. These measurements were obtained from an anterior segment OCT. (See Figures 2 and 3). There was no blanching 360 degrees around either lens and trace movement of both lenses. The patient’s vision was 20/25 in the right eye and 20/25+ in the left eye. Binocularly, her vision was 20/25+2 at a distance.

Figure 2: OD with a scleral lens showing 250µm of clearance.

Figure 3: OS with a scleral lens showing 170µm of clearance.

At this point, the patient’s lens fit was finalized, and the patient was scheduled to return in 1 month for a scleral lens follow up.
Visit #6: 1-month follow-up (with Lens #2)

Her vision at this time with her scleral lenses was 20/25, in the right and left eye, respectively. The patient arrived at the exam wearing the lenses, and her presenting scleral lens clearance was 200µm of central clearance and 100µm of limbal clearance in the right eye, along with 150µm of central clearance and 50µm of limbal clearance in the left eye. There was minimal lens movement, no vessel impingement, and good scleral landing zone. The patient was recommended to return in 6 months for a scleral lens follow up.

Visit #7: 6-month follow up (with Lens #2)

The patient arrived at her 6-month follow up and reported an average wear time of 8 hours, but up to 15 hours during particular days. With her lenses, her visual acuity was 20/25 in the right eye and 20/25 in her left eye. Binocularly, her vision was 20/20. After 5 hours of wear, apical clearance in the right eye was 250µm with 100µm of limbal clearance and 150µm of apical clearance in the left eye with 5µm of limbal clearance. It was documented that the lenses had a good scleral landing in both eyes with minimal lens movement and no vessel impingement. The patient was recommended to return in 6 months for her annual scleral lens exam.
Discussion: RK incisions flatten the corneal surface to reduce myopia initially. Long-term, literature and clinical reports show that this induces moderate and fluctuating hyperopia, with haloes and glare in this patient [4]. Post-RK patients can present a challenge to fit conventional contact lenses as the altered refractive surface of the cornea is oblate instead of prolate [5]. Since normal and even abnormal cornea shapes are prolate in nature, most conventional scleral lenses are designed to fit a prolate shape which is steepest in the apex and progressively flattens in the mid-periphery. Therefore, an oblate scleral lens shape with a flatter central base curve and higher mid-peripheral curve (reverse curve) was needed to help match the shape of the cornea.

MDF is a commonly noted complication and fitting challenge associated with scleral lens wear [12]. MDF can occur promptly following the application of the lens, as in this patient case, or progress gradually throughout the day. [12] Up to 30% of scleral lens wearers can experience MDF [14]. When visualized in the slit lamp, MDF presents as particulate matter trapped between the tear reservoir between the lens and ocular surface [12]. The patient initially experienced MDF with her scleral lens wear. She noticed that shortly after wearing her lenses, her vision would become blurry, and she would need to reinsert new solution into the scleral shell of her lens to clear up her vision. This was confirmed in biomicroscopy examination which showed debris in the tear film reservoir.

There are many theories about what causes MDF and new evidence implies inflammatory activity in the fluid reservoir of MDF patient[15]. Reports of artificial tears assisting to decrease MDF is possibly due to a nutritious ion presence, physiological osmolality, or high viscosity – but the reason is still unknown [12]. Also, other anecdotal stories of adjusting the scleral lens fit
can help alleviate symptoms of MDF. If there is a large tear reservoir between the lens and
cornea, this may allow for an excessive amount of debris from the tears into the lens [16]. It has
also been suggested that creating a thinner, post-lens tear reservoir can decrease MDF[12]. In
this patients’ case, the use of non-preservative artificial tears along with altering the scleral lens
fit appeared to decrease the patient’s symptoms of MDF.

The patient’s diagnosis of Sjogren’s syndrome helped lead to an explanation of her suffering
from dry eye symptoms. This autoimmune disease causes a lack of tears, causing excessive
exposure to the cornea. While the primary goal of aqueous-deficient dry eye is to increase tear
volume, and the patient was sent to a rheumatologist for complete management, scleral lenses
can also have a therapeutic benefit[17]. Patients with Sjogren’s syndrome often find relief with
artificial tears, punctal plugs, topical cyclosporin, and scleral lens [18]. In this patient’s case, all
4 treatments were implemented to help provide corneal hydration.

**Conclusion:** Patients with multiple comorbidities, including ocular and systemic, can be
challenging to fit. It is important to differentiate underlying symptoms, and understand which
treatment is best. A practitioner needs to obtain a proper diagnosis early for these different
conditions. In fortunate cases, similar types of treatment can be used to treat the symptoms. In
this patient case, a scleral lens not only improved visual acuity from post-RK but also helped
manage ocular surface disease and improve this patient’s quality of life.

Special thanks to Dr. Maria Walker for the co-management and continued care of this patient
throughout the years.
References:


