Taiwan Journal of Ophthalmology 4 (2014) 73–76

Contents lists available at ScienceDirect

Taiwan Journal of Ophthalmology

journal homepage: www.e-tjo.com

Original article

Scleral contact lenses for visual rehabilitation in keratoconus and irregular astigmatism after refractive surgery

Hua-Lin Lo [a], Shu-I Yeh [a], Huey-Chuan Cheng [a,b,*]

[a] Department of Ophthalmology, Mackay Memorial Hospital, Taipei, Taiwan
[b] Mackay Medicine, Nursing and Management College, Taipei, Taiwan

ARTICLE INFO

Article history:
Received 6 December 2013
Received in revised form
25 February 2014
Accepted 26 February 2014
Available online 13 May 2014

Keywords:
ectasia
irregular astigmatism
keratoconus
refractive surgery
scleral contact lens

ABSTRACT

This study aims to report our experience of using fluid-ventilated, gas-permeable scleral contact lenses (SCLs) for visual rehabilitation of patients with keratoconus and irregular astigmatism after refractive surgery. This is a noncomparative interventional case series reporting eight consecutive patients fitted with SCLs because of irregular astigmatism following the failure of other optical corrections. Retrospective chart review and data analysis included age, sex, etiology prior to lens fitting, visual outcomes, follow-up time, and complications. Twelve eyes of eight patients were studied. All eyes were fitted with SCLs due to unsatisfactory vision with spectacle correction or other contact lens modalities. Five eyes had keratoconus and seven had irregular corneas post refractive surgery. The mean follow-up period was 14.4 ± 1.3 months (range 11–17 months). The mean age was 32.63 ± 7.68 years (range 18–48 years). The average steepest keratometry(Kmax) of our series was 49.56 ± 12.2 D. The mean refractive astigmatism was 5.50 ± 5.3 D. The mean best corrected visual acuity (BCVA) in logarithm of the minimum angle of resolution improved from 0.71 ± 0.50 (range 0.10–1.40) to 0.05 ± 0.07 (range 0.00–0.15) after SCL fitting ($p < 0.001$). All reported eyes achieved significant improvement in the BCVA with SCL fitting. None of the patients discontinued to wear SCLs. SCLs should be considered lenses of choice in irregular corneas refractory to conventional optical correction.

1. Introduction

Scleral contact lenses (SCLs) have lately become an important tool for visual rehabilitation of patients with irregular corneas or severe ocular surface disorders. The first description of SCLs in the medical literature was provided in a report on contact lenses by Adolf Eugen Fick in 1888. The early SCLs were made of glass, which were impermeable to oxygen and difficult to manufacture. The introduction of polymethyl methacrylate as a lens material made the manufacture of lenses easier, but significant hypoxia of the cornea caused by the lens material remained a critical drawback; meanwhile, inadequate limbal clearance and problems with back surface junctions were also noticed.[1–3] The introduction of rigid gas-permeable (RGP) materials with sufficiently high gas permeability (Dk) reduced corneal hypoxia significantly. Technological innovations in the design and manufacturing of SCLs, such as fenestration design that allows air ventilation or haptic design with channels or contours that allows fluid ventilation with no intrusion of air bubbles, solved problems related to lens suction and opened new perspectives for SCL use.[4,5]

Conventional RGP contact lenses can mask complex optical aberrations by allowing a tear lens to form between the contact lens and the irregular corneal surface. However, they may not be suitable in patients who cannot adapt to lens sensation or in those with significant irregularities of the anterior corneal surface that preclude an adequate lens centration and stability, leading to frequent contact lens dislocations.[6] SCLs are advantageous as they are supported by the sclera without any touch of the cornea, thus remaining stable in a centered position and providing nonsurgical options for visual correction. The constant precorneal liquid reservoir between the lens and the cornea both neutralizes irregular astigmatism and confers a continuous moist environment that protects the cornea from exposure to air and friction of blinking.[7] SCLs have gained popularity among contact lens practitioners worldwide and are used in a spectrum of corneal disorders to

Conflicts of interest: All authors declare no conflicts of interest.

* Corresponding author. Department of Ophthalmology, Mackay Memorial Hospital, Number 92, Section 2, Zhongshan North Road, Zhongshan District, Taipei City 104, Taiwan.

E-mail address: hccheng@ms2.mmh.org.tw (H.-C. Cheng).

http://dx.doi.org/10.1016/j.tjo.2014.02.002

promote optical correction of an irregular corneal surface. Successful visual rehabilitation with SCL fitting was reported in primary corneal ectasias such as keratoconus, keratoglobus, and pellucid marginal degeneration; and in secondary irregular corneas post refractive surgery, penetrating keratoplasty, or trauma.[8–13] The use of SCLs has become an important therapeutic strategy in the treatment of irregular corneas refractory to conventional nonsurgical therapy.

In recent years, SCLs are increasingly gaining importance as a treatment option for ocular surface diseases. The large size and scleral bearing surface of SCLs can help retain a precorneal tear reservoir for corneal hydration, providing total protection from the external environment, lid margins, and lashes. SCLs may relieve pain, prevent exposure keratitis, and enhance epithelial healing in severe ocular surface diseases such as severe keratoconjunctivitis sicca,[14] chronic graft-versus-host disease,[14,15] Stevens–Johnson syndrome,[16] toxic epidermal necrolysis,[16] ocular cicatricial pemphigoid,[17] limbal stem cell deficiency,[18] persistent corneal erosion,[19] exposure keratopathy,[20] neurotrophic keratopathy,[21] and atopic keratoconjunctivitis.[22] Moreover, SCLs may serve as a useful adjunct in drug delivery for corneal neovascularization, and maintenance of a healthy ocular surface and visual function during delayed repair of surface defects.[23,24]

In this case series, we report our experience with fluid-ventilated, gas-permeable, corneoscleral lenses (HiClear; Taiwan Macro Vision Corp., Taipei, Taiwan) fitted in 12 consecutive eyes for visual rehabilitation due to keratoconus and irregular astigmatism post refractive surgery, which were refractory to conventional nonsurgical therapy, and a review of literature.

2. Methods

We retrospectively reviewed the medical records of eight consecutive patients fitted with SCLs for visual rehabilitation of irregular astigmatism at Mackay Memorial Hospital, Taipei, Taiwan, from September 2012 to March 2013. The study was approved by the Research and Ethical Committee of the Mackay Memorial Hospital. All patients have been referred due to visual dissatisfaction after failure of nonsurgical methods of visual rehabilitation such as glasses or contact lenses. Patients who were unable to handle the SCLs or showed poor compliance for follow-up were excluded from the analysis. Data on age, sex, diagnoses, ocular history, previous contact lens experience, and indication for SCL fitting were collected. The best corrected visual acuity (BCVA) with any conventional optical correction and best corrected visual acuity with SCL fitting (BCVA-SCL) were recorded. Visual acuity was measured using the Landolt C chart and converted to the logarithm of the minimum angle of resolution (logMAR). Slit-lamp biomicroscopy findings such as conjunctival abnormalities, corneal opacities, and corneal vascularization and their location were recorded. Topographic images and simulated keratometry (OPD-Scan II; Nidek, Gamagori, Nagoya, Japan) were obtained prior to fitting SCLs for all patients unless the corneal surface was too irregular to provide meaningful videokeratoscopic data. SCL fitting was considered successful if a functional improvement was observed in patients' quality of vision.

Our patients were fitted with HiClear corneal scleral lenses (Taiwan Macro Vision Corp.), which were made up of a highly gas-permeable material of fluorosilicone acrylate copolymer, FluoroPerm 60 (paflufocon B; Paragon Vision Sciences, Mesa, Arizona, USA). Its oxygen transmissibility (Dk) is 60×10^{-11} Fatt units at 35°C (International Organization for Standardization/Fatt method). It is inherently wettable, making plasma treatment optional. All scleral lenses were lathe cut at an authorized laboratory (Taiwan Macro Vision Corp.). The overall lens diameter was in the range 7–16 mm and the optic zone was 7.30 mm. The average central thickness of the lenses was 0.22 mm and the power ranged from −20.00 D to +20.00 D in 0.25 D steps. Base curves ranged from 6.50 mm to 9.00 mm.

All patients in our series were fitted with 14.0–15.0-mm-diameter diagnostic lenses, including standard and keratoconus designs. These corneo-SCLs were designed to distribute pressure, equally, along the corneal and scleral surfaces. The selection of the initial diagnostic SCL differs from that of corneal lens, for appropriate sagittal deptph (SAG) is more important than alignment with the central cornea in SCL fitting.[8] SAG is determined by the rate of curvature as well as the area of the curve. We based our initial diagnostic lens selection on the reference sphere from the elevation map generated by a corneal topographer and external observation of the profile of the anterior corneal surface. Fitting goals included complete limbal clearance and scleral alignment, with little or no blanching of the conjunctival vasculature. A larger SAG lens would be tried if associated findings suggest the trial lens to be too shallow or lens SAG inadequate as sectorial edge lifts. A lens with smaller SAG would be tried if associated findings suggest the trial lens to be too deep or associated with excessive SAG, for example, tight peripheral fit (blanching of conjunctival vasculature) or excessive clearance (air bubble under optic zone). Once proper SAG was achieved, the base curve would be adjusted to achieve adequate mid-peripheral clearance. A change in the base curve alone will not change the SAG of the lens (Fig. 1). The peripheral curve was then adjusted to optimize the fit. The last step is spherocylindrical over-refraction. The optimal lens vault and perimeters of individual lenses were determined by on-eye evaluation. A single examiner (H.C.C.) fitted the lenses for all patients.

Statistical analysis compared the outcomes according to the two reported diagnoses, keratoconus and irregular astigmatism post refractive surgery. The groups were compared using Mann–Whitney U test, and $p < 0.01$ were considered statistically significant.

3. Results

In this case series, 12 eyes of eight patients were included. The main indication for scleral lens fitting was failure of other modalities (intolerance, instability, or unsatisfactory vision improvement). Regarding the etiology prior to lens fitting, five eyes had keratoconus and seven irregular corneas post refractive surgery. Five of these underwent post radial keratectomy and two post laser-assisted *in situ* keratomileusis. The mean follow-up was 14.4 ± 1.3 months (range 11–17 months). The mean age was 32.63 ± 7.68 years (range 18–48 years). The average steepest keratometry (K_{max}) of our series was 49.56 ± 12.2 D and the mean refractive astigmatism 5.50 ± 5.3 D. Significant differences were observed among the outcomes when comparing keratoconus and irregular astigmatism post refractive surgery eyes. The mean age of patients with keratoconus and irregular astigmatism post refractive surgery was, respectively, 22.0 ± 5.3 years (range 18–28 years) and 39.0 ± 7.7 years (range 31–48 years). Patients with keratoconus

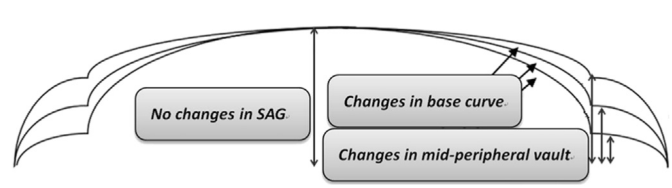

Fig. 1. Changing the base curve while keeping the sagittal depth unchanged. The peripheral curve system compensates for the base curve changes to maintain sagittal depth. The base curve was flattened to increase the mid-peripheral vault and steepened to decrease it.