Case report

Scleral lenses in the treatment of post-LASIK ectasia and superficial neovascularization of intrastromal corneal ring segments

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A B S T R A C T

Objective: This case report aims to explore the use of scleral lenses for the treatment of ocular and visual complications in an adult patient presenting with post-LASIK (Laser-Assisted in situ Keratomileusis) ectasia in both eyes with cross-linking in the right eye and intrastromal corneal ring segments (ICRS; Intacs, Addition Technology, Fremont, CA) in the left eye.

Methods: Following a comprehensive eye exam and specific testing for contact lens fitting, scleral lenses were fitted with success in both eyes and dispensed. Due to progressive fibrosis and neovascularization of the inferior ICRS in the left eye, the inferior ICRS was removed and scleral lenses were refit with success.

Results: Prescribed scleral lenses helped the patient achieve optimal visual correction (20/20) as well as ocular protection of the cornea.

Conclusion: Post-LASIK ectasia is a common finding among contact lens specialists today. When ICRS surgery is involved, the fitting of contact lenses may become more challenging. Scleral lenses offer a unique way of addressing many issues raised in this case report including corneal neovascularization and ectasia. This lens modality may be considered for any other case involving irregular corneal curvature following surgery resulting in reduced visual acuity.

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1. Introduction

Post-LASIK ectasia is defined as refractive or optical regression resulting from a bulging forward of the ablated cornea slightly to steepen both the anterior and posterior corneal curvature, after an uneventful LASIK (Laser-Assisted in situ Keratomileusis) procedure [1,2]. This bulging forward occurs similarly with corneal relaxation incisions after radial keratotomy (RK) [2]. In RK, however, the peripheral cornea is weakened, leading to steepening of the peripheral and flattening of the central cornea, whereas in myopic LASIK, the thinner and weaker central cornea results in central steepening. Currently, this condition is challenging to manage for refractive surgeons, and several therapeutic options have been proposed in recent studies [1]. These include RGP (rigid gas-permeable) contact lenses, corneal collagen crosslinking, topography-guided PRK (photorefractive keratectomy) with simultaneous crosslinking, corneal transplantation, and ICRS (intrastromal corneal ring segments).

Evidence is meager regarding the best indication for each treatment option [1]. For reasons that are not apparent, the patient reported in this case received two different treatments in each eye. The case is relevant and particularly instructive, because despite different treatments in each eye and several modifications to the initial lens fitting, scleral lens therapy resulted in good acuity and comfort bilaterally. This report explores the challenges of fitting a scleral lens after different treatments in each eye and the troubleshooting involved in reaching a successful outcome in both. Of note, patient consent was received for both use of images and publication of the case.

2. Case report

In the summer of 2013, patient JV, a 38 year-old Hispanic male, presented to the Global Vision Rehabilitation Center. He was referred by a cornea specialist for a contact lens evaluation for the treatment of fluctuating and unstable vision in both eyes and difficulty driving at night owing to halos and starbursts around lights. A review of his ocular history revealed LASIK in both eyes in 2001. ICRS surgery 2 months prior in the left eye and a cross-linking procedure in the right eye 4 weeks prior to this initial presentation. He was also wearing an amniotic membrane corneal bandage lens, PROKERA® (Bio-Tissue, Miami, USA), 3 weeks prior to presentation.
for 4–5 days over his right eye following the cross-linking. He had no history of glaucoma or trauma and was not using any eye drops. He had no family history of ocular disease nor had he been diagnosed with any medical problems, was not taking any medications and had no allergies to drugs.

Entering acuities measured 20/40 in the right eye and 20/30 in the left eye with spectacle correction. His refraction measured OD: +2.25 − 4.50 × 080 and OS: +2.75 − 5.00 × 105. With this correction, his acuities were 20/30 and 20/25, respectively; yet he reported significant distortion of the letters. His pupils were equal, round and reactive to direct and consensual illumination, and no afferent pupillary defect in either eye was observed. Confrontational visual fields were full to finger counting in both eyes and extraocular motility was full in both eyes. Slit lamp examination revealed Intacs segments in place 2 mm above and below the pupil in the left eye, with crystallized deposits around the ring segments. He had superficial stromal vascularization extending to and arborizing along the inferior ring segment at 4:00 and 6:00 can be seen. Mild underlying haze around the inferior ring segment can also be observed.

that way, the soft carrier aims to protect the cornea while the RGP restores visual acuity. Another solution includes the implementation of hybrid lenses. These consist of a gas-permeable rigid center surrounded by a silicone hydrogel soft skirt. In fitting this lens, the skirt is designed to lift the rigid center off the corneal surface so that it never has to interact with it. However, cases of warpage with these lenses have been reported [3]. In addition, few, if any, hybrid lenses offer enough oxygen permeability to maintain ocular health in the presence of a compromised cornea [3].

Large-diameter RGP lenses can also be considered. These designs have become more and more popular and are available in several options: a corneo-scleral lens (12.5–15 mm), supported partly by the cornea and partly by the sclera; a mini-scleral lens (15–18 mm) vaulting the cornea, supported by the fluid layer and the conjunctiva; or a larger scleral lens (18–25 mm) with the same fitting philosophy as the mini-scleral lenses but with different parameters [4]. They are fitted in a way to vault the cornea. They maintain a constant reservoir of fluid between the posterior surface of the lens and the anterior surface of the cornea to ensure hydration [5]. This fluid layer also compensates for the surface irregularities, leading to improved visual acuity. In fact, correction of irregular astigmatism was the primary indication for scleral lenses in early studies, but more recent studies have confirmed their utility in the management of various ocular surface diseases including keratoconjunctivitis sicca, neurotrophic keratopathy, cicatizing conjunctivitis, limbal stem cell deficiency, and exposure keratopathy [4]. The unique way scleral lenses are fitted enable them to protect the ocular surface from the friction generated by eyelid movement and provide corneal hydration [5]. This modality can provide the comfort of a soft lens with the optical quality of a gas-permeable lens [4]. Large-diameter RGP lens designs currently available are therefore considered the best option to provide health benefits and increased comfort compared to smaller corneal RGP and, in this case, soft lenses.

In the current case of post-LASIK ectasia followed by cross-linking in one eye and ICRS in the other, the choice of which type of large-diameter RGP lens to use should ensure that no touch on the cornea occurs. Corneo-scleral lenses are contraindicated, because a small portion of the cornea supports most of the weight of the lens. This may result in a stress to the tissue that could cause a corneal epithelial defect and/or generate scarring. Mini-scleral lenses represent an improved option, where cornea–lens touch is absent but the fluid layer limited. They are also smaller than the large scleral lenses and are therefore easier to handle and less intimidating for patients to insert into their eyes [4].

The Jupiter scleral lens (Essilor Contact Lens, Dallas, TX) was chosen and the fitting was facilitated by the use of a diagnostic set of 14 lenses. The initial diagnostic lens was selected according to the manufacturer’s fitting guidelines. The base curve radius of the diagnostic lenses ranged from 6.25 to 8.44 mm, the lenses were 16.00 mm in diameter, and made of Boston XO material. The clearance or fluid reservoir under the lens was evaluated with the help of the Visante™ Anterior Segment OCT (Ocular Coherence Tomography) (Zeiss, Jena, Germany). When adequate apical clearance was confirmed (150–200 μm) in both eyes (Fig. 2), the lenses were ordered with the following parameters:

OD: diameter: 16.60 mm, base curve 41.00 D (8.23 mm) reverse curve, power −0.75
OS: diameter: 16.60 mm, base curve 39.00 D (8.65 mm) reverse curve, power +1.50.

Following appropriate training, the patient was proficient with both insertion and removal of the lenses. He was instructed in lens care and handling with RGP cleaner and conditioning
solution (Boston™). Non-preserved 0.9% NaCl inhalation solution was prescribed to fill the lens before insertion.

At the next visits, the patient reported pain after lens removal in the left eye. Slit lamp and Visante™ Anterior Segment OCT examination both showed the inferior corneal ring segment pushing anteriorly at 6:00 against the scleral lens (Figs. 3 and 4), with positive staining in this area of the cornea. Lens wear was discontinued, and moxifloxacin ophthalmic solution was prescribed every hour. When the patient returned the following day, he reported improvement but still had positive staining in the same area of the cornea. Moxifloxacin ophthalmic solution was prescribed every 2 h in the left eye on the first day and every 4 h on the second day.

At follow-up three days later, the staining had mostly resolved. Because the fibrovascular growth around the inferior corneal ring segment seemed to be progressing, however, the patient was referred for evaluation to a cornea specialist at the Bascom Palmer Eye Institute. The latter agreed with the prior assessment of fibrosis or infiltration of the inferior ring segment, with outward protrusion in addition to neovascularization in the lower half of the cornea.

The specialist discussed with the patient the recurrent inflammation and potential infection due to the Intacs and planned to remove the inferior ICRS. Antibiotics were continued and cultures obtained for the left eye.

Two months later, the inferior corneal ring was explanted. Cultures and pathology were negative, and the patient was prescribed PredForté 6 times a day and Vigamox 4 times a day. The steroid drops were progressively tapered. At the final follow-up with the surgeon, the latter reported that the cornea had healed nicely in the area of explantation, with no staining. The antibiotic drops were discontinued, and PreForté was maintained at 4 times a day for 1 month and then slowly tapered thereafter.

The patient was then referred back to the Global Vision Rehabilitation Center for a new contact lens fitting. A new scleral lens was fit on the left eye, for which a base curve of 8.39 mm, plano power, and a diameter of 20.60 mm to completely vault over the cornea, the limbus and perilimbal bulbar conjunctiva were chosen. When the lens was dispensed, the superior corneal ring segment was touching the back of the lens, so it was steepened by 60 μm.

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The patient now wears a 20.60 mm diameter lens with a base curve of 8.23 mm, in reverse geometry and a power of −1.50. The vision continues to be 20/20 in both eyes with no distortion. Apical clearance and comfort are adequate in both eyes (Fig. 5); the lens therefore provides an adequate vault over the surface and has succeeded in maintaining corneal integrity. Although the patient continues to have neovascularization on the inferior portion of the cornea in the left eye, the insult has been removed; and further improvement is expected.

3. Additional tests/referrals

See Fig. 6.

4. Differential diagnosis

4.1. Ring segment extrusion

The most common cause of ICRS explantation (48.2%), according to Ferrer et al. [6]. It is caused by the superficial part of the corneal stroma thinning over time, causing the ring segment to protrude forward and consequent epithelial breakdown. The latter is a required finding for diagnosing ring segment extrusion [6]. In most cases, extrusion is accompanied by melting; vascularization also occurs in some cases [6]. Our patient had corneal staining, indicating an epithelial break. However, the cause of the irritation was not stromal thinning but forward protrusion of the superficial cornea and rubbing on the scleral lens. This was evident when the scleral lens was discontinued and steepened at a later visit; the patient then experienced almost complete resolution of the corneal staining. If the epithelial break had been caused by insufficient stromal integrity, the epithelium would not have healed by discontinuing contact lens wear or improving the fit. A scleral lens was deemed necessary for adequate vision. Because superficial neovascularization and fibrosis of the ICRS prevented an adequate fit of the scleral lens the patient was referred for an explantation evaluation.

4.2. Infectious keratitis

This is one of the four leading causes of ICRS explantation [6]. To make a definitive diagnosis, cultures must be positive [6]. In the case reported here, preoperative cultures and pathology of the corneal epithelium, as well as post-operative cultures and pathology of the Intacs, were both negative, thus excluding microbial keratitis as a potential diagnosis.

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4.3. Mild channel deposits around the ICRS

Channel deposits of cells and protein are usually found on the proximal end of the ring segment near the incision [6]. Ruckhofer et al. suggest that the deposits are caused by the physical separation of stromal lamellae when they are opened to create a channel for implantation of ICRS [7]. They also report that the incidence and density of deposits increase with segment thickness and duration of implantation. Although they report an incidence as high as 60% [7], no deposits could be seen on clinical examination or using the Visante™ Anterior Segment OCT in the patient described here.

4.4. Segment migration

This post-operative complication causes undesirable refractive outcomes [8]. The patient had no refractive complaints, and vision was stable with the help of scleral lenses. Segment migration has not been shown to cause discomfort such as that experienced by this patient [8]. In addition, his topography was stable from the time we first saw him until his referral back to the surgeon, further confirming the stability of the segment’s position.

4.5. Corneal melting

This is one of the four leading causes of ICRS explantation [6]. Given the fact that the patient’s corneal staining was completely resolved following discontinuation of the scleral lens, corneal melting could not be the causative factor here. The insult was the superficial cornea protruding forward and rubbing on the scleral lens. This was evident when the lens was discontinued at one visit and steepened at a later visit; the patient experienced almost complete resolution of the corneal staining. If the epithelial break had been caused by a lack of corneal integrity, the epithelium would not have healed after discontinuing contact lens wear or improving the fit. In cases of corneal melting, the epithelium begins to breakdown, followed by stromal loss [6]. The patient reported here had no stromal loss, as confirmed by the Visante™ Anterior Segment OCT and slit lamp examination. A scleral lens was deemed necessary to provide adequate vision. Secondary to neovascularization and fibrosis of the ICRS, an adequate fit could not be obtained with a scleral lens and the patient was referred for possible explantation.

5. Discussion

The patient reported here had superficial corneal neovascularization after implantation with ICRS. ICRS is touted to be a minimally invasive and reversible refractive treatment for the management of low to moderate myopia, keratoconus and post-LASIK ectasia [6,9,10]. It was intended to achieve a clear central optical zone, to preserve corneal tissue and defer corneal transplant surgery [11]. The rings are made of polymethylmethacrylate (PMMA) in circumferential sections and are inserted in a semicircular channel between the lamellae of the stroma. The 3 main ICRS on the market are Intacs (Addition Technology, Inc.), Ferrara (Ferrara Ophthalmics Ltd.), and Keraring (Mediphacos Ltd.) [6]. The changes induced in corneal curvature can be predicted using Barraquer’s law; when a material is added to the periphery of the cornea, a flattening effect is achieved [12]. ICRS improves distance visual acuity, cylinder, and coma-like aberrations in post-LASIK ectasia [13], but the indications for ICRS implantation for this condition remain unclear [13]. In a case series reported by Brenner et al., the best candidates for ICRS in patients with post-LASIK ectasia were those who lost two or more lines of best-corrected visual acuity because of ectasia and patients with grade 4 post-LASIK ectasia, defined as severe visual debilitation and a best-corrected visual acuity less than 20/40 [1]. These patients showed a mean improvement of 2.89 lines of visual acuity 12 months after ICRS implantation. Those who had grades 2 and 3 ectasia actually gained little acuity, however, and those who had grade 1 ectasia experience loss of visual acuity after implantation [1].

Intrastromal corneal ring segment implantation has been associated with intraoperative and postoperative complications [6]. Intraoperative complications include segment decentration [14], ICRS asymmetry [14], inadequate channel depth [14], superficial channel dissection with anterior Bowman layer perforation [6], and anterior chamber perforation [6]. Although ICRS is usually well tolerated, some in vitro studies found activation of keratocytes, accumulation of lipids in cells and new collagen formation after implantation [15]. Several postoperative complications have been described, including ring segment extrusion [6,14], corneal neovascularization [6,9,14], infectious keratitis [6,14], mild channel deposits around the ICRS [6], segment migration [6,14], and corneal melting [6]. In the U.S. Food and Drug Administration phases II and III clinical trials of Intacs, segment removal was necessary in 4.68% of eyes [11]. The authors of the latter study concluded that intrastromal ring segments were safely, effectively and easily removed, with a return to preoperative refractive status within 3 months [11].

Corneal neovascularization after Intacs has been infrequently reported [9,16]; it is usually superficial and localized to the site of the surgical wound [9]. In a study of 33 eyes with keratoconus after Intac surgery, Siganos and associates found superficial, mild vascularization at the wound site in 1 eye after 2 months [17]. Kymionis and colleagues described similar findings in 2 of 10 eyes treated with Intacs for post-LASIK ectasia [18]. Both Al-Torbak et al and Cosar et al reported cases of deeper vascularization 7 months and 3 years after surgery, respectively [9,16]. Cosar et al speculate that hypoxia of the cornea superficial to the Intacs may be the triggering factor for neovascularization, as no inflammation was found on clinical examination [16]. Both Al-Torbak et al and Cosar et al report disappearance of the vessels after explantation of the Intacs and anti-inflammatory therapy, suggesting that the Intacs incited the neovascularization [9,16].

It is safe to assume that neovascularization will continue to progress if the causative factor is not removed. Although a scleral lens may provide visual correction of a post-LASIK ectasia cornea with ICRS, neovascularization and fibrovascular growth progression may prevent an adequate fit, and ICRS explantation may be necessary. Achieving adequate visual acuity may require postsurgical refitting. Scleral lenses of various designs have been used in the management of several ocular surface diseases [4]. The Jupiter scleral lens was used in this study; it is likely that other commercially available scleral lens designs with similar fitting characteristics would have also been successful in the management of this condition. Scleral lens fitting with a standard set of diagnostic lenses can be accomplished efficiently. Although minor alterations were required to optimize vision and fit, the fitting process was successfully completed when appropriate fit and expected visual acuity were observed and when the patient reported comfortable wear for at least 8 h a day.

6. Conclusion

In the patient reported here, scleral lens fitting failed to achieve adequate visual acuity in the left eye until the ICRS was removed. The patient’s inferior ICRS caused hypoxia in the lower cornea, inducing superficial neovascularization and outward fibrovascular proliferation, causing corneal epithelial breakdown and moderate to severe discomfort with continued scleral lens use. Following inferior ICRS explantation, a scleral lens was successfully fit. The
neovascularization is expected to regress further because the insult has been removed.

Although fitting a scleral lens on an eye with ICRS complications remained challenging following appropriate evaluation and treatment by a cornea specialist, adequate vision and comfort were achieved and the patient’s chief complaint was resolved.

With the increasing recent interest of clinicians and manufacturers, scleral lenses are becoming far more “mainstream” in contact lens practice. Optometrists should continuously update their expertise in the area of contact lens design, thereby providing their patients with the latest lens technology and to optimize treatment.

References