Management of advanced keratoconus using a semi-scleral contact lens: A non-surgical option

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Abstract

Background: Keratoconus is a bilateral, progressive disease characterised by steepening and thinning of the cornea. In the early stages, spectacles improve visual acuity (VA) but as the disease progresses, rigid contact lenses (CL) are required to neutralise the irregular cornea. In advanced cases, when CLs do not provide a satisfactory fit or VA or are intolerable, keratoplasty is indicated. In Kenya, corneal donor tissue may not be readily available or affordable.

Case: This report describes the fitting of semi-scleral CLs in a patient with advanced keratoconus. A 23-year-old female, referred for CL fitting, presented with advanced keratoconus with minimal improvement in VA on refraction. Tomography revealed a maximum anterior corneal curvature of 90.86 D in the right eye (RE) and 76.52 D in the left eye (LE). Both eyes were fitted with semi-scleral CLs using a diagnostic fitting set. After fitting, using several trial lenses to achieve the optimal central and peripheral fit, VA improved from 1.3 logMAR to 0.3 logMAR and 1.0 logMAR to 0.2 logMAR in the RE and LE respectively. The patient reported to be comfortable wearing the CLs for approxiamtely 12 hours a day.

Conclusion: Noting the limited access to keratoplasty, this case report shows that semi-scleral CLs provide a satisfactory, non-surgical alternative to improve VA in patients with advanced keratoconus.

Keywords: keratoconus, rigid contact lenses, scleral contact lenses, keratoplasty

Introduction

Keratoconus is mostly a bilateral corneal ectatic disease (1), typically presenting in the 2nd and 3rd decades of life (2, 3). However, recent evidence suggests an increase in the presentation of the disease in adolescence (4, 5) and even in children as young as 4-6 years old (6, 7).

To date, the exact aetiology remains unknown but is known to be caused by a combination of genetic and environmental factors (8). Ocular allergy, eye rubbing, family history of keratoconus, Down syndrome, ethnic factors and inherited connective tissue disorders are known risk factors for developing the disease (9).

The Belin ABCD classification (10) is one of several existing systems used to grade the severity of keratoconus. The anterior and posterior corneal curvature at a 3mm optical zone centred at the thinnest point are represented by 'A' and 'B' respectively. The minimal corneal thickness and the best spectacle distance visual acuity (VA) are represented by 'C' and 'D' respectively. The tomographer generates 'A', 'B' and 'C' whilst 'D' is subjective and entered by the operator. Each parameter is independently staged from 0 to 4, where stage 0 resembles a non-keratoconic cornea.

In the early stages of the disease, spectacles will correct the induced myopia and astigmatism. However, as the disease progresses, specialised contact lenses (CL) are required to neutralise the irregular conical-shaped cornea to improve VA. The CL treatment options for keratoconic patients include soft toric CLs, customised soft CLs, rigid corneal and scleral CLs, hybrid lenses and piggyback systems (11).

Scleral CLs are large-diameter lenses which vault over the cornea and rest on the scleral conjunctiva; providing a more stable, comfortable and centralised fit as compared to rigid corneal CLs. The fluid-filled reservoir between the cornea and the lens neutralises high amounts of astigmatism and corneal irregularities and protects the epithelial surface (12).

This paper describes an advanced keratoconus case successfully managed with a semi-scleral CL to improve VA.

Case Report

A 23-year-old female (MN), with bilateral, advanced keratoconus was referred by her ophthalmologist for CL fitting in the right eye (RE) in March 2023. She was subsequently referred for CL fitting in the left eye (LE) in May 2023, three months after corneal cross-linking. A thorough eye examination was conducted at City Eye Hospital, including refraction, slit-lamp biomicroscopy, ocular funduscopy and corneal imaging using the MS-39 anterior segment optical coherence tomographer (CSO, Scandicci, Italy), (*Figures 1 and 2*).

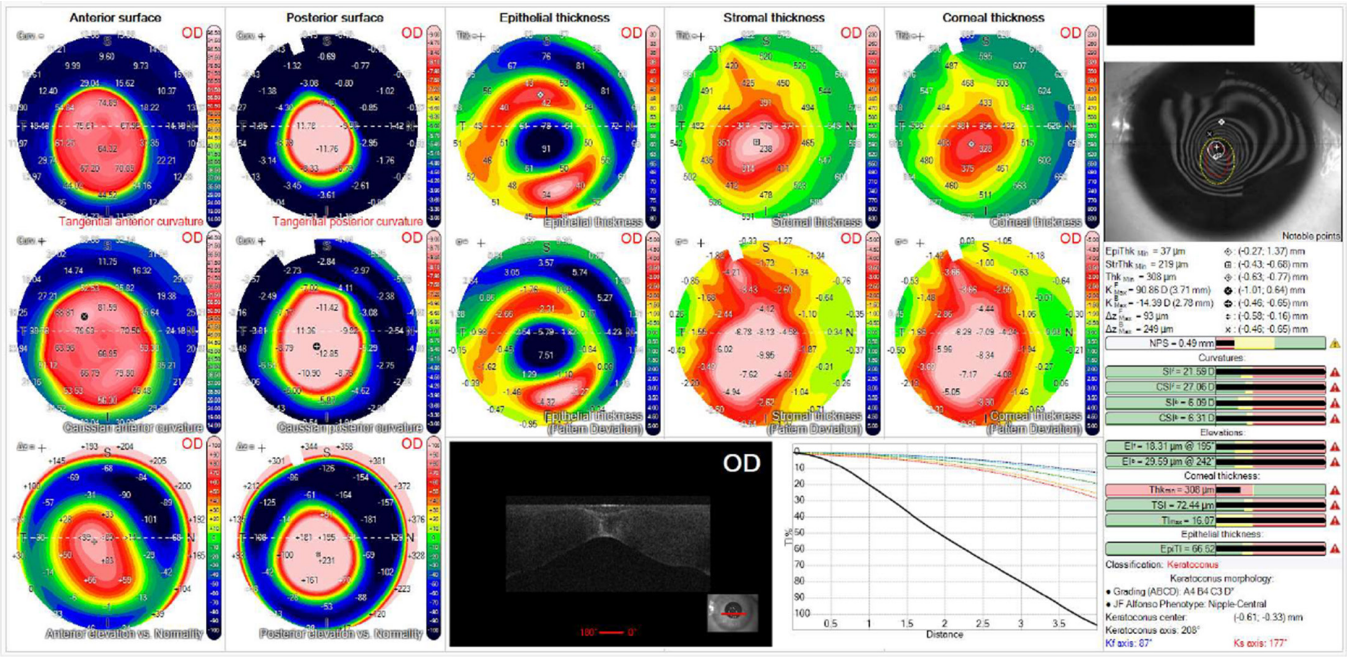

Fig. 1. Right Eye, MS-39 anterior segment optical coherence tomography revealing pronounced central steepening and thinning.

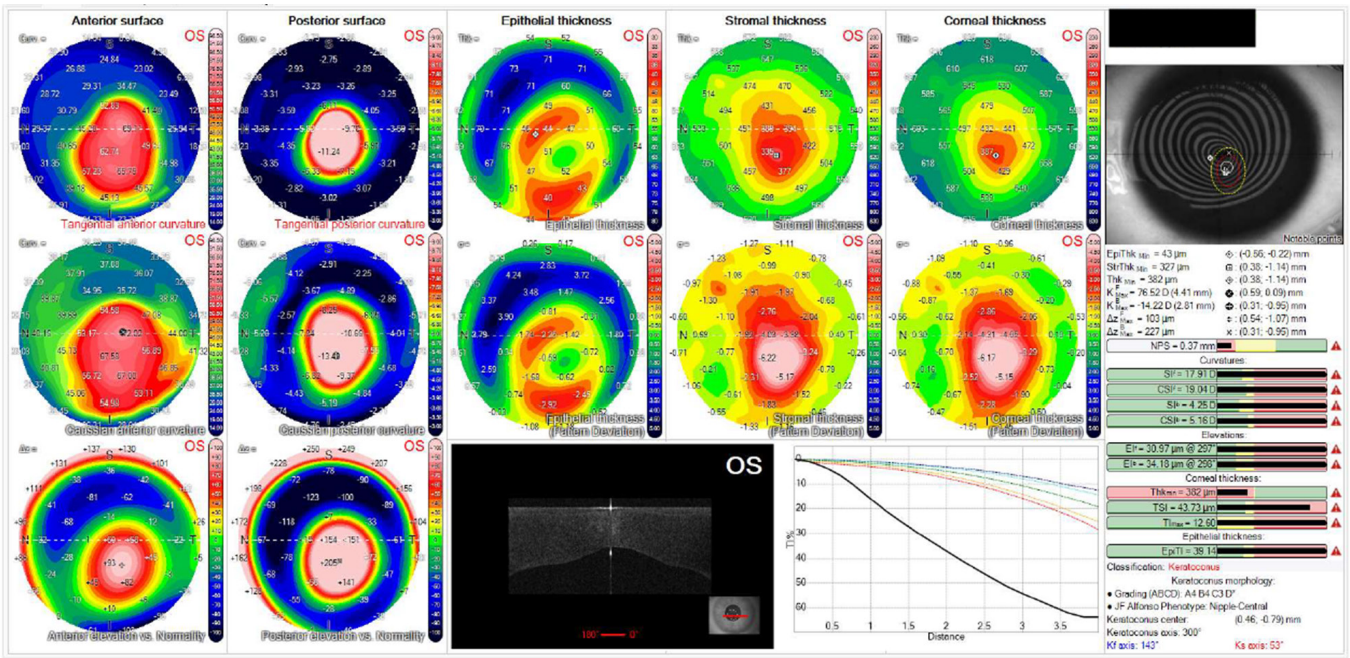

Fig. 2. Left Eye, MS-39 anterior segment optical coherence tomography revealing pronounced central steepening and thinning.

Unaided VA was 1.3 logMAR in the RE and 1.0 logMAR in the LE. Subjective refraction resulted in minimal improvement in VA in either eye. The maximum anterior corneal curvature and thinnest corneal point were 90.86 D and 308 µm for the RE and 76.52 D and 382 µm for the LE. Corneal tomography confirmed the diagnosis of advanced keratoconus in each eye (A4 B4 C3 D4 RE and LE; Belin ABCD classification).

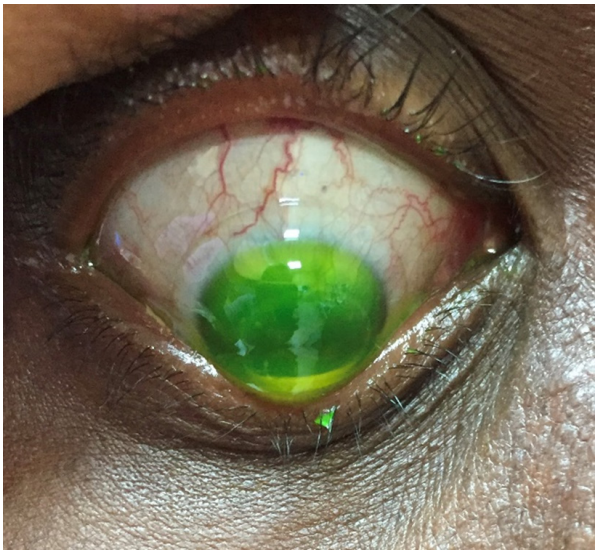

Fig. 3. One of the trial semi-scleral CLs fitted on the right eye (© Zahra Rashid)

Rigid corneal CLs were not attempted as it was expected that they would decentre due to the steepness of the corneas, resulting in poor comfort and variable VA. Hybrid lenses and piggyback systems were not offered as they can be more expensive than semi-scleral CLs in the long term. A Rose K2 XL (Menicon Co. Ltd., Nagoya, Japan) diagnostic trial fitting set was used to select the final lens. The first trial lens was selected by following the manufacturer's instructions and taking into account keratometry. The lens was filled with preservative-free saline and sodium fluorescein and inserted in the eye *Figure 3*. The CL fitting was assessed using slit-lamp biomicroscopy. Steeper or flatter lenses were subsequently selected until there was no touch at the highest point of the cornea. Once the central fit was optimal, the edge lift was evaluated to ensure minimal pressure on the conjunctival vessels under the lens. The lens was allowed to settle for 20 minutes, after which the fitting was re-evaluated ensuring no staining at the corneal apex or blanching of the sclera at the rim of the lens. An over-refraction was performed and the final lens was ordered. When the lens arrived, a dispensing visit was scheduled whereby the CL fitting was assessed and the patient was taught insertion and removal using plungers as well as cleaning and storage of the lenses and advised on the wearing schedule. Modifications to the lens parameters were decided at the follow-up visit, one week later where the lenses had been worn for 4 hours. A total of two lenses for each eye were ordered to achieve optimal central and peripheral fit, comfort and VA.

The fitting parameters of the back optic zone radius, diameter, power and edge lift of the final lenses dispensed to the patient were 6.00 mm, 14.60 mm, -19.00 D, +2.00 for the RE and 6.60 mm, 14.60 mm, -11.00 D, -1.00 for the LE. To maximise oxygen transmissibility to the eye, the lenses were manufactured using tisilfocon A (Menicon Z, Menicon Co. Ltd., Nagoya, Japan), with a Dk of 189. Visual acuity improved from 1.3 logMAR to 0.3 logMAR and 1.0 logMAR to 0.2 logMAR in the RE and LE respectively. Upon insertion of the lenses, MN noticed a marked improvement in vision in both eyes. She wears the CLs for 12 hours a day. The patient follow-up was at 6 months and 1 year, where the VA, comfort and prolonged wearing time were maintained in both eyes. No adverse effects were found during this period.

Discussion

This case report demonstrates that scleral CLs can provide satisfactory visual outcomes in steep corneas, providing a non-surgical alternative to keratoplasty.

Diagnosing KC in the early stages can be challenging as clinical signs on the slit-lamp are only evident in moderate to advanced cases. In Kenya, a lack of national guidelines, essential equipment and inadequate knowledge and skills among optometrists are barriers to the early diagnosis and management of keratoconus (13). Hence, clinicians continue to receive patients with advanced keratoconus despite the availability of corneal cross-linking services in the country. Further, corneal donor tissue is not always available or affordable and financial barriers have been reported as the most common cause for the loss of follow-up which can impact the graft survival rate (14).

Scleral CLs have been shown to be comfortable and

improve VA (12) and vision-related quality of life (15), respect corneal health (16) and reduce ocular aberrations (17) and the number of referrals for keratoplasty (18). Scleral CLs have the advantage of immediate improvement in VA and can prevent/delay surgery, avoiding the risks of infection, rejection, post-surgical astigmatism and secondary glaucoma associated with keratoplasty (19). However, in the developing world, access to scleral CLs may be a challenge (20) due to a limited number of optometrists who fit these lenses (21) and their cost (22). In addition, CL fitting of irregular corneas can be complex, making the fitting and ordering process time-consuming, increasing chair-time, patient visits and ordered lenses requiring patience from both the patient and the practitioner.

Conclusion

Given the potential complications, shortage and cost of donor corneas, clinicians should be encouraged to explore scleral CLs before proceeding with keratoplasty.

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Author Contribution: Z.R. drafted and wrote the case report. V.M guided and reviewed the drafts up to the final article.

Ethical considerations: This case was conducted in accordance with the tenets of the Declaration of Helsinki. The patient consented to the use of her clinical data for research purposes.

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