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Inverted lens provides reverse geometry solution for post laser vision correction (LVC) corneas

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ABSTRACT

Many patients require optical correction post-laser vision correction (LVC). While mildly irregular corneal topographic patterns or asymmetry can sometimes be treated with conventional soft lenses, often this proves inadequate. This article introduces a novel technique to provide visual improvement and comfort for these patients. An inverted senofilcon A (Acuvue Oasys®, Johnson & Johnson Vision Care) lens (off-label)was inserted on a patient's eyes that reported discomfort with his current soft contact lenses, which provided improved centration as was seen with a slit lamp and high molecular fluorescein through a yellow filter. The patient achieved a visual acuity of 6/6+ in each eye and reported that the vision did not fluctuate. The post-lens tear film decreased to 35micron versus 43micron in the conventional position, as shown in OCT. The patient reported that he wore the lenses 9 hours a day. His Dry Eye Questionnaire-8 (CLDEQ-8) score decreased from 22 to 15 when wearing the lenses in the inverted position. This case demonstrates that post-laser vision correction patients with minimal asymmetric topography within the treated zone requiring refractive correction may be helped using an inverted conventional soft frequent replacement lens.

1. Introduction

Patients post-laser vision correction (LVC) such as laser-assisted in-situ keratomileusis (LASIK) or photorefractive keratectomy (PRK) can develop refractive errors after surgery, particularly in cases with pre-surgical high refractive errors,[1–6] yet prefer not to have to return to wearing spectacles.[7] Many of these patients are not candidates or are not interested in enhancement surgery. Quality of life impact of refractive correction (QIRC) surveys have further shown that contact lens wearers score significantly higher than spectacle wearers.[7]

Fitting a contact lens post-LVC is a viable alternative but can be challenging for both the practitioner and patient. The patient must cope with the disappointment of requiring optical aid after surgery and the additional unwanted expense.[8] The practitioner is presented with a significantly altered corneal shape, one that most contact lenses are not designed for, and the fit often requires a custom design and lengthy chair time.[9] Many corneas exhibit an irregular topographic pattern post-LVC or a decentered ablation zone which is best optically corrected with a contact lens,[8,10] specifically a rigid gas permeable (RGP) contact lens. Often a reverse geometry design is required to better conform with the shape of the cornea and provide maximal visual acuity and comfort.[8,11,12]

Some patients present with minimal optical error and minimal corneal irregularities, and a clinician may be tempted to prescribe a conventional soft lens. Clinical experience has shown that frequent replacement contact lenses on these corneas often drape over the irregular cornea more easily but decenter, exhibit edge fluting or central bubbles.[8] Some patients displayed a wrinkling of the optic zone of the soft lens as it sinks into the ablated zone of the cornea.[10,13]

Presented here is a technique for post-LVC cases, those with slight to moderate refractive errors with symmetric topography with minimal to no corneal irregularities and are uncomfortable with their current modality.

2. Case presentation

A 24-year-old patient presented a year post-PRK surgery with a chief complaint of discomfort and fluctuating vision with his current contact lenses but did not want to wear spectacles. After several practitioners unsuccessfully tried to fit him with contact lenses, the patient presented

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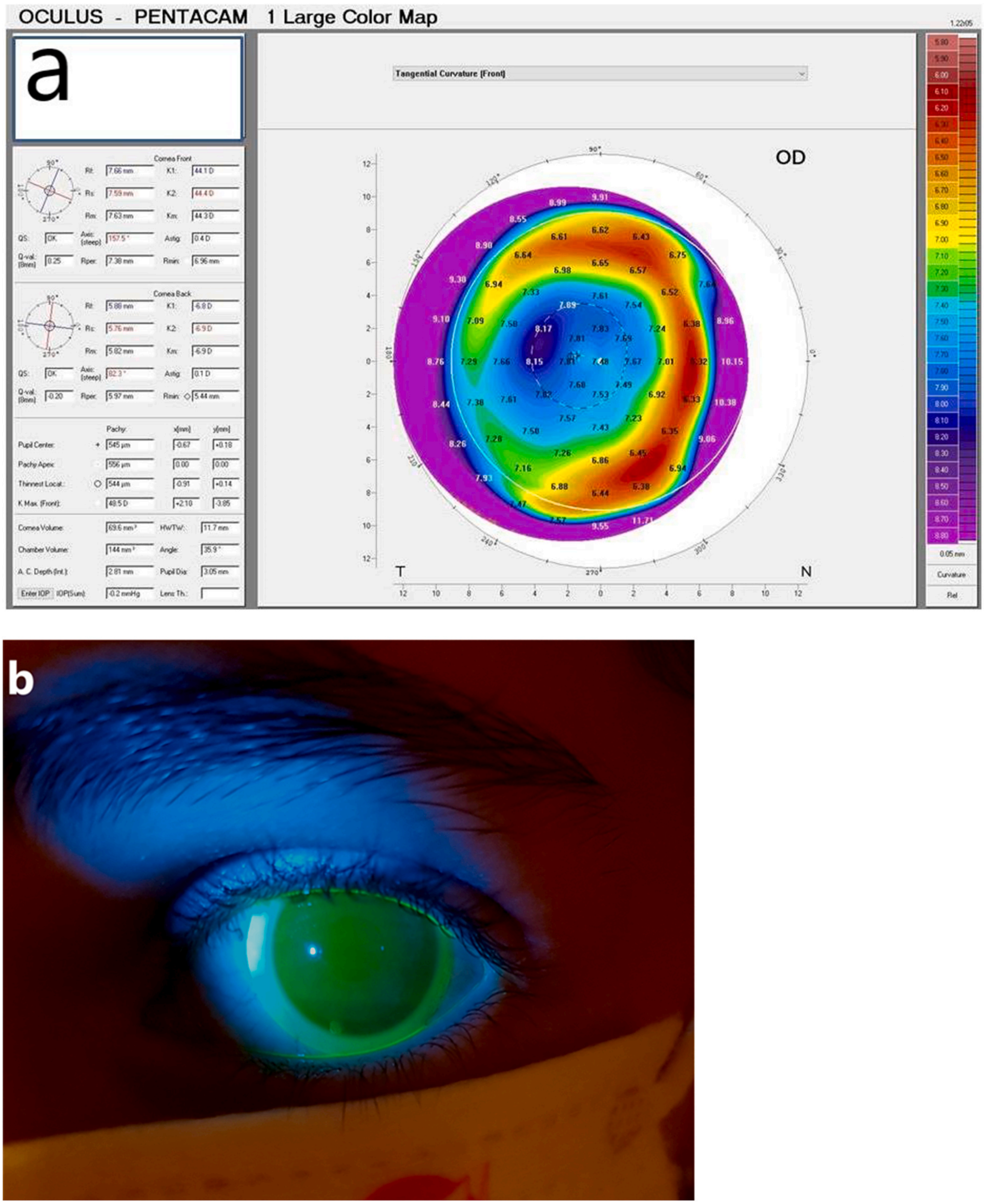

Fig. 1. (a)Tangential topography map of post-PRK cornea and (b) high molecular fluorescein pattern with a yellow filter, inverted contact lens on the eye. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

to this clinic. These attempts included both spherical and custom-made toric soft lenses and spherical RGP. The patient was similarly unable to adapt to custom reverse geometry RGP and the Rose K Irregular Cornea (IC) designs.

His refraction pre-surgery was −8.50-1.00X175 in the right eye and −7.50-1.00X180 in the left eye. The entrance subjective refraction was examined using early treatment diabetic retinopathy study (ETDRS) visual acuity (VA) and was measured as −1.00-0.25X40 VA 0.0–2 and −0.75-0.25X90 VA 0.0–1 in the right and left eye, respectively.

Anterior slit-lamp examination findings were unremarkable in both eyes. Tarsal conjunctiva exhibited no papillae, and non-invasive tear break up time was 10 seconds.

Topography was measured with a Pentacam® (Oculus Inc. Optikgeräte GmbH, Wetzlar, Germany). The tangential maps of the anterior cornea show an oblate ablated zone and a relatively steeper periphery expressed in the Q-value of 0.24 and 0.39 in the right and left eye, respectively. The I–S index was1.04 and 0.82 in the right and left eye, respectively.

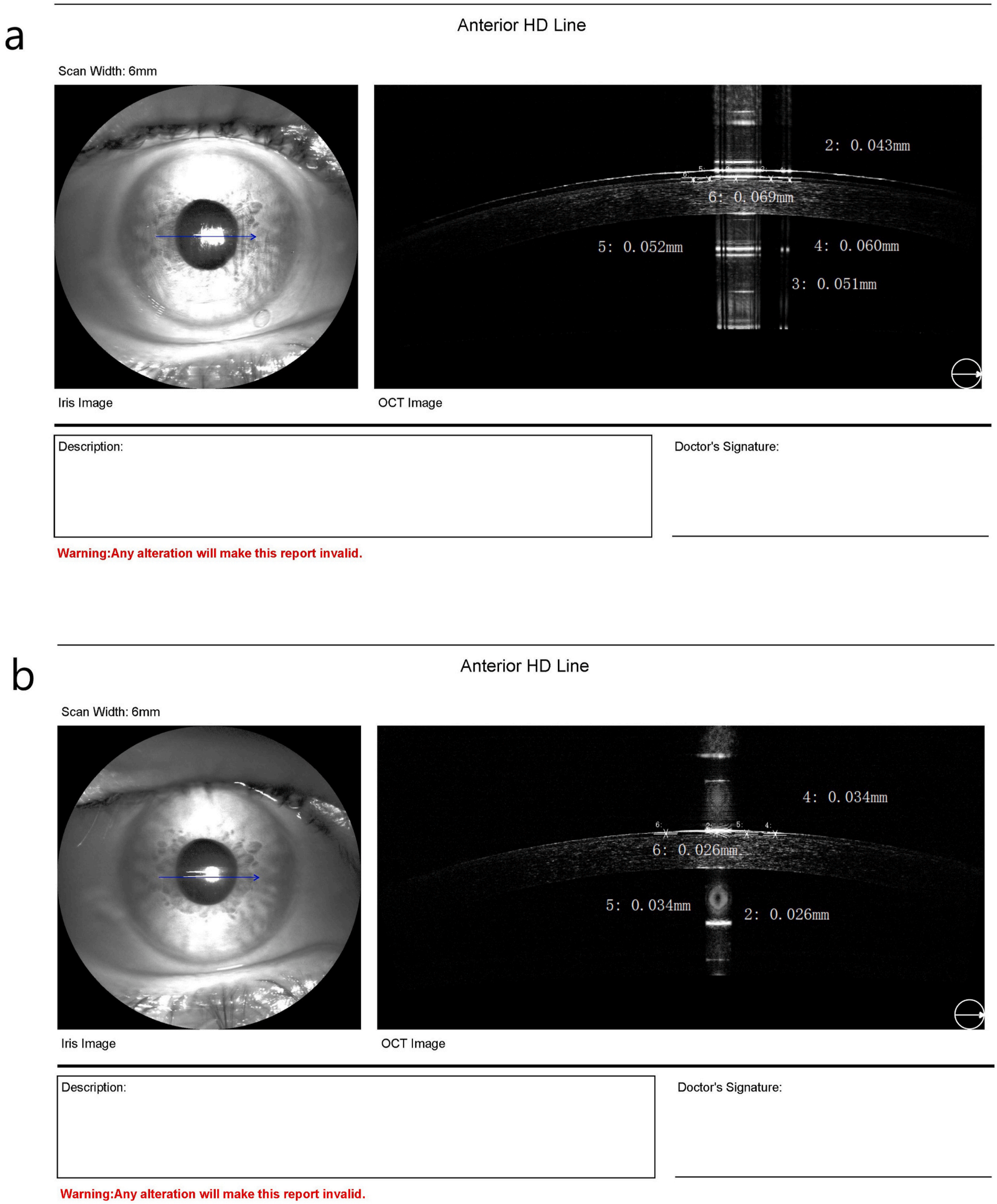

Fig. 2. OCT images display the posterior lens tear film with a contact lens on the post-surgery cornea in the conventional position (a) and the inverted position (b).

3. Methods

An inverted senofilcon A (Acuvue Oasys®, Johnson & Johnson Vision Care) diameter (Dia) 14.0mm, base curve (BC) 8.4, center thickness 0.07mm, Dk/t 147 $\times$ 10^9 modulus 0.72, knife edge profile, bi-weekly replacement contact lens was placed on the eyes (off-label). Trial with the same lens in its customary position decentered from the central cornea. Both a conventionally placed and an inverted BC 8.8 of the same lens design also decentered.

The power of the lens was selected as the closest spherical equivalent to the subjective refraction. Over-refraction was then measured with the inverted lens in the eye.

The Moptim Mocean 4000 plus OCT system (Shenzhen Slton Technology Co. Ltd., China) measured the vaulting of the contact lens over the cornea in the conventional and inverted position.

The prescribed lenses were: Inverted (off-label) Acuvue Oasys®, Dia 14.00, BC 8.4, OD -1.00D sphere, OS -0.75D sphere.

The centration, peripheral draping on the sclera, and movement upon blink were evaluated with a slit-lamp using white light as well as high molecular fluorescein with a cobalt blue light and yellow filter.

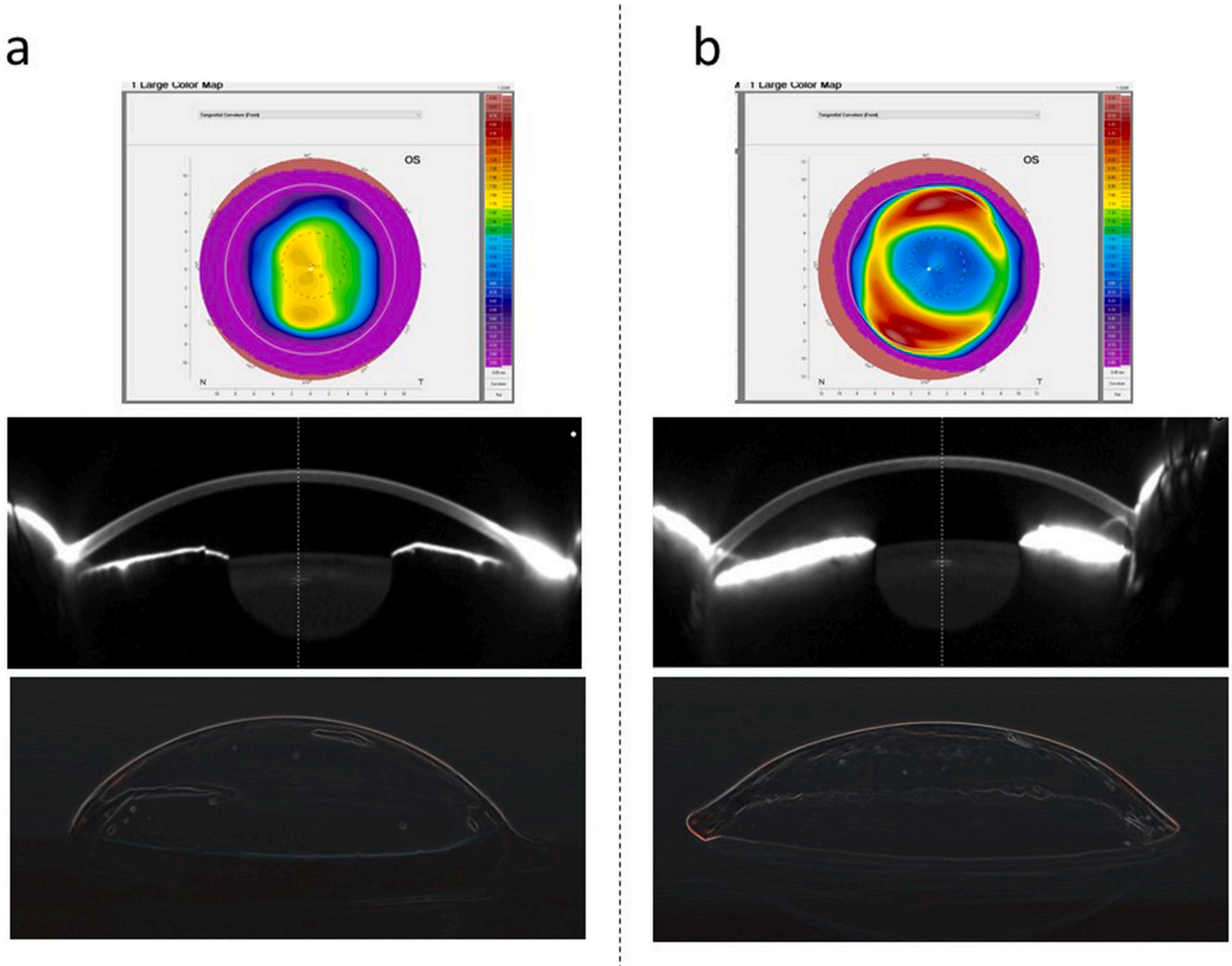

Fig. 3. The change in corneal shape is exhibited in the tangential anterior corneal map pre-surgery (a) and post-surgery (b). The Scheimpflug images from pre-surgery (a) and post-surgery (b) are directly below. The bottom of the image shows an Acuvue Oasys® contact lens in the conventional position (a) and inverted position (b). Note the prolate versus oblate contour of the lens.

Follow up visits were conducted at one week, one month, six months, and one year after dispensing.

4. Results

The prescribed contact lenses caused no significant change in VA (OD 0.0 + 3, OS 0.0 + 2, examined with ETDRS chart). The patient reported stable visual acuity that did not fluctuate during blinking.

The inverted lens positioned centrally as was seen with high molecular fluorescein and yellow filter as shown in Fig. 1. There was a smaller post-lens tear film of 35micron versus 43micron in the conventional position, as demonstrated in OCT in Fig. 2.

Staining was absent, and there was no evidence of lid wiper epitheliopathy upon slit lamp evaluation, including fluorescein and lissamine green staining, which were conducted at each follow up visit. The patient reported a daily wearing schedule of 9 hours. Dry Eye Questionnaire-8 (CLDEQ-8) score of the patient was 15 while wearing the inverted contact lens, compared with a score of 22 when wearing the lens in the conventional position.

5. Discussion

Inverting a silicone hydrogel contact lens can provide an excellent solution for patients requiring visual improvement post-LVC. The reverse geometric shape that an inverted lens creates corresponds more closely to the oblate shape[14] of the cornea and therefore achieves better centration and is comfortable, as shown in Fig. 3.

Corneas respond differently to LVC surgery, and changes can occur even years post-procedure.[15] After surgery, some of the layered lamellae structure is severed circumferentially, reducing the tension and allowing expansion in the remaining peripheral segments.[8] This can result in increased curvature and thickness of the peripheral stroma, generate a radial force outwards and cause the central cornea to flatten. This extra flattening, the amount of which is difficult to predict, causes an overcorrection post-surgery and an even more significant difference between the central corneal curvature and the periphery than accounted for.[8] In addition to the unique individual properties of a post-LVC cornea, each frequent replacement lens has slightly different parameters and characteristics, so when selecting a lens for this technique, one needs to consider a few components.[13]

One characteristic is the sag height of the lens. This is determined by choosing a diameter, or chord, dropping an imaginary line from the highest point of the inner curve of the lens to that base, measured in microns, and is a relationship between the total diameter, base curve, and optic zone diameter of a lens. Refractive surgery dramatically reduces the sag of the cornea with central flattening. Underneath a standard soft lens, this deeper sag causes a reservoir of tears that does not retain its shape upon blink.[8,11] It can sink onto the ablated zone of the cornea, causing fluctuating vision, movement of the lens, and fluting of the edge.[8,11] An everted lens becomes a reverse geometry shape with shallower sag and central zone closer to the cornea thereby eliminating this issue.[8,11]

Most frequent replacement lenses have an optic zone of 6–9 mm, which allows for complete coverage even over a conventional 6 mm refractive surgery ablation zone.[16,17] Patients with a decentered ablation zone can be left with various degrees of uncorrected refractive error, loss of acuity, monocular diplopia, and ghosting images depending on the pupil's amount of decentration and size.[8] The position of the inverted lens, even with a large optic zone, may or may not be adequate to resolve these symptoms.[8,11]

The periphery and edge of the inverted contact lens are slightly more elevated, potentially allowing for tear exchange. Nevertheless, the periphery must adhere close enough to the sclera to avoid the edge irritating the lids when blinking, which could cause lid wiper epitheliopathy. Lissamine green staining on the upper lid noted at follow up visits may be an objective indication of this irritation.

As mentioned, the topography of the cornea's periphery is potentially affected by corneal LVC. Studies have shown different results regarding how and what parameters influence these changes. Some have shown temporal steepening,[18] suggested to occur more in shallower ablations,[19] flattening[20] suggested perhaps more frequently in deeper ablations,[19] and one study found an asymmetric response where the nasal cornea had a more significant increase in curvature compared to the temporal side.[21] This can result in lenses with different designs potentially draping and centering differently over a cornea.

The frequent replacement lens's optics are on the lens's front surface, resulting in a steeper, more convex anterior surface.[8,22,23] When inverting the lens, the optic zone has a slight convex protrusion towards the cornea and theoretically has the potential to push into the ablated zone.[8,11] The assumption in this patient was that the curve was slight given the low prescription and the modulus of this material is low. In this patient's examination, no staining was noted at follow-up visits, which would clinically indicate possible excessive touch. In cases involving a patient with a high prescription or a lens with a higher modulus that the practitioner suspects may push into the ablated cornea, it may be prudent to perform topography at a follow up visit.[8,22,23]

The edge profile of a lens can influence comfort both in the conventional position and inverted.[8,22,23] The Acuvue Oasys® lens has a knife edge profile, very thin and comfortable.[24] When another lens design is evaluated, this parameter should also be considered.

This case presents an accessible alternative to provide comfortable, stable vision to post LVC patients for whom conventional lenses proved inadequate. Inverting a contact lens modifies the contour to correspond with the ablated cornea and can be attempted before turning to custom designs.

To the best of our knowledge, this technique has not been utilized in connection with post-LVC cases, and hopefully, this report will benefit patient care. Positive outcomes may further encourage research to develop frequent replacement reverse geometry lenses for post LVC corneas.

Statement of ethics

Written informed consent was obtained from the patient to publish this case report and any accompanying images.

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Author contributions

Nir Erdinest: patient examination, contact lens fitting, and follow-up, manuscript preparation. Naomi London: manuscript preparation. Itay Lavy: involved in the design, revision, and conduct of the study, manuscript preparation. Nadav Levinger: manuscript preparation. All authors approved the final version of the manuscript for publication.

Declaration of competing interest

The authors of this manuscript do not have any conflict of interest to declare.

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