Scleral lens management of corneal irregularity and ocular surface disease secondary to surgical and chemotherapeutic treatment of conjunctival melanoma

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Abstract

Scleral lenses are frequently prescribed for the management of corneal irregularity and refractive error, and they are also increasingly being utilized as a therapeutic treatment for dry eye syndrome and other types of ocular surface disease. A scleral lens allows similar optimization of vision to a corneal gas permeable lens, with the additional benefits of protection and continuous hydration of the ocular surface via the post-lens tear reservoir. Scleral lenses are a valuable treatment option in the management of irregular astigmatism as well as many types of ocular surface disease.

Keywords: *Scleral lenses, contact lenses, irregular astigmatism, corneal scarring, ocular surface disease, dry eye, limbal stem cell deficiency, conjunctival melanoma, corneal melanoma*

Introduction

Gas permeable (GP) contact lenses have been used for decades for the improvement of vision in patients with irregular astigmatism. GP lenses are classified into three categories: corneal, which rest entirely on the sclera; corneo-scleral, which rest partly on the cornea and partly on the sclera, and scleral, which rest entirely on the sclera.[1] All three GP lens types provide vision improvement for patients with irregular astigmatism, but larger diameter scleral lenses have been growing in popularity in recent years due to the added benefits of improved comfort, stability, and continuous lubrication of the ocular surface. Scleral lenses are increasingly being utilized not only to improve vision in patients with irregular astigmatism, but to treat ocular surface disease by providing ocular surface protection and promote healing of the cornea and conjunctiva by providing continuous hydration.

Irregular astigmatism can have many potential etiologies. The most common causes of visually significant irregular astigmatism are degenerative corneal diseases such as keratoconus, corneal scarring, and iatrogenic or post-surgical causes such as post-LASIK ectasia, radial keratotomy or post-corneal transplant. Iatrogenic irregular astigmatism can also result from less common corneal surgeries such as the surgical biopsy or excision of benign or malignant corneal neoplastic disease.

The case presented here discusses how a patient suffering from both ocular surface disease and decreased vision following treatment of conjunctival melanoma with corneal extension achieved both symptom relief and improved vision by being refit from a corneal GP lens into a scleral GP lens.

Case Report

HPI

A 74 year old white male presented for examination on 11/28/2016 having been referred for an optometric consultation for evaluation of contact lens discomfort and blurred vision in his left eye. The patient was a habitual wearer of a corneal GP lens in his left eye with progressive spectacle correction also worn over both eyes. The patient complained that the contact lens has become increasingly uncomfortable over the past year since he was fit with the lens by another optometrist one year prior. The patient reported that he was using Refresh preservative free artificial tears (PFAT's) 2-3 times per day, and was only able to tolerate wear of his contact lens for an average of six hours per day.

Ocular and Medical History

The patient's ocular history was positive for conjunctival melanoma with corneal extension in the left eye which was being managed by his cornea specialist at Bascom Palmer Eye Institute. The condition was diagnosed three years prior, at which time he underwent surgical excision of the melanoma followed by three rounds of treatment with topical mitomycin C. Following the mitomycin C treatment he developed limbal stem cell deficiency, corneal scarring and severe ocular surface disease in his left eye. The patient was monitored for melanoma recurrence with repeated ocular surface biopsies every three months. With each biopsy his ocular surface disease symptoms and corneal healing worsened, and he eventually underwent a limbal stem cell transplant one year prior to this visit. Following the transplant an amniotic membrane was placed on the patient's eye to promote healing of the cornea. Though the amniotic membrane was successful in improving the patient's ocular surface disease signs and symptoms, the amniotic tissue adhered to the patient's cornea and did not dissolve in several places. Two weeks prior to this visit, the patient had undergone a superficial keratectomy to remove the amniotic membrane remnants as well as a routine ocular surface biopsy to monitor for recurrence of melanoma. The superficial keratectomy was successful and healed without complication, but unfortunately one of the twelve corneal and conjunctival sites biopsied was positive for atypical cells. Consequently, the patient was scheduled to begin a course of topical interferon alfa-2b starting the day following this visit.

In addition to the patient's history of ocular melanoma and limbal stem cell transplant, the patient's ocular history was also positive for bilateral cataract extraction. The patient's medical history was positive for benign prostatic hyperplasia for which he was taking Avodart (dutasteride) 0.5mg once daily. A review of systems was completed to which the patient reported no other positives. The patient reported no known allergies to medications, and his social history was negative for tobacco, alcohol or recreational drug use. The patient's family history was positive for macular degeneration (mother) and colon cancer (maternal uncle). His mood was appropriate and he was oriented to person, place and time.

Examination

The patient's uncorrected entering visual acuity was 20/40 in the right eye and 20/50 in the left eye. With his habitual spectacle correction his corrected entering visual acuity was 20/25-2 in the right eye and 20/50 in the left eye. The patient's habitual spectacle correction was OD +0.50 -1.50 x110 and OS +0.25 sph, with a +3.00 add. This spectacle correction had been prescribed for use over his habitual corneal GP lens in his left eye, with no contact lens to be worn in the right eye. The patient presented to this visit not wearing his habitual corneal GP lens in his left eye due to discomfort. The patient's pupils were equal, round and reactive to light and no afferent pupillary defect was noted. Extraocular motilities were full

in all gazes, and confrontation visual fields were full to finger counting in both eyes.

The patient's manifest refraction was measured to be OD: +0.50 -1.50 x115 (VA 20/20) and OS: +4.50 -1.00 x90 (VA 20/40-2) with an add of +2.50 and a near VA of 20/25 OU. Slit lamp biomicroscopy revealed normal adnexae, lids, lashes and puncta in both eyes. Examination of the right eye showed that the conjunctiva was white and quiet and the cornea was clear. Examination of the conjunctiva of the left eye showed trace conjunctival injection with a small temporal subconjunctival hemorrhage and irregular temporal elevation. The cornea of the left eye showed peripheral conjunctivalization of the cornea concentrated inferiorly and temporally with areas of 3-4mm of anterior stromal neovascularization. Numerous small and large irregular patches of anterior stromal scarring were also present scattered throughout the cornea, and partially involved the central cornea over the pupil inferiorly and superiorly. One drop of Fluress (fluorescein sodium 0.25% and benoxinate hydrochloride 0.4% ophthalmic solution) was instilled into both eyes and the patient's intraocular pressures were measured with Goldmann applanation tonometry. The intraocular pressures were 10 mmHg in the right eye and 11 mmHg in the left eye measured at 12:02pm. The right eye was clear to sodium fluorescein, while the left eye showed fluorescein staining highlighting 2+ scattered superficial punctate keratitis concentrated over the areas of corneal scarring. The patient's tear break up time (TBUT) was 10 seconds OD and 5 seconds OS.

Both anterior chambers were deep and quiet, both irides were flat and intact, and both eyes had a posterior chamber intraocular lens which was clear and in place. The patient could not be dilated at this visit because he had to drive himself four hours to his home, so records from his most recent dilation with his cornea specialist were obtained. The cornea specialist's records reported a dilated fundus examination on 8/16/2016 which showed clear posterior chamber IOLs OU, normal vitreous OU, healthy pink and distinct optic nerves with a cup-to-disc ratio of 0.70 OU, normal retinal vessels OU, clear maculae OU, and flat and intact retinal periphery 360 OU. The cornea specialist diagnosed the patient as a glaucoma suspect based on the patient having a large cup-to-disc ratio in both eyes, and an OCT of the retinal nerve fiber layer was scheduled to be performed at the patient's next visit with his cornea specialist.

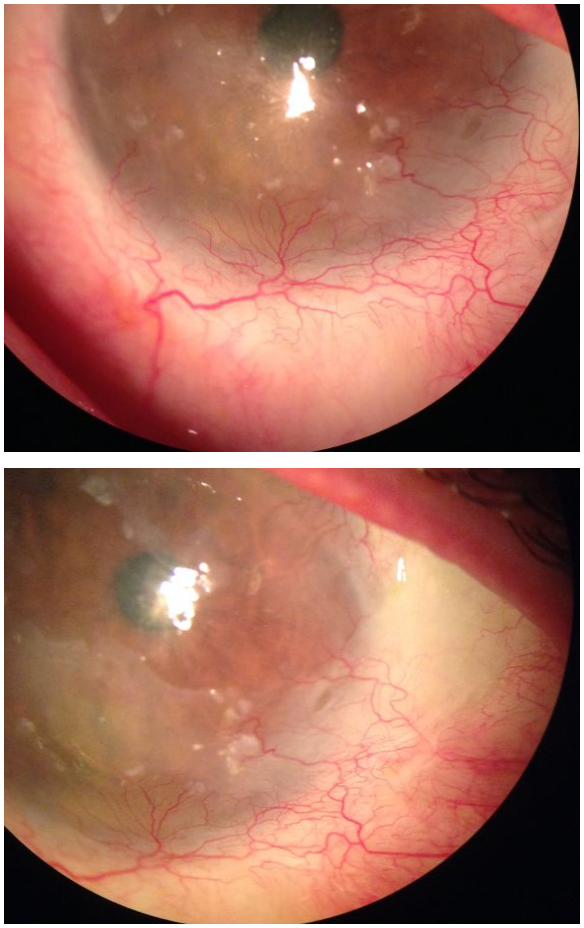

Figure 1 and 2. Anterior segment photography of the patient's left eye.

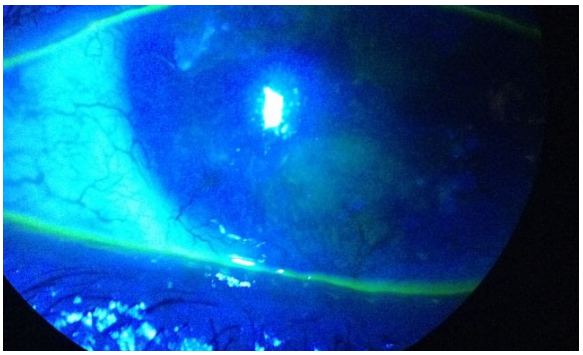

Figure 3. Corneal staining of the left eye with sodium fluorescein.

The patient had removed his corneal GP contact lens prior to his appointment. To evaluate the fit of the lens, the lens was placed on the eye and sodium fluorescein was instilled. The parameters of the patient's habitual corneal GP lens were as follows:

Manufacturer	Lens Dynamics
Lens Type	Dyna Intralimbal
Diameter	11.4
Optic Zone Diameter	9.6
Base Curve	8.13
Rx	-1.87 sph
Peripheral Curves	Quad-Sim Design - Flat Quadrants 1,2,3 Standard Quadrant 4
Material	Optimum Extra

The visual acuity with this lens was 20/40, and there was no improvement in vision with over-refraction or pinhole. The lens showed a lid attachment fit with an irregular fluorescein pattern showing areas of clearance greatest nasally and superotemporally, with areas of moderate mid-peripheral bearing greatest temporally and inferiorly. Insufficient edge lift was present nasally and inferiorly.

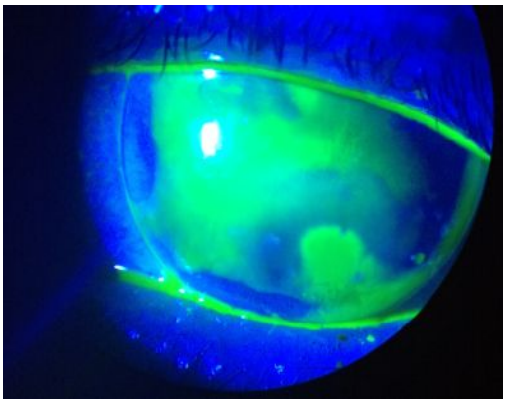

Figure 4. Anterior segment photograph of the left eye showing the sodium fluorescein pattern with the patient's habitual corneal gas permeable contact lens on the eye.

Impressions

- History of conjunctival and corneal melanoma OS s/p excision, MMC and interferon alfa-2b with recent positive biopsy
- Limbal stem cell deficiency (LSCD) OS s/p limbal stem cell transplant
- Corneal scarring and conjunctivalization OS secondary to LSCD and multiple ocular surgeries
- Irregular astigmatism OS secondary to corneal scarring
- Dry eye syndrome OS
- Subconjunctival hemorrhage OS s/p recent biopsy
- Glaucoma suspect OU, with excellent IOPs OU
- Pseudophakia OU

Plan

Due to the significant amount of corneal staining OS, the patient was instructed to temporarily discontinue wear of his current RGP contact lens and start Refresh Optive preservative free artificial tears (PFATs) every two hours. The patient was also to start topical interferon alfa-2b four times per day (QID) OS the next day as prescribed by his cornea specialist. The patient's diagnosis of glaucoma suspicion OU was to continue being managed by his cornea specialist, with an OCT of

the retinal nerve fiber layer scheduled for his next visit. The patient's intraocular pressures were to continue to be monitored at each visit to our clinic. The patient was instructed to return in two weeks for follow-up of ocular surface disease and to consider performing a contact lens re-fit.

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Follow up - Visit #2

HPI

The patient returned for a follow-up of his ocular surface disease and to continue performing a contact lens re-fit. He reported that since starting interferon alfa-2b QID OS two weeks prior, he was experiencing irritation, light sensitivity and mild blurred vision OS. He had not been using artificial tears as was prescribed. The patient reported no other changes in vision or health since the previous visit.

Examination

The patient's corrected entering visual acuity with his habitual spectacle correction was 20/25+ OD and 20/50+1 OS (no contact lens worn OS). Slit lamp biomicroscopy revealed normal adnexae, lids, lashes, puncta, anterior chambers, and irides in both eyes. The conjunctiva of the right eye was white and quiet and the cornea was clear. The conjunctiva of the left eye showed 2+ hyperemia and irregular temporal elevation. The small temporal subconjunctival hemorrhage seen at the last visit had resolved. The cornea of the left eye showed stable superior and inferior conjunctivalization, 3-4mm anterior stromal neovascularization, and scattered irregular patches of anterior stromal scarring. One drop of Fluress was instilled which revealed 3+ scattered coalesced punctate keratitis greatest inferiorly and temporally. The intraocular pressures were measured to be 10 mmHg OD and 12 mmHg OS.

Plan

The patient was to continue interferon alfa-2b QID OS and to use Refresh Optive PFAT's an hour after each interferon dose. A scleral contact lens fitting was recommended OS, as a scleral lens would allow a more ideal fitting relationship than the patient's corneal GP and would likely provide significant improvement in ocular surface disease signs and symptoms by providing continuous lubrication. The patient's intraocular pressures were to continue to be monitored each visit. The patient was scheduled to return for a scleral contact lens fitting in one month.

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Follow-up - Visit #3

HPI

The patient presented for a scleral contact lens fitting OS. The patient reported pain, foreign body sensation, redness and photophobia OS which had worsened since the last visit. The patient reported that he had experienced these symptoms in the past from interferon treatment and found that his ocular discomfort had significantly worsened over the three-month course of treatment. The patient was using interferon alfa-2b QID OS and PFAT's every hour. The patient reported no other changes since last visit.

Examination

The patient's corrected entering visual acuities through his habitual spectacle correction were 20/25 OD and 20/40 OS (with contact lens OS). Slit lamp biomicroscopy revealed normal adnexae, lids, lashes, puncta, anterior chambers, and irides in both eyes. The conjunctiva of the right eye was white and quiet and the cornea was clear. The conjunctiva of the left eye had 1+ hyperemia and irregular temporal elevation. The cornea of the left eye showed stable superior and inferior conjunctivalization, 3-4mm anterior stromal neovascularization, and scattered irregular patches of anterior stromal scarring. One drop of Fluress

was instilled which revealed 3+ scattered coalesced punctate keratitis greatest inferiorly and temporally, with a TBUT of 2 seconds. The intraocular pressures were measured to be 11 mmHg OD and 12 mmHg OS.

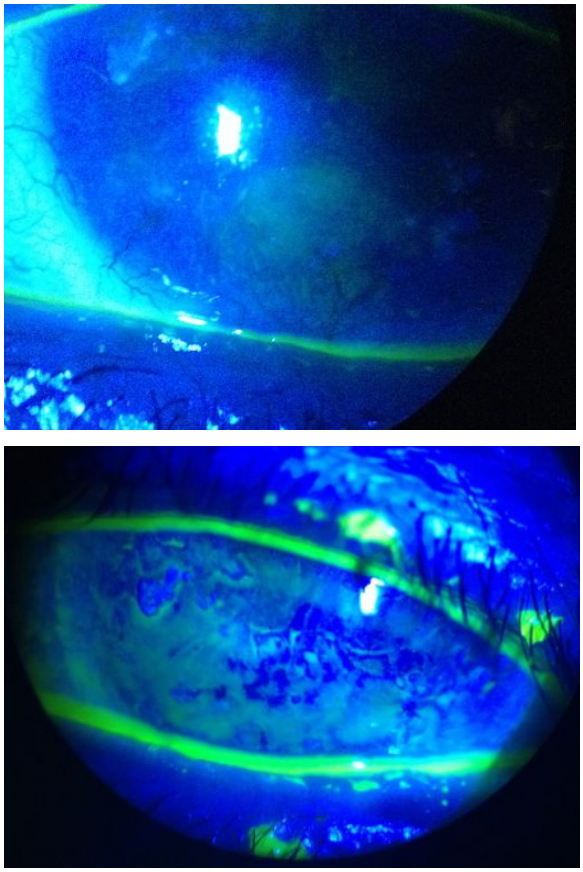

Figure 5. Anterior segment photography of the left eye showing corneal sodium fluorescein staining prior to treatment with interferon alfa-2b (left, from visit #1), and then showing marked worsening of ocular surface staining and tear quality after two months of topical interferon alfa-2b treatment (right, from visit #3)

Corneal Topography

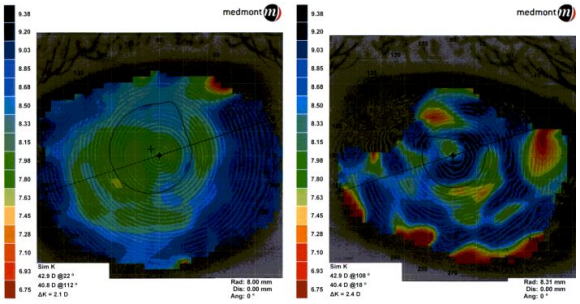

Figure 6. Medmont corneal topography of both the right and left eye from the patient's previous records, taken on 7/23/2016 by the O.D. who fit the patient's current habitual corneal GP lens. The topography shows that the right eye has an essentially spherical cornea with poor image quality due to surface dryness. The scan of the left eye is of even poorer quality due to surface dryness, and demonstrates multiple mid-peripheral areas of irregular steepening due to corneal scarring.

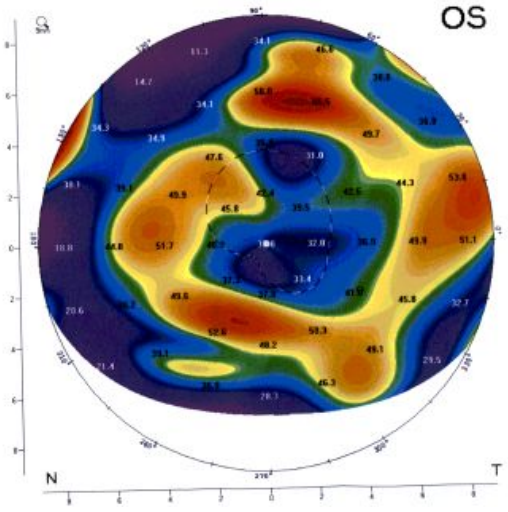

Figure 7. Corneal topography of the left eye taken of the left eye on 1/13/2017 with the Oculus Pentacam showing multiple areas of mid-peripheral steepening secondary to scarring following repeated biopsies. The steepening at the temporal limbus was secondary to scarring from

surgical excision of the primary neoplasm. While this scan and the Medmont scan taken 6 months prior were taken on different instruments which introduces some variability, the mid-peripheral steepening appeared to have worsened and progressed to involve the paracentral cornea closer to the visual axis The patient had had two additional 12-site incisional corneal biopsies in between the first topography and the second.

Scleral contact lens fitting

A trial scleral contact lens was selected from a Valley Contax Custom Stable Elite fitting set. A diameter of 15.8 was selected based on the patient's horizontal visible iris diameter (HVID) which measured 11.7mm in the left eye. The fitting guide for this lens recommended selecting an initial diameter of 15.8mm for HVIDs in the range of 11.6 - 12.4mm. The sagittal depth of the initial trial lens was selected using the patient's flat sim-K measurement for the left eye, which was 40.4 D (see Figure 6). The fitting guide for this lens recommended that within the 15.8mm diameter trial lenses, an initial sagittal depth should be chosen by multiplying the flat K in diopters by 100 to achieve a starting sagittal depth in microns of 4040. Subsequently, the closest sagittal depth to 4040 microns in the fitting set was chosen as the initial trial lens, which had a sagittal depth of 4070 microns. All of the parameters of the initial trial lens were as follows:

Manufacturer	Valley Contax
Brand	Custom Stable Elite
Diameter	15.8
Base Curve	8.65
Sagittal Depth	4070 microns
Rx	+2.00 sph
Limbal Clearance Zone	Standard
Scleral Landing Zone	Standard Toric (+5 flat / -2 steep)
Center Thickness	0.40
Material	Optimum Extra

The visual acuity with this trial lens was 20/50+. With a spherical over-refraction of -1.00 sph, the patient's visual acuity improved to 20/25-1. Upon slit lamp evaluation with diffuse illumination, the fit of the lens showed good centration and coverage, and the toric landing zone markings were aligned at 3:00 and 9:00. Using slit lamp estimation technique with an optic section beam, the trial lens was measured to have 300 microns of central corneal clearance, 125 microns of limbal clearance superior and nasal, and 75 microns of limbal clearance inferior and temporal. Trace conjunctival impingement was present at the edge of the lens superiorly and inferiorly. The edges were well aligned nasally and temporally.

The patient was able to achieve better visual acuity with the Custom Stable Elite trial scleral lens than he had previously achieved with his habitual corneal GP lens. He reported excellent comfort with the trial scleral lens on.

Plan

Modifications were made to the lens parameters to incorporate the over-refraction and to reduce conjunctival impingement by flattening the scleral landing zone by 2 steps in the vertical (steep) meridian. The material Optimum Extra was chosen for this patient's initial lens because this material has both high oxygen permeability (Dk of 100) and a low wetting angle of 3^{o}. Choosing a material with high oxygen permeability was very important for this patient, as a lens with low oxygen permeability would carry a higher risk of causing hypoxia leading to corneal edema or progression of this patient's existing neovascularization. Some GP materials with even higher oxygen permeability (Dk) have the unwanted correlation of a much higher wetting angle, which can lead to poor surface wetting and compromised vision especially in patients with

pre-existing ocular surface disease, so Optimum Extra was selected as having a good balance between these two important parameters.

The following lens was ordered:

Manufacturer	Valley Contax
Brand	Custom Stable Elite
Diameter	15.8
Base Curve	8.65
Sagittal Depth	4070 microns
Rx	+0.75 sph
Limbal Clearance Zone	Standard
Scleral Landing Zone	+5 flat / 0 steep
Center Thickness	0.30
Material	Optimum Extra

The patient was to continue using Refresh PFAT's as needed. The patient's intraocular pressures were to continue to be monitored each visit. The patient would be called when the new scleral lens came in.

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Follow-up - visit #4

HPI

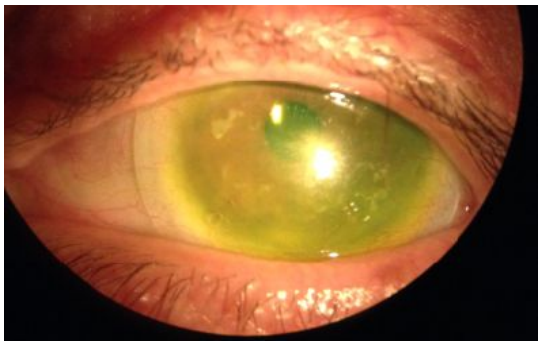
The patient presented for dispense of his Valley Custom Stable Elite scleral lens OS. The patient reported using Refresh PFAT's once every 30 minutes to one hour The patient reported no changes in symptoms since the last visit.

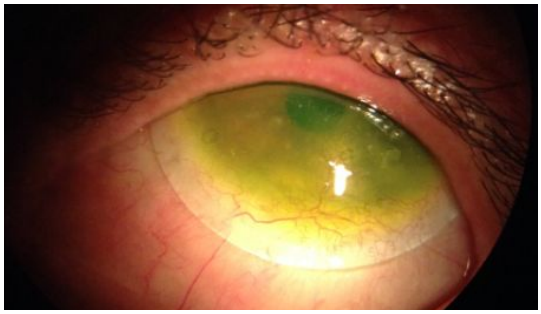
Examination

The patient's corrected entering visual acuity was 20/25+ OD and 20/40- OS (with contact lens OS). Slit lamp biomicroscopy revealed normal adnexae, lids, lashes, puncta, anterior chambers, and irides in both eyes. The conjunctiva of the right eye was white and quiet and the cornea was clear. The conjunctiva of the left eye had trace conjunctival injection and irregular temporal elevation. The cornea of the left eye showed stable superior and inferior conjunctivalization, 3-4mm anterior stromal neovascularization, and scattered irregular patches of anterior stromal scarring. One drop of Fluress was instilled which revealed 3+ dense coalesced punctate keratitis and TBUT of 3 seconds. The intraocular pressures were measured to be 12 mmHg OD and 11 mmHg OS.

Contact lens evaluation

The ordered Valley Contax Custom Stable Elite scleral lens was placed on the left eye. Visual acuity measured with this lens was 20/25 in the left eye. The lens was allowed to settle on the patient's eye for 20 minutes, and then the fit was evaluated using the slit lamp. The fit of the lens showed good centration and coverage, 300 microns of central corneal clearance with slit lamp estimation, and 100 microns limbal clearance in all quadrants. The scleral landing zone was well aligned with the sclera in all quadrants and showed no areas of compression or impingement upon the conjunctiva or conjunctival vessels.





Figures 8 and 9. Anterior segment photography of the patient's left eye with the Valley Contax Custom Stable Elite scleral contact lens on the eye. The sodium fluorescein instilled into the bowl of the lens demonstrated that the entire cornea and its areas of irregular scarring were successfully vaulted by the scleral lens with no areas of bearing. There was adequate limbal clearance evidenced by the extension of the sodium fluorescein past the limbus which is present in all quadrants. No compression or impingement of the conjunctiva was noted at the scleral landing zone.

Excellent fit, vision and comfort was achieved OS with the Custom Stable Elite scleral lens. The patient reported immediate reduction in symptoms of dryness and improvement in quality of vision compared to his habitual corneal GP lens. The patient was successful at insertion and removal of the lens in office.

Plan

The patient was thoroughly educated on proper insertion, removal and cleaning of scleral lenses, including to fill the lens with non-preserved saline solution before insertion, to disinfect the lens nightly with ClearCare hydrogen peroxide solution, and to use either non-preserved saline or Biotrue if needed for rinsing prior to insertion. The patient was instructed never to sleep, swim or shower in the contact lens, and to discontinue wear and return to the clinic if significant redness, pain, photophobia or decreased vision occured. The scleral lens was dispensed.

The patient had a biopsy scheduled two days later with his cornea specialist to assess whether his recent course of interferon was effective. The patient was given permission to wear the new scleral lens for up to 4 hours per day until the biopsy. Per discussion with the patient's cornea specialist, the patient was instructed to discontinue wear after the biopsy to allow for healing and then resume wear 3 weeks post-biopsy. The patient was instructed to start at 4 hours per day of wear and gradually increase wear time, but not to exceed 8 hours of wear time prior to the next visit. The patient was scheduled to return in 1 month for follow-up, having worn the scleral lens for at least 4 hours prior to the next visit.

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Follow-up - visit #5

HPI

The patient presented for follow-up for evaluation of the fit, vision and comfort of his new scleral lens OS. He reported that he had begun wearing the scleral lens OS one week prior as instructed, beginning with 2-3 hours per day and slowly increasing to an average wear time of 6 hours per day. The patient reported that he had had the lens The patient reported excellent vision with the lens alone at distance. He reported excellent vision at near as well when using his habitual progressive glasses over the lens, which were designed for use over his prior corneal GP lens and had a +0.25 sph with a +3.00 add in the left eye. The patient reported that he had been using PFAT's every 1-2 hours when the lens was not on, but did not feel any discomfort or the need to use tears when the lens was on. The patient was extremely happy to be symptom-free while wearing the lens. The patient reported that he had been filling the lens with Lacripure, disinfecting overnight with ClearCare, and rinsing with Biotrue in the morning prior to insertion. The patient was very pleased to report that his corneal biopsy results showed that he was cancer-free, and his cornea specialist planned to wait 6 months to do another biopsy.

Examination

The patient's corrected entering visual acuity was 20/30 OD with habitual spectacle correction, and 20/25-3 OS with the new scleral contact lens. The fit of the scleral contact lens was evaluated (see below) and then the lens was removed. Slit lamp biomicroscopy revealed normal adnexae, lids, lashes, puncta, anterior chambers, and irides in

both eyes. The conjunctiva of the right eye was white and quiet and the cornea was clear. The conjunctiva of the left eye was white and quiet with irregular temporal elevation. The cornea of the left eye showed stable superior and inferior conjunctivalization, 3-4mm anterior stromal neovascularization, and scattered irregular patches of anterior stromal scarring. One drop of Fluress was instilled which revealed trace scattered punctate keratitis and TBUT of 6 seconds. The intraocular pressures were measured to be 12 mmHg OD and 11 mmHg OS.

Contact lens evaluation

The fit of the Valley Contax Custom Stable Elite scleral contact lens dispensed at the last visit was assessed. The patient reported that he had been wearing the lenses for 6 hours that day. The fit of the lens showed good centration and coverage with slit lamp examination. The central corneal clearance was measured to be 106 microns using anterior segment OCT. Slit lamp estimation showed 75 microns of limbal clearance in all quadrants. The scleral landing zone was well aligned with the sclera in all quadrants with no areas of compression or impingement upon the conjunctiva or conjunctival vessels.

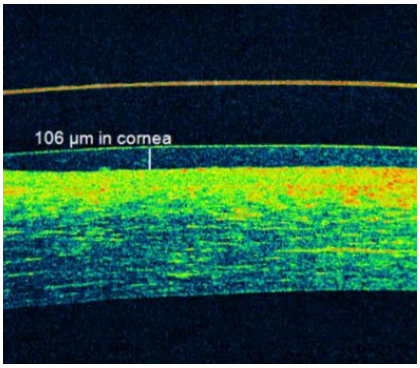

Figure 10. Anterior segment OCT over the scleral lens demonstrating approximately 106 microns of central clearance and successful vaulting of areas of irregular corneal elevation after 6 hours of wear.

Excellent fit, vision and comfort was achieved OS with the Valley Custom Stable Elite scleral lens. The patient reported no symptoms of ocular discomfort while the lens was on, and was able to dramatically reduce frequency of artificial tear use from multiple times per hour to only 1-2 times per day.

Plan

The contact lens Rx was finalized and a new spectacle Rx was given for progressives to wear over the contact lens. The patient was instructed to continue filling lenses with non-preserved saline, using ClearCare for lens disinfection, and using Refresh PFAT's over lens as needed. The patient was educated to discontinue contact lens wear and RTC as soon as possible if pain, redness, discharge or sudden blurred vision occured. The patient was scheduled to return in 3 months for follow-up.

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Follow-up - visit #6

HPI

The patient presented for follow-up on 8/16/2017, four months after his final scleral lens OS was dispensed on 04/17/2017. The patient reported excellent comfort and vision with the scleral lens OS. The patient reported an average wear time of 6 hours per day, approximately four days per week, or whenever he needed to drive or leave the house. The patient reported using Boston Simplus for lens conditioning and ClearCare Plus for overnight disinfection, and denied sleeping, swimming or showering in the lens. The patient reported that he has been using Refresh Optive preservative free artificial tears about 5 times per day for relief of dry eye symptoms. The patient reported that the lens had been inserted 3 hours prior to this appointment.

Examination

The patient's corrected entering visual acuity was 20/20-1 OD with habitual spectacle correction, and

20/25-2 OS with his scleral contact lens. The fit of the scleral contact lens was evaluated (see below) and then the lens was removed. Slit lamp biomicroscopy revealed normal adnexae, lids, lashes, puncta, anterior chambers, and irides in both eyes. The conjunctiva of the right eye was white and quiet and the cornea was clear. The conjunctiva of the left eye was white and quiet with irregular temporal elevation. The cornea of the left eye showed stable superior and inferior conjunctivalization, 3-4mm anterior stromal neovascularization, and scattered irregular patches of anterior stromal scarring. Fluorescein was instilled which revealed no corneal staining in either eye.

Contact lens evaluation

The fit of the scleral contact lens was assessed using the slit lamp. The patient reported that he had been wearing the lenses for 3 hours prior to this visit. The fit of the lens showed good centration and coverage, and 200 microns of central clearance was measured using slit lamp estimation. There were 75 microns limbal clearance in all quadrants. The scleral landing zone was well aligned with the sclera in all quadrants. A few deposits were present on the lens surface.

Plan

The patient was instructed to continue filling lenses with non-preserved saline, using ClearCare for lens disinfection, and using Refresh PFAT's as needed. Proper cleaning and insertion techniques were reviewed. The patient was educated to discontinue contact lens wear and RTC as soon as possible if pain, redness, discharge or sudden blurred vision occured. The patient was scheduled to return to clinic in 6 months for a contact lens follow-up. The patient was also confirmed to have a follow-up scheduled with his cornea specialist in two months.

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Discussion

Conjunctival melanoma is a rare condition which represents 2% of all ocular malignancies.[2] It is capable of threatening vision by spreading to the cornea and other ocular tissues, and carries a significant risk for recurrence, metastasis and mortality. The risk for metastasis increases from 16% at 5 years to 32% at 15 years following successful treatment, and tumor-related death occurs in 7% of cases at 5 years and 13% at 10 years.[3]

Even after successful excision, the recurrence rate for conjunctival melanoma is 26% at 5 years, 51% at 10 years and 65% at 15 years.[3] Excisional biopsy can be combined with one or more adjuvant therapies such as cryotherapy, topical chemotherapy or radiation to increase the likelihood of full eradication of cancerous and atypical cells. The current standard of care for most ocular surface neoplasias including conjunctival melanoma is wide excision biopsy with cryotherapy along the surgical margins.[4] Topical chemotherapy is often added if histopathology of tumor margins demonstrates PAM with atypia, or in cases of diffuse PAM with atypia.[2] One of the most widely used adjuvant topical chemotherapy agents is mitomycin C (MMC).

MMC is an antibiotic isolated from the bacterium *Streptomyces caespitosus* which causes several cytotoxic effects to kill tumor cells and inhibit growth. MMC acts as an alkylating agent which promotes breakage of single-stranded DNA and halting of DNA, RNA and protein synthesis.[5] Topical MMC has been shown to have a beneficial effect in many ocular surgeries by inhibiting wound healing response and reducing scarring. MMC offers numerous benefits in comparison to or when used in addition to surgery, including lower recurrence rates, less dependence on surgical margins, and ease of repeatability.[3] However, MMC carries significant risk for complications

such as pain, corneal erosions, conjunctivitis, occlusion of the puncta and scleral melting.[3]

Limbal stem cell deficiency (LSCD) is a rare potential complication of topical MMC use that has been increasingly described in the literature over the past two decades. A case report by Dudney et al.[6] in 2003 described a case in which a 92-year -old African-American woman was treated for conjunctival-intraepithelial neoplasia (CIN). The patient underwent excisional biopsy and, after complete healing of the biopsy site, was given five one-week courses of topical 0.04% MMC QID with a 1-week break between each course. The patient's CIN regressed completely, but the patient developed recurring non-healing corneal epithelial defects which were determined to be the result of LSCD. The authors of this case report suggest that fewer courses of MMC may be beneficial in reducing risk for LSCD following MMC treatment, since MMC's cytotoxicity has been shown to be dose-related.

A retrospective interventional study conducted by Ditta et al.[7] in 2010 reported that of 15 patients receiving topical MMC for conjunctival melanoma, four patients developed LSCD. Other reported complications included injection (13 patients), tearing (10 patients), irritation (9 patients) and pain (9 patients).

While MMC is a highly effective adjunct treatment option for ocular surface neoplasias, these frequently reported adverse effects have led researchers to investigate alternatives to MMC. Interferon alfa-2b has been found to have tumor-reducing results similar to MMC with a much lower risk of complications.[8]

Interferons are a family of glycoproteins that bind to cell membrane receptors and induce a cascade of intracellular activity leading to anti-viral and anti-tumor effects.[4] Topical interferon alfa-2b is increasingly being used for ocular surface neoplasias including conjunctival intraepithelial neoplasia (CIN), primary acquired melanosis and conjunctival melanoma, although there are fewer published studies demonstrating the efficacy of topical interferon alfa-2b for these conditions than there are supporting use of mitomycin C. In a 2008 retrospective interventional case series published by Finger et al,[8] use of interferon alfa-2b for primary acquired melanosis led to complete regression in 4 of 5 subjects over a mean follow-up period of 15 months, with no systemic side effects. A 2010 prospective case series by Herold et al.[9] demonstrated regression of 7 conjunctival melanocytic lesions in 9 patients after a 6-week course of topical interferon alfa-2b (1 million IU per ml) used 5 times per day. Three patients needed a second round of treatment due to incomplete regression, one patient required a third cycle, and a fourth patient required a fourth cycle of treatment and additional surgery to achieve stable regression. No side effects were reported in the study, and all nine patients were then followed for a median 24.8 months with no recurrence after complete regression was achieved.

Topical use of interferon alfa-2b has been demonstrated to have side effects, but they are much less severe and less common than those of MMC. A study performed by Schechter et al.[4] in 2008 at Bascom Palmer Eye Institute reported side effects of mild conjunctival hyperemia and follicular conjunctivitis in 12% of the 27 patients with conjunctival and corneal intraepithelial neoplasia (CCIN) who were treated with topical interferon alfa-2b four times daily until clinical resolution was achieved. The study reported that in all cases, the side effects completely resolved within one month of discontinuation of topical interferon treatment.

Today, many clinicians are using topical MMC initially followed by long-term use of interferon alfa-2b as was done in the case presented in this report. Further research is needed to compare the efficacy of topical MMC and topical interferon alfa-2b for conjunctival melanocytic lesions. A number of other topical chemotherapy agents are currently being studied for potential use against

conjunctival melanoma including 5-Fluorouracil, an antimetabolite which prevents DNA and RNA synthesis and has been used to treat ocular surface squamous neoplasia.[2] Continued research is needed to find and compare the efficacy of topical chemotherapy treatments which are effective against conjunctival melanoma but less toxic to the ocular surface.

Even following successful treatment, patients with a history of conjunctival melanoma require long-term follow-up with systemic surveillance and repeated biopsies of ocular surface tissue to ensure that any recurrence can be treated as early as possible. Repeated biopsies and the use of topical chemotherapy agents can be highly damaging to the ocular surface and can result in irregular corneal astigmatism, ocular surface disease, limbal stem cell deficiency and scarring, all leading to impaired vision and dry eye. As the case described in this report has demonstrated, scleral lenses can be a beneficial treatment strategy to address both the ocular surface disease and irregular astigmatism which may be seen in post-treatment conjunctival melanoma patients.

A scleral lens is a large diameter gas permeable contact lens that vaults over the cornea and rests on the anterior scleral surface.[1] The lens is filled with non-preserved saline solution prior to insertion, creating an enclosed liquid reservoir that allows for optical correction of irregular astigmatism without direct contact between the lens and the cornea. Scleral lenses reduce mechanical stress to the cornea in comparison with corneal GP lenses, and therefore can be a better option for correction of irregular astigmatism in patients with ocular surface disease. In recent years, the indications used for scleral lenses have been expanding from optical correction to therapeutic uses such as for OSD.

Like any contact lens, scleral lens wear does carry potential risks, and steps should be taken to minimize those risks. The most serious potential complications of scleral lens wear are microbial keratitis and hypoxia-related complications such as corneal edema and corneal neovascularization. Microbial keratitis is very rare in gas permeable lens wear, and scleral lenses do not seem to pose any additional risk when compared to corneal GP lenses.[1] Risk for infection can be minimized by thoroughly training the patient in proper contact lens hygiene and lens care, and by reviewing these instructions at follow-up visits to ensure patients are maintaining good habits.

A risk for corneal edema due to mild hypoxic stress does exist with scleral lenses, and is greater than that of corneal GP lenses. The large diameter of a scleral lens necessitates a greater central thickness to maintain the structural dimensions of the lens, in contrast to a smaller diameter corneal GP lens.[10] The flow of oxygen through a contact lens is described in two main parameters: oxygen permeability (Dk) and oxygen transmissibility (Dk/t). Dk is a value determined by the material of a contact lens, and Dk/t represents the oxygen permeability of the lens material divided by the thickness of a particular contact lens made of that material. The percentage of oxygen transmitted through a contact lens is thus lowered as the thickness of the lens increases. A prospective study by Michaud et al.[10] in 2012 demonstrated for the first time that an 18 mm scleral lens fit with 400µm of clearance over the cornea reduced the oxygen tension available to the cornea by 30% compared to a lens of the same diameter fit with 200µm of clearance. As a result, the authors presented the following ideal model for scleral lens fitting to minimize hypoxia: use the highest available Dk lens (>150) with a maximum central thickness of 250µm and fit with a central clearance of no more than 200µm. However, in practice these parameters are not always possible to achieve without compromising vision, comfort or ocular health. While the highest Dk lens materials are ideal, a higher Dk value is correlated with a higher wetting angle. A higher wetting angle is not desirable and means that it is more difficult for

the tear film to adequately wet the surface of the lens, which can lead to discomfort or blurred vision. A high wetting angle can be especially problematic in patients with OSD who already have poor quality or inadequate tear production, so the Dk must be optimized without sacrificing wetting angle to an extent that the patient's comfort and vision are affected. The second ideal recommendation from this study is to fit lenses with a maximum central thickness of 250µm, but most commercially available scleral lenses are made to a standard central thickness of 300 to 350µm. Some manufacturers can make lenses thinner upon request, but thinner scleral lenses are less durable and more prone to lens flexure. High plus refractive error correction can also necessitate a higher center thickness. The third ideal fit parameter presented in this study is to keep central thickness below 200µm, which represents a low amount of central clearance.[10] Scleral lenses settle into the conjunctiva and sclera throughout the day due to the relative weight and size of the lens, because these tissues are much more compressible in comparison to the cornea. Settling means that the amount of lens clearance, or tear reservoir, reduces over the course of the day. A small study by Esen et al.[11] in 2017 fit 22 eyes with scleral lenses and found that the average amount of lens settling was 62.8µm, 80% of which occurred during the first four hours of wear. While 200µm of clearance is an achievable goal, practitioners should make sure to assess the fit of the lens after 4 or more hours of wear time. Greater than expected settling of a lens fit with low clearance could lead to to end-of-day central touch and abrasion of the ocular surface, and thus negate the potential benefits of scleral lens therapy in an ocular surface disease patient.

Considering the reduction in oxygen transmission to the cornea with a scleral lens compared to the naked eye, performing endothelial cell count is highly advisable prior to scleral lens fitting in any patients with corneal guttata, endothelial dystrophies or history of corneal transplantation. Any scleral lens patient with endothelial cell count less than 1,000 cells/mm^2 should be monitored carefully, and the scleral lens should be fit with maximizing oxygen transmission as a primary goal.[1] Scleral lenses may not be a good treatment option in patients with very low endothelial cell count below 800 cells/mm^2 due to the high risk for corneal edema. As with all medical interventions, the potential risks must be weighed against the potential benefits for a particular patient in deciding whether the patient is a good candidate for scleral lens wear.

Scleral lenses are increasingly being utilized for the treatment of dry eye disease and ocular surface disease (OSD).[12,13] The saline fluid reservoir underneath a scleral lens provides continuous lubrication of the ocular surface, which for many chronic OSD patients results in dramatic relief of ocular surface dryness and can produce an improvement in visual acuity. The scleral lens also provides protection for damaged corneal epithelial cells from the shear forces of the eyelids, allowing for regeneration of the epithelium.

The treatment of ocular surface disease typically starts with more conservative treatment options before progressing to the level of considering a scleral lens. The TFOS DEWS II Report suggests a staged management approach to treatment of ocular surface disease.[14] Step one involves patient education, dietary and environmental modifications, ocular lubricants, and lid hygiene and warm compresses when appropriate. If those options are inadequate, Step 2 includes non-preserved lubricants, ointments, punctal occlusion, moisture chamber goggles, in-office heating and expression of meibomian glands, topical corticosteroids, topical cyclosporine or lifitegrast, and topical or oral antibiotics for blepharitis. If appropriate Step 2 treatments fail, Step 3 recommends consideration of autologous serum tear drops, oral secretagogues, soft bandage lenses, and rigid scleral lenses. If the patient's symptoms and signs are still not under control,

Step 4 recommends consideration of amniotic membrane grafts, surgical punctal occlusion, long duration topical corticosteroids, and other surgical approaches including tarsorrhaphy or salivary gland transplantation.

As scleral lenses have become more accepted and utilized as a treatment option for severe OSD, many patients have been able to postpone or entirely avoid invasive surgical approaches such as tarsorrhaphy via therapeutic wear of a scleral lens.[14] A retrospective review by Schornack et al.[12] in 2014 examined 115 patients (188 eyes) fit with scleral lenses for the purpose of management of OSD. The most common types of OSD treated in the study were undifferentiated OSD, exposure keratopathy, and neurotrophic keratopathy. The therapeutic goals in the study were defined as improved comfort, ocular surface protection, and/or resolution of keratopathy, and these goals were achieved in all but two of the 115 subjects. With scleral lens wear, visual acuity in these patients improved from an average of 0.32±0.37 logMAR (Snellen equivalent of 20/42) to 0.12±0.19 logMAR (Snellen equivalent of 20/26).

Another study by Romero-Rangel et al.[15] in 2000 looked at 76 eyes fit with scleral lenses for various types of OSD including Sjogren syndrome, post-herpetic keratitis, inflammatory corneal degeneration, congenital deficiency of meibomian glands, exposure keratitis, and Stevens-Johnson syndrome. 15 patients had persistent corneal epithelial defects at the beginning of the study, and in 8 of those patients, the defects healed with scleral lens wear. 53% of the eyes gained 2 or more Snellen lines in best corrected visual acuity, and 92% reported improvement in their quality of life due to reduction in discomfort and photophobia. The average scleral lens wear time in this study was 4 to 18 hours per day, with a mean of 13.7 hours per day.

A case report presented by M. Schornack[16] in 2011 details the management of a patient with limbal stem cell disease with scleral lenses. The author describes a patient with clinical signs of bilateral LSCD who did not have a transplant, but whose signs and symptoms resolved after 9 months of scleral lens wear. The patient then discontinued scleral lens wear, was asymptomatic for 18 months, and then mild epitheliopathy recurred so scleral lenses were again used for one month until healing of the epithelium was complete. The author proposed that protection of the limbus and of the corneal epithelial cells by a scleral lens may facilitate some regeneration of limbal stem cell function in patients who have reduced function but not complete destruction of their limbal stem cells. Further studies are certainly needed to better understand the role and mechanism of scleral lens therapy in managing patients with limbal stem cell deficiency.

Conclusion

The patient described in this case report reported immediate relief of ocular surface discomfort upon insertion of a scleral lens. Unfortunately this patient's corneal irregularity and ocular surface disease will likely continue to worsen as he undergoes repeat corneal biopsies every six months to monitor for melanoma recurrence, with three-month courses of topical interferon alfa-2b required whenever atypical cells are observed. This patient will not be treated with mitomycin C again due to the limbal stem cell deficiency and subsequent ocular surface scarring that he developed following MMC treatment.

In addition to improving vision by correcting irregular astigmatism, this patient's scleral lens will allow for corneal rehabilitation and promotion of healing following his biopsies and topical chemotherapy treatments, and will promote the health of his transplanted limbal stem cells and reduce the risk of transplant failure.

Patients who have undergone surgical excision and topical chemotherapy treatment of ocular surface

melanoma are at risk for development of scarring, irregular astigmatism, dry eye syndrome, and limbal stem cell deficiency, in addition to the risk for continued local invasion and metastasis of the tumor. While corneal gas permeable lenses are a good option for the correction of irregular astigmatism, scleral lenses offer the additional benefit of providing continuous hydration, and can dramatically improve ocular surface disease signs and symptoms. Scleral gas permeable contact lenses should be considered in these cases to improve vision, promote healing after repeated biopsies and exposure to chemotherapeutic agents, reduce ocular discomfort and improve quality of life.

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