Visual fluctuations in patients with a history of RK and scleral lens wear

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Introduction

Radial Keratotomy (RK) is a refractive surgical procedure performed to correct myopia. The procedure gained popularity in the United States in the 1980s and 90s. RK flattens the corneal topography by creating spoke-like, partial-thickness radial incisions in the paracentral and peripheral cornea using a diamond blade (photos 1 and 2)

The wounds leave behind a flattened corneal topography (figures 1-4), producing clearer distance vision. Due to the complexity of RK, outcomes were inconsistent. In severe cases, iatrogenic ectasia resulted and produced decreased contrast sensitivity and higher order aberrations which cannot be corrected by spectacles alone. Additionally, RK reduces corneal stability by unequally distributing tensile stresses on the stroma, resulting in diurnal fluctuations in visual acuity.

Rigid gas permeable lenses such as scleral lenses are a great option for these patients. The scleral lenses provide stable visual correction for the duration of wear, however upon removing the lenses a subset of patients experience increased blurred vision at the end of the day versus in the morning prior to insertion. It has been documented that patients with RK have diurnal changes; however, this retrospective case series looked to address if the changes were due to RK alone or if scleral lens wear contributes to visual fluctuation.

Patients and Methods

A retrospective review of five post RK patients fitted with scleral lenses. The initial manifest refraction was done prior to scleral lens fitting and was performed in the morning in four out of five cases. Corneal topography was captured prior to fitting, see figures 1-4. Figures 1 and 2 are representative of severe irregularity, figures 3 and 4 are representative of typical post RK patients. Manifest refraction was performed upon completion of lens fitting at the end of the day with the intent that these patients will wear glasses in the evening upon removing their lenses.

Photo 1: OD patient LF; 8 cut RK with 4 cut AK

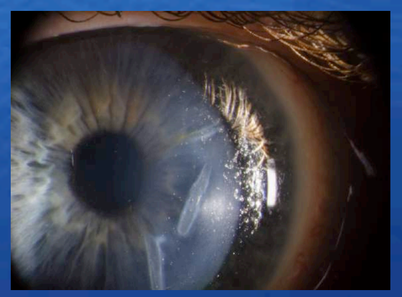

Photo 2: OS patient DA; Splayed RK and AK incisions at 3 and 6 o'clock

Results

All patients were fit with scleral lenses; cases two and three were fit with a design from the same lab while case one, four, and five were fit from a different lab. These designs were comparable as they all utilize reverse geometry in order to optimally follow the corneal contour.

Six of the ten eyes evaluated demonstrated in increase in hyperopia while four eyes exhibited an increase in myopia. See table 1.

	SE pre- scleral lens		SE post-scleral lens		Difference	
	OD	OS	OD	OS	OD	OS
Case 1 BB	-2.25	-4.37	-2.37	-6.62	-0.12	-2.25
Case 2 LF	+1.87	+2.50	+0.87	+4.62	-1.00	+2.12
Case 3 DA	+5.00	+0.75	+5.75	+3.00	+0.75	+2.25
Case 4 DL	+0.62	+0.87	+1.37	+2.00	+0.75	+1.13
Case 5 OB	+1.87	+2.25	+2.50	+2.50	+0.63	-0.25

Table 1: Spherical equivalent (SE) data pre and post scleral lens wear.

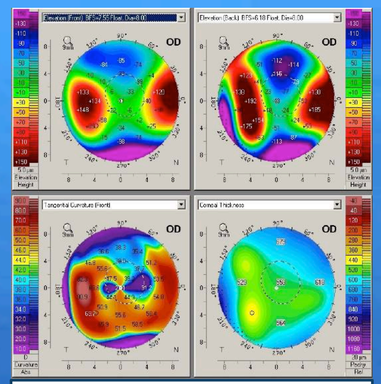

Figure 1: Patient DA, OD Pentacam topography pre scleral lens wear

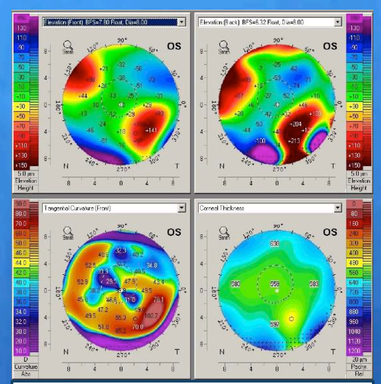

Figure 2: Patient DA, OS Pentacam topography pre scleral lens wear

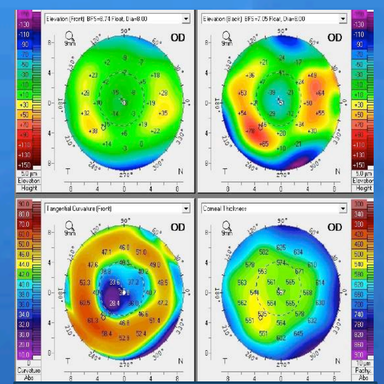

Figure 3: Patient OB, OD Pentacam topography pre scleral lens wear.

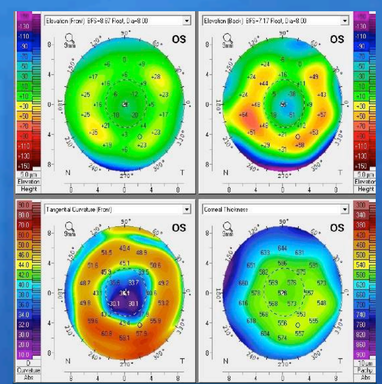

Figure 4: Patient DA, OS Pentacam topography pre scleral lens wear

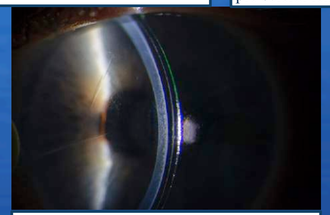

Photo 3: OS scleral lens vault of patient DA

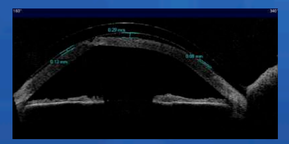

Photo 4: Vistante of scleral vault over OS in patient DA

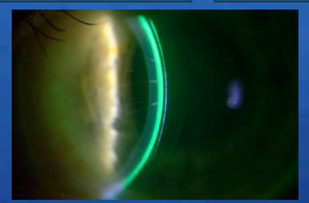

Photo 5: Patient OB scleral lens vault, initial fitting. Decreased vault by 100 microns

Discussion

Numerous articles have been presented regarding the outcome of RK surgery, the most pivotal being the Prospective Evaluation of Radial Keratotomy (PERK) Study. The PERK study revealed 43% of post RK corneas demonstrated a progressive hyperopic shift over 10 years. Since the first PERK study publication, further research has been completed regarding long-term outcomes including diurnal fluctuations in visual acuity and corneal curvature. Kemp et al., reported that morning-to-evening changes persisted with fluctuations ranging from 1.5 to 3.0 diopters and showed a decrease in uncorrected visual acuity, an increase in myopia, and central corneal steepening at the end of the day. This change is due to alterations in overall corneal topography from fluctuations in intraocular pressure, corneal hydration, and mechanical factors such as eyelid pressure. The definitive mechanism for refractive instability and the persistence of diurnal fluctuation is largely unknown; nonetheless, it is thought that the most likely cause is corneal instability. As a result of decreasing intraocular pressure from morning to evening the unstable cornea is flattened at the periphery near the incision sites and the center is steepened.

All patients in this case series presented with inadequate spectacle correction and unperceived diurnal fluctuations in vision. It is possible diurnal changes were not identifiable prior scleral lens wear, but with the introduction of scleral lenses these patients were able to obtain improved acuity and stable visual correction while the lenses were worn. Once that stable source of correction is removed it is possible that the patient is more perceptive to the change from morning to evening. This is thought to be the reasoning for the myopic shift patients upon removing the lenses. The shift is due to the natural variation as described in the PERK study, i.e. more myopic at the end of the day.

Hyperopic visual fluctuations due to scleral lens wear may be secondary to increased corneal thickness which is caused by excessive hydration or temporary hypoxia from a low DK as a result of the combined lens and tear layer. Mader et al, reported a high-altitude hypoxic environment can cause increased corneal hydration in the area of the RK incisions, leading to peripheral steepening and central corneal flattening. Furthermore, increased intraocular pressure has been shown to be a component to the multifactorial cause of diurnal fluctuation. Preliminary studies from the Mayo Clinic and Pacific University College of Optometry revealed a transient increase in intraocular pressure during scleral lens wear. By increasing intraocular pressure while the scleral lens is on, the peripheral cornea is steepened and the central cornea is flattened creating a more hyperopic refractive error after lens removal.

Limitations to the retrospective review are the lack of data of corneal thickness, topography, and intraocular pressure for each of these patients post scleral lens wear. Further studies need to be conducted to determine if these factors account for the change in vision upon removing scleral lenses or if the lenses mask the natural behavior of the cornea following radial keratotomy. Implications for the future in fitting post RK patients include applying a standard fitting protocol, incorporating topography scans, pachymetry pre- and post- lens fitting, intraocular pressure measurements with scleral lenses on, as well as fitting with the highest DK possible.

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