

Case Report

# Rigid Gas-Permeable Semi-Scleral Contact Lenses after Radial Keratotomy: Apical Space, Lens Diameter, Limbal Clearance, Peripheral O-Rings, and Tear Exchange as Contact-Lens-Fitting Success Factors

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**Citation:** Capote-Puente, R.; López-Muñoz, A.; Bautista-Llamas, M.-J.; Silva-Viguera, C.; Romero-Luna, M.; Sánchez-González, J.-M. Rigid Gas-Permeable Semi-Scleral Contact Lenses after Radial Keratotomy: Apical Space, Lens Diameter, Limbal Clearance, Peripheral O-Rings, and Tear Exchange as Contact-Lens-Fitting Success Factors. *Optics* **2022**, *3*, 209–215. <https://doi.org/10.3390/opt3030020>

Academic Editor: Thomas Seeger

Received: 30 May 2022

Accepted: 24 June 2022

Published: 28 June 2022

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**Abstract:** The purpose of this case report is to verify if the adaptation of a rigid gas-permeable contact lens can improve VA and comfort in a patient with complications derived from radial keratotomy (RK) surgery. A semi-scleral contact lens was fitted in a 46-year-old female patient who had undergone bilateral RK before 30 years. The uncorrected distance visual acuity in the right eye (RE) and left eye (LE) was 0.5 and 0.6 logMAR (minimum angle resolution), respectively. The RE and LE manifest refractions were +2.00 – 4.25 × 155 diopters (D) and +2.00 – 3.00 × 15 D, respectively. A semi-scleral rigid gas-permeable Rose K2 XL<sup>TM</sup> lens was fitted in both eyes. The central clearance was 400–450 μm in the RE and 300–350 μm in the LE. The semi-scleral corrected distance visual acuity in the RE and LE was 0.1 and 0.16 logMAR, respectively. Semi-scleral contact lenses are comfortable and a beneficial choice for patients after RK when associated with visual problems and intolerance to other therapeutic options. Semi-scleral lenses permit prolonged duration of use without discomfort, adverse alterations, and improve the feeling of glare in scotopic vision. In the present case, there were multiple factors that influenced the resolution, such as the amount of apical space, lens diameter, limbal clearance, peripheral O-rings, and tear exchange.

**Keywords:** radial keratotomy; scleral lens; contact lens; refractive surgery

## 1. Introduction

Radial keratotomy (RK) is a refractive surgical procedure performed to irreversibly flatten the central corneal curvature to correct myopia [1]. Popularized by Fyodorov and Durnev in the 1980s and 1990s, this procedure has largely been replaced by corneal laser vision corrective techniques, such as photorefractive keratectomy and laser in-situ keratomileusis [1]. Radial incisions are made on the periphery of the cornea to a depth of 85–95% of the total corneal thickness. Myopia is corrected because the cornea is weakened by the incisions, due to which the central area flattens and the periphery becomes more curved [2]. The type of incision, its length, depth, and number needed to correct myopia varied in each case, depending on parameters, such as age, health, or the curvature of the patient's cornea. This technique was not widely accepted because the effect of the procedure was minimal and the potential dangers of perforation, incision irregularity, and surgical trauma could not be guaranteed [3]. The most common long-term complications of RK include concomitant hyperopia, astigmatism, and corneal irregularity, with visual impairment that cannot be corrected with spectacles. The side effects of corneal weakening are daytime fluctuations in vision and hyperopic regression in approximately 50% of the

patients [4]. After RK, a solution is needed to eliminate residual refractive errors and to improve visual acuity (VA).

The scleral lens is generically defined as a semi-rigid contact lens that distributes its support only in the sclera. This support must be soft and uniform, distributing the pressure exerted by the lens in a balanced manner. The separation between the posterior face of the scleral lens and the anterior face of the cornea must be completed by a totally transparent solution that respects the ocular physiology [5]. Numerous indications have been described for these lenses in the literature. Scleral lenses are prescribed, in most cases, for corneal irregularity, followed by ocular surface disease and uncomplicated refractive error [6]. Its optical principles are the same as in RGP lenses; they use the tear film to correct aberrations, but advances in optical instruments, such as the use of OCT, scleral topography, impression measurements and advances in materials, with high Dk that increase wettability, make adaptations easier and more personalized, reducing complications, such as corneal oedema, pannus, and microbial contamination/infections [7–9].

The purpose of this case report is to verify if the adaptation of a rigid2. gas-permeable contact lens can improve VA and comfort in a patient with complications derived from RK surgery.

## 2. Case Report

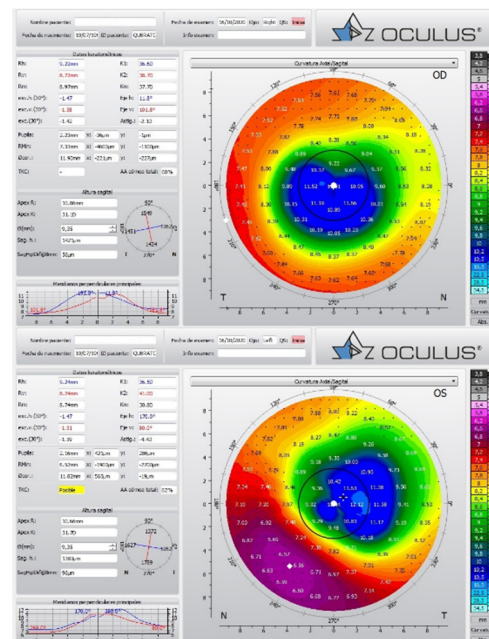
A 46-year-old female patient was referred by an ophthalmologist in November 2019 to our clinic for visual rehabilitation assessment using special contact lenses. The patient had a surgical history of bilateral RK performed before 30 years and a pre-surgical history of refractive treatment for myopia and astigmatism. For three years, the patient tried to adapt to corrective glasses as well as soft and hard contact lenses to improve her visual symptoms, without any success. A statement of consent to publish this case and associated images was obtained from the patient. During the first consultation, the patient informed us regarding blurring of distant and near vision in both eyes, and night glare that affected her ability to perform daily living activities comfortably.

At the first appointment, the uncorrected distance visual acuity (UDVA) in the right eye (RE) and left eye (LE) was 0.5 and 0.6 logMAR, respectively. The RE and LE manifest refraction was  $+2.00 - 4.25 \times 155$  diopters (D) and  $+2.00 - 3.00 \times 15$  D, respectively. The corrected distance visual acuity (CDVA) in the RE and LE was 0.3 and 0.5 logMAR, respectively. The corneal topography Oculus Keratograph<sup>®</sup> 5M (OCULUS Optikgeräte GmbH, Wetzlar, Germany) of the RE and LE is presented in Figure 1. The keratometry readings Oculus Keratograph<sup>®</sup> 5M (OCULUS Optikgeräte GmbH, Wetzlar, Germany) of the RE were  $36.60 \times 11.8^\circ$  D and  $38.70 \times 101.8^\circ$  D, while those of the LE were  $36.50 \times 170^\circ$  D and  $41.00 \times 80^\circ$  D. Anterior segment analysis with a slit lamp (SL500, Essilor, Charenton-le-Pont, France) revealed a clear cornea with 16 compatible RK incision scars (Figure 2), and grade I diffuse conjunctival injection was observed in each eye.

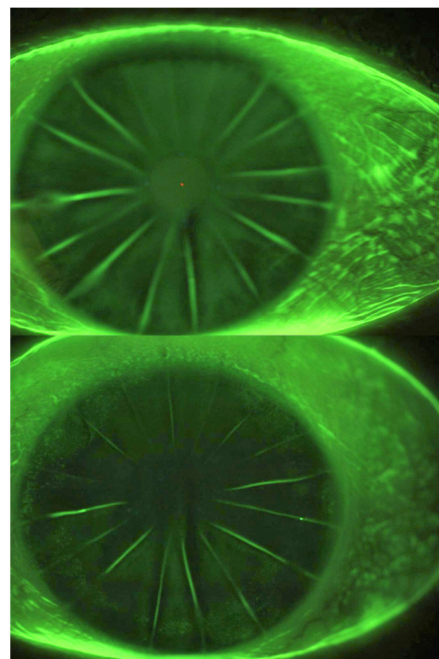
During the next appointments, a semi-scleral rigid gas-permeable Rose K2 XL<sup>™</sup> lens (Menicon Z, Menicon Co., Ltd., Nagoya, Japan) was fitted in both eyes [10]. This contact lens was produced using tisilfocon A. We performed corneal keratometry to fit the lenses according to the manufacturer's instructions [11].

For the adjustment of ROSEK XL lenses, the manufacturer's guidelines were used, and they were always inserted by the same specialist. It was used in a set of diagnostic lenses that incorporated different base curve (BC) with a fork of 6 A 8.40 mm, standard diameter of 14.60 mm, and standard edge lift [11]. The first lens was chosen following the manufacturer's guidelines with a parameter 0.7 mm, more curved than the average K. The lenses were inserted, filled with a sterile saline solution without preservatives and adding sodium fluorescein (Bioglo, HUB Pharmaceuticals, Inc., Rancho Cucamonga, CA, USA) for further evaluation with slit lamp and with the help of a scleral suction cup. The adjustments were made 20 min after insertion, evaluating the central adjustment first and adjusting the edge lift about 1 mm approximately. The total diameter should not

exceed the recommendations of 1.5 mm outside the limb and had to be supported uniformly without observing any abnormality in the vascular framework of the conjunctiva [6].



**Figure 1.** Corneal topography of both eyes measured with topographer. Right eye on the top and left eye on the bottom.



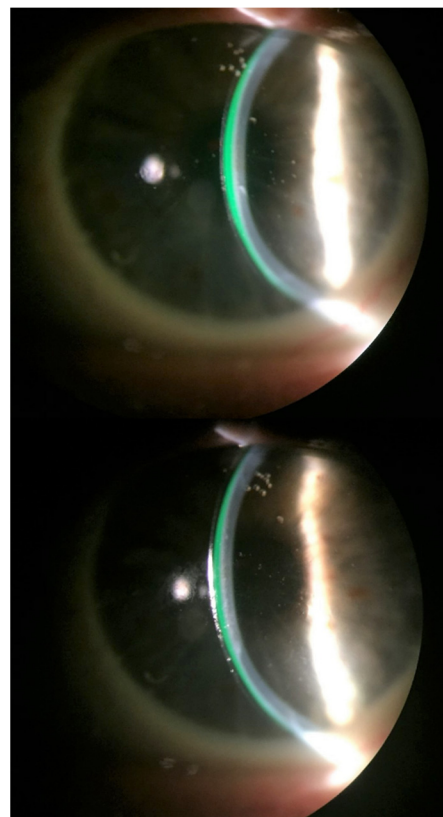
**Figure 2.** Fluorescein image of both eyes measured with static fluorescein software. Right eye on the top and left eye on the bottom.

We evaluated the physiological function and corneal state, corneal clearance and alignment of peripheral techniques, and subjective tolerance after one, four, and eight hours of wearing the lens. Special attention was paid to the cornea, limbal zone, and 360-degree alignment, conjunctival staining after lens removal, conjunctival hyperemia, rebound, and general patient comfort. During the treatment period, we did not observe any clinically significant adverse effects. The contact lens parameters are presented in Table 1. No

conjunctival staining was observed after removal. The central clearance was 400–450  $\mu\text{m}$  in the RE and 300–350  $\mu\text{m}$  in the LE (Figure 3). The image was taken with an iPhone camera (12-megapixel camera, iPhone 6S, Cupertino, California, United States).

**Table 1.** Semi-scleral contact lens parameters.

Parameter	Right Eye	Left Eye
Lens Model	Rose K2 XL <sup>TM</sup>	Rose K2 XL <sup>TM</sup>
Material	Tisilfocon A (Menicon Z)	Tisilfocon A (Menicon Z)
Base Curve [mm]	6.70	6.90
Diameter [mm]	14.60	14.60
Power [Dioptres]	−9.00	−10.00
Edge Lift Control	45°/135° (Steep −1.50)	45°/135° (Steep −0.50)
Peripheral Fit [Degrees]	225°/315° (Steep −1.00)	225°/315° (Steep −1.00)



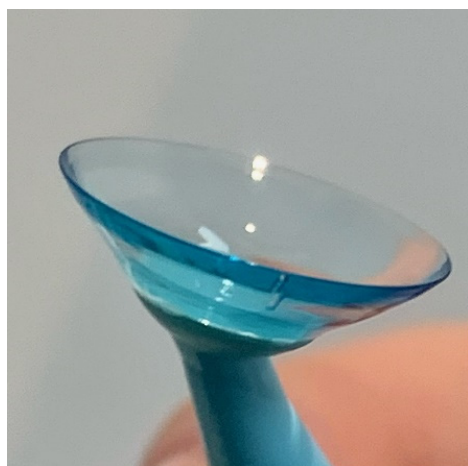
**Figure 3.** Corneal clearance image of both eyes measured with slit-lamp biomicroscope attached to a smartphone camera in January 2021. Right eye on the top (between 400  $\mu\text{m}$  and 450  $\mu\text{m}$ ) and left eye on the bottom (between 300  $\mu\text{m}$  and 350  $\mu\text{m}$ ).

The RE and LE semi-scleral CDVAs were 0.1 and 0.16 logMAR, respectively. At the next appointment, after one month of wearing the lenses, the CDVA was stable and no slit-lamp disorders were identified. The mean wearing time was 14 h and the patient did not report any discomfort, adverse events, or night glaring. Subsequently, the patient was evaluated at six months and one year, during which she reported total comfort and visual stability.

### 3. Discussion

Rosek XL is a rigid gas-permeable lens of large diameter and design with semi-scleral support; it is among the best therapeutic options to manage irregular cornea [6,11], since it avoids direct contact with the cornea and limbus by rising on them and resting on the conjunctival tissue that supports the sclera, providing greater comfort and significant visual

improvements due to the better control of high-order aberrations by the regular interface, produced between the cornea and the contact lens [12]. The peripheral curves and diameter used by the manufacturer can improve peripheral alignment and tear exchange on corneas and irregular surfaces (Figure 4). We consider the adaptation of the design of RoseK XL as a great therapeutic option through the use of specific frontal curves that improve the control of high-order aberrations and aspherical posterior optical zones to obtain better visual results and greater comfort [13]. Other previous studies also considered the use of this same design for 27 and 36 subjects, respectively, with irregular corneas and were also able to confirm the success of these Rose K XL contact lenses in the relationship of visual acuity and great comfort [10]. The objective of this case report is to demonstrate the properties and impact produced by a semi-scleral contact lens in a patient with radial keratotomy treatment, when the results are not optimal with other therapeutic options.



**Figure 4.** RoseK XL rigid gas permeable lens.

Scleral contact lenses have clear optical and therapeutic advantages over other types of lenses. One of the most important aspects is the improvement in visual quality, which means that scleral contact lenses compensate, identical to those of other corneal rigid lenses, the majority of anterior corneal astigmatism and higher-order aberrations due to the presence of the post-lens tear layer, thereby resulting in better VA in irregular corneas [7,13]. This principle led to the scleral contact lens being the first choice for our patient, wherein the topography presented central and peripheral irregularities, since corneal rigid lenses can cause decentration problems [14]. In the present case, we followed both objectives with the scleral lens, a centered adaptation and achievement of a CDVA of 0.1 logMAR in the RE and 0.16 logMAR in the LE versus an UDVA of 0.5 logMAR in the RE and 0.6 logMAR in the LE. This was highlighted in the studies by Gruenauer-Kloevekornc [14] and Chu et al. [15], who reported an increase in VA with these contact lenses in irregular corneas.

Kumar et al. [13] described a decrease in high-order aberrations in different groups of scleral contact lens users with irregular corneas (keratoconus, intra-corneal ring segments, RK, and penetrating keratoplasty), with an influence on the outcome of the final CDVA and improvement in visual quality. Regarding adaptation of the contact lens in irregular corneas, a good relationship between the posterior face of the lens and anterior aspect of the cornea is important to ensure good tear exchange and the prevention of hypoxia. In this case, the patient demonstrated good tolerance without any compromise in corneal physiology, favored by the design of the scleral lenses, which are an excellent solution for eyes with irregular corneas, considering that they do not rest on the cornea [16].

#### 4. Conclusions

This case report shows that semi-scleral contact lenses are comfortable and a beneficial choice for patients after RK, when associated with visual problems and intolerance to other therapeutic options. Semi-scleral lenses permit prolonged duration of use without

discomfort, adverse alterations, and improve the feeling of glare in scotopic vision. In the present case, there were multiple factors that influenced the resolution, such as the amount of apical space, lens diameter, limbal clearance, peripheral O-rings, and tear exchange. Semi-scleral contact lenses are an excellent option that can drastically improve the vision of patients with radial keratotomy treatment, when the results are not optimal with other therapeutic options, such as spectacles, soft contact lenses, or GP corneal, due to decentering, high-order aberrations, astigmatism, and irregular surfaces. New semi-scleral lens designs with more personalized profiles can help improve daily wear comfort and vision for patients.

**Author Contributions:** Conceptualization, R.C.-P., A.L.-M., M.-J.B.-L., C.S.-V., M.R.-L. and J.-M.S.-G.; resources, R.C.-P., A.L.-M., M.-J.B.-L., C.S.-V., M.R.-L. and J.-M.S.-G.; writing—original draft preparation, R.C.-P., A.L.-M., M.-J.B.-L., C.S.-V., M.R.-L. and J.-M.S.-G.; writing—review and editing, R.C.-P., A.L.-M., M.-J.B.-L., C.S.-V., M.R.-L. and J.-M.S.-G.; supervision, R.C.-P., A.L.-M., M.-J.B.-L., C.S.-V., M.R.-L. and J.-M.S.-G. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University of Seville.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to containing information that could compromise the privacy of the research participants.

**Acknowledgments:** The authors appreciate the support offered by the members of the Department of Physics of Condensed Matter, Faculty of Physics, University of Seville, with special thanks to Javier Romero-Landa and Clara Conde-Amiano. In addition, the authors also appreciate the technical support offered by the members and facilities of the Faculty of Pharmacy, University of Seville, with special thanks to María Álvarez-de-Sotomayor.

**Conflicts of Interest:** The authors declare no conflict of interest.

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