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PTK-Assisted Corneal Lenticule Implantation for Enhancement after RK: A Case Report

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Case Report

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Abstract

Objective

To investigate the safety and efficacy of superficial corneal stromal lenticule implantation in treating patients with overcorrection after radial keratotomy (RK), and to evaluate the application value of this "additive" surgical method in the correction of refractive abnormalities after special refractive surgeries.

Methods

A retrospective analysis was conducted on a 52-year-old male patient who had undergone bilateral radial keratotomy (RK) 32 years earlier and experienced worsening near vision and visual fatigue over the past 3 years. Preoperative examination revealed bilateral overcorrection and age-related accommodative dysfunction. In March 2024, the right eye underwent phototherapeutic keratectomy (PTK)-assisted surface corneal stromal lenticule implantation. PTK was used to remove the corneal epithelium and smooth the surface, creating an optimal bed for the lenticule. One month later, the same procedure was performed on the left eye after satisfactory results were obtained. Follow-up assessments included corneal curvature, central corneal thickness, visual acuity, refractive power, corneal topography, and RK incision status.

Results

At 1-year follow-up, uncorrected distance visual acuity improved from 0.5 bilaterally to 0.3(LogMAR) in both eyes; uncorrected near visual acuity improved from 0.8 at 30 cm to 0.3 at 30 cm（LogMAR）. Corneal curvature and central thickness increased in both eyes. Anterior segment OCT confirmed good lenticule position, with no incision rupture, neovascularization, or adverse events (e.g., infection, rejection, lenticule displacement) observed.

Conclusion

Surface corneal stromal lenticule implantation—an “additive” approach distinct from traditional “subtractive” ablation—effectively corrected hyperopia after RK surgery, with stable postoperative parameters and significantly improved uncorrected visual acuity. This technique preserves the original RK incisions, theoretically reducing the risk of incision rupture and minimally impacting corneal biomechanics, thereby offering a new treatment option for patients with overcorrection after RK.

Introduction

The RK surgery involves making radial incisions in the non-optical area of the cornea to alter the curvature of the cornea and achieve the correction goal. This surgery typically requires the creation of 8 to 16 large incisions, with the incision depth reaching 80% to 90% of the corneal stroma layer [1].However, due to the poor predictability after RK surgery, over-correction and under-correction often occur after the surgery.

Case presentation

The patient is a 52-year-old male who presented to the ophthalmology department with complaints of "difficulty with near vision for over three years and severe visual fatigue.". The patient reported that he underwent bilateral refractive keratotomy surgery in another hospital in 1995. His vision had been stable since then, but in the past three years, he has experienced progressive difficulty in seeing close objects, accompanied by severe visual fatigue, which has affected his work and daily life.

The ophthalmic examination results showed: Uncorrected near vision:OD 0.16/30cm, OS 0.16/30cm; Uncorrected distance vision: OD 0.5, corrected to 0.2, OS 0.5, corrected to 0.1(All the visual acuity records in the text are in LogMAR units.); Refraction (Cycloplegic refraction): OD + 7.50DS -1.75DC×75°, OS + 6.25DS -0.75DC×95°; Intraocular pressure: OD 13 mmHg, OS 11 mmHg.

Anterior segment examination showed: 12 radial incision marks could be seen in both eyes, and no obvious abnormalities were found in the remaining examinations (Fig. 1).

Auxiliary examinations: Corneal topography examination: Corneal curvature: OD K1 29.3 D, K2 31.5D, OS K1 30.5 D, K2 31.6D(Fig. 2); Thinnest point thickness of the cornea: OD 540μm, OS 540 μm; Corneal epithelial thickness: OD 59μm, OS 58μm (Fig. 3).

The patient experienced severe ocular discomfort in the eyes and requested surgical treatment. Following a review of the current examination findings, bilateral enhancement surgery was deemed feasible. The surgical plan involved a stromal lenticule implantation procedure on the right eye using a surface corneal approach. The treatment modality included PTK laser-assisted epithelial excision, followed by wavefront-guided excimer laser reduction of part of the refractive power. The proposed laser treatment parameters were + 1.25DS − 1.50DC75°, with an optical zone of 6.7mm, a cutting depth of 141 (CW mode) μm, and a remaining stromal bed thickness of 422 μm. After laser treatment, the corneal lenticule was laid flat on the stromal bed, and the implantation parameters of the lenticule were − 5.95D, with an optical zone of 6.5mm and a lenticule thickness of 101 μm (Fig. 4). After the lenticule was laid flat, its position was adjusted, flattened, fully dried, and the excess water was removed before wearing the treatment bandage contact lens. After the operation, 0.1% fluorometholone eye drops, levofloxacin eye drops, and sodium hyaluronate eye drops were applied for eye drops. On the first day after the operation, the treatment bandage contact lens was in place, but there was corneal epithelial loss. On the seventh day after the operation, the uncorrected distant visual acuity of the right eye was 0.3, and the near visual acuity was 0.33/30cm. The corneal contact lens was in place, and the corneal epithelium had healed(Fig. 5). The anterior segment OCT examination and slit lamp examination showed no abnormalities. The treatment bandage contact lens was removed. One month after the operation, the uncorrected distant visual acuity of the right eye was 0.3, and the near visual acuity was 0.5/30cm. The anterior segment OCT examination and slit lamp examination showed no abnormalities. The postoperative effect was satisfactory, and the patient requested left eye surgery treatment. The left eye surgery was performed in the same way. Follow-up was conducted until one year after the operation. The uncorrected distant visual acuity of the right eye was 0.3, and the near visual acuity was 0.3/30cm. The

left eye was 0.3, and the near visual acuity was 0.3/30cm. Computer refraction: Right eye + 2.00DS − 3.50DC×75°, Left eye − 2.25DS − 0.75DC×90°.The intraocular pressure of the right eye was 13.2 mmHg, and that of the left eye was 13.9 mmHg. The anterior segment OCT examination and slit lamp examination showed no abnormalities, and the follow-up was ongoing.

Discussion

Radial Keratotomy (RK) was once a common surgical method for correcting myopia. By making radial incisions in the non-optical zone of the cornea, the central cornea was flattened to achieve the correction goal. However, after RK surgery, long-term problems such as over-correction of refraction, under-correction of refraction, unstable refraction, and increased astigmatism often occur, causing discomfort to the patient's visual quality [2–3]. Such patients have always been a clinical challenge. The enhancement surgery for these patients has been a difficult issue. The patient's eye condition is complex, with an age of 52 years. Due to the impact of age-related insufficient accommodation, the over-correction effect of the surgery has gradually worsened over time. According to the patient, it has seriously affected their life. The patient has a strong desire for surgery, but the surgical difficulty is relatively high. The principle of choosing enhancement surgery is to select different enhancement surgical methods for different surgical procedures and different degrees of refractive regression to improve the surgical effect and reduce related complications [4–5]. Currently, the commonly used enhancement surgical methods after RK surgery include[6–7]: 1. Making a corneal flap, lifting the flap for secondary correction; 2. Surface surgery for secondary enhancement; 3. ICL (currently only for treating refractive regression due to myopia); 4. Surface corneal stromal lenticule implantation. Considering the patient's relatively flat corneal curvature, numerous corneal incisions, high hyperopic refractive power, advanced age, and other ocular conditions, it is recommended that the patient undergoes surface corneal stromal lenticule implantation. The surgical epithelial removal is performed using a femtosecond laser (PTK), and after removing the epithelium, aberration-guided quasi-analytical laser ablation was applied(CW). The corneal shape becomes more regular, which is helpful for improving visual quality after surgery[8]. Surface corneal stromal lenticule implantation involves using the corneal tissue with refractive power that was removed during the SMILE surgery for correcting myopic patients, and placing it flat on the stromal bed where the corneal epithelium has been removed. This method can increase the thickness and curvature of the central part of the cornea, actively correct the hyperopic refractive power, reduce the risks caused by cutting and making corneal flaps, and is less risky for the patient. In previous studies[9–10], the superficial corneal stromal lenticule surgery was used to treat diseases such as hyperopia and thin corneal keratoconus, and satisfactory results were achieved. Compared to other enhancement surgeries, this surgical method avoids the risk of haze caused by excessive cutting in simple surface surgery and the risks of incision splitting, corneal thinning, and secondary keratoconus caused by re-making the corneal flap, making it a suitable and relatively safe option for this patient.

Conclusion

The surface corneal stromal lenticule implantation assisted by PTK is a minimally invasive and biologically stable method for treating patients with excessive refractive correction after RK surgery. This case provides a safe and effective enhancement treatment strategy for clinical practice. Further verification of its long-term efficacy through larger sample sizes and long-term follow-up is required in the future.

Declarations

Ethics approval and consent to participate

The study protocol conformed to the tenets of Declaration of Helsinki, and was approved by the Human Ethics Committee of Jinan Mingshui Eye Hospital (Ref Ethics/2022/016). The patient and their family members signed the informed consent form before the operation for the publication of their personal and/or clinical details, as well as any identifying images.

Consent for publication

Written informed consent was obtained from all participants/patients for the publication of their personal and/or clinical details, as well as anyidentifying images, in this study.

Competing interests

The authors declare that they have no conficts of interest.

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Author Contribution

All the authors were involved in the discussion, treatment and follow-up process of this case. Zhang Jing was responsible for the treatment and follow-up of the case, and wrote the initial draft of the paper. Sun Fangfang collected and managed the case data, conducted the patient's follow-up, Hou Jie and Lei Yulin made key revisions to the paper, and Lei Yulin was the executor of the patient's surgery. All the authors reviewed and approved the final paper.

Acknowledgement

None.

Data Availability

The datasets used during the current study available from the corresponding author on reasonable request.

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Figures

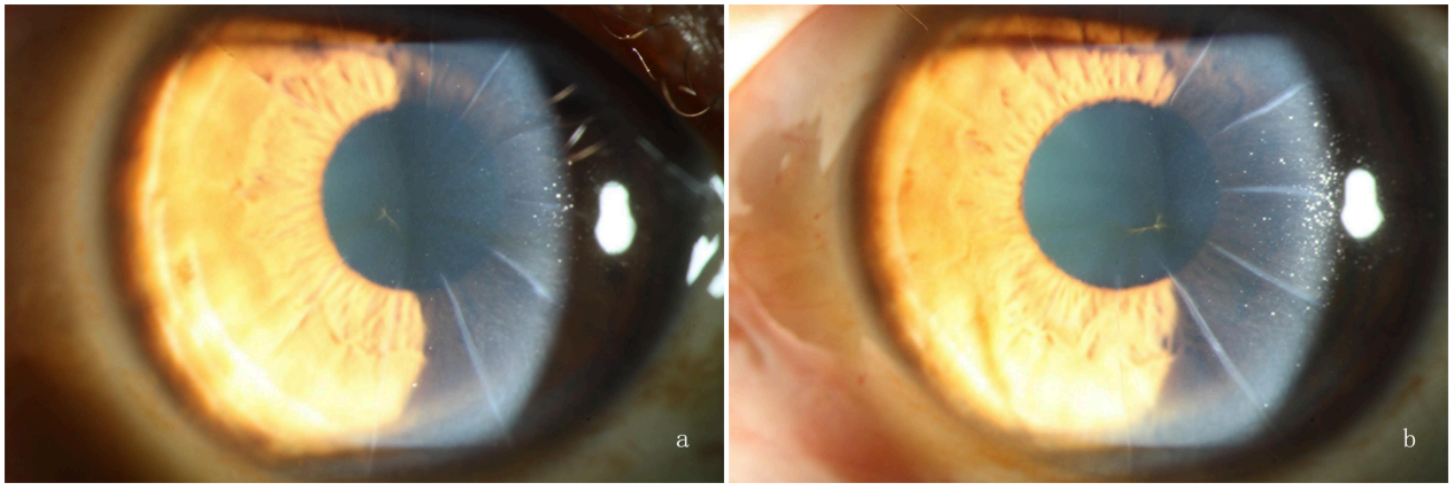


Figure 1

shows the preoperative slit lamp microscopic examination photos of the patient. a represents the right eye, b represents the left eye. Each eye has 12 radial incision marks.

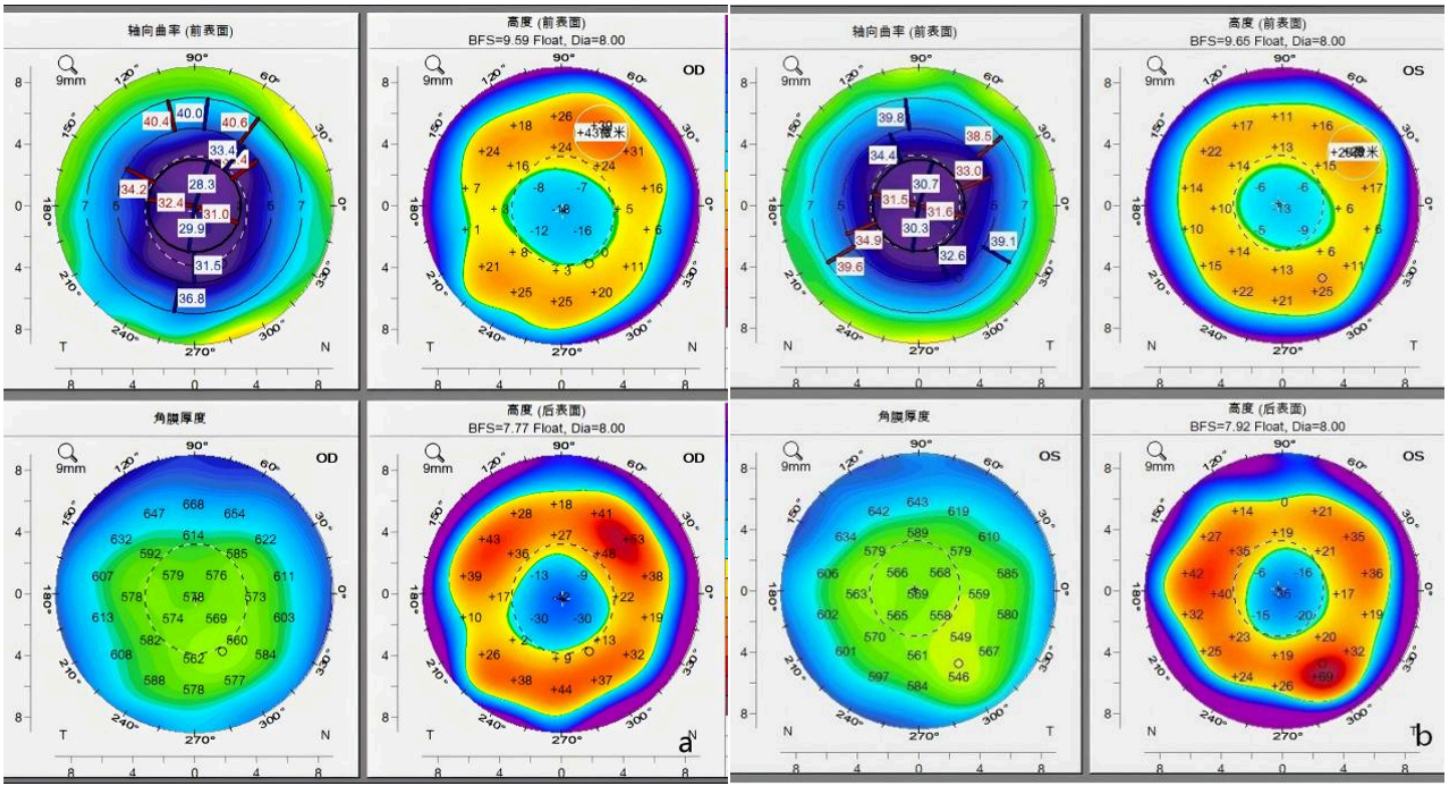


Figure 2

The corneal topography shows that the central curvature of the corneas in both eyes is low and flat, and the symmetry of the corneal shapes in both eyes is acceptable. a represents the right eye, and b represents the left eye.

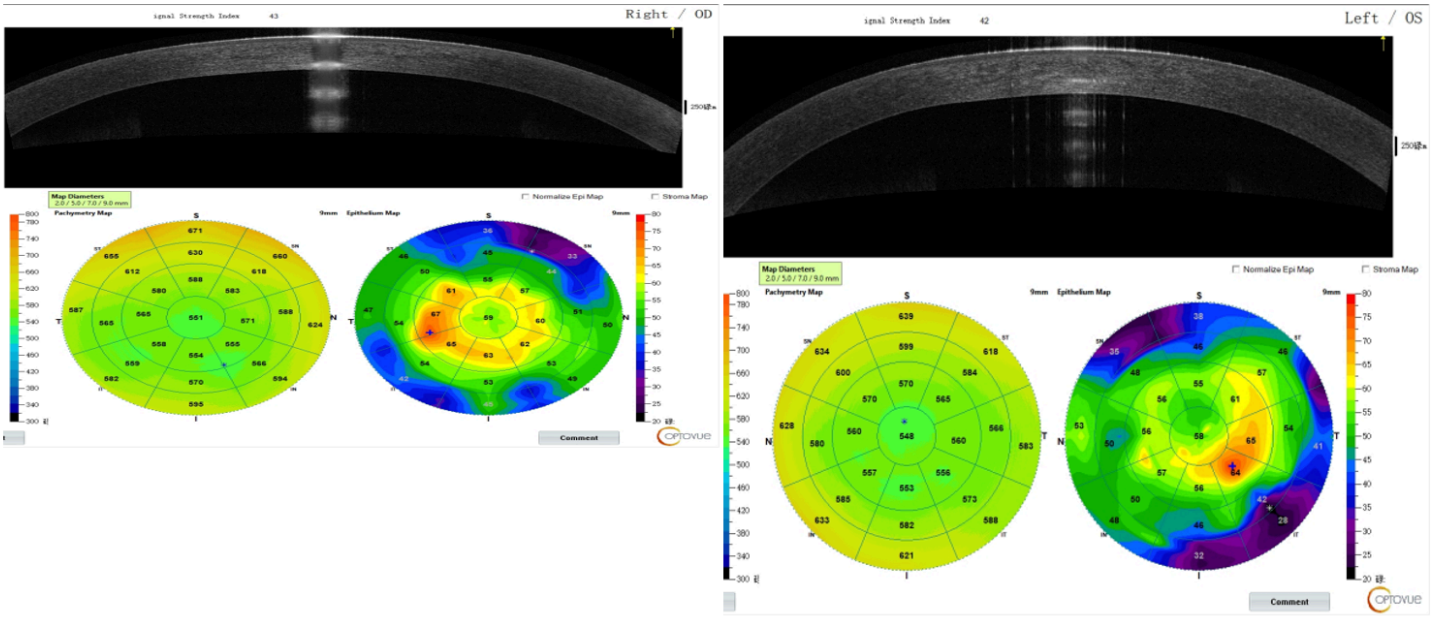


Figure 3

The OCT images of the anterior segment of both eyes show that the corneal thickness is normal in both eyes, but the thickness distribution of the central epithelium is uneven.The right eye/left eye is marked at the top right of the picture.

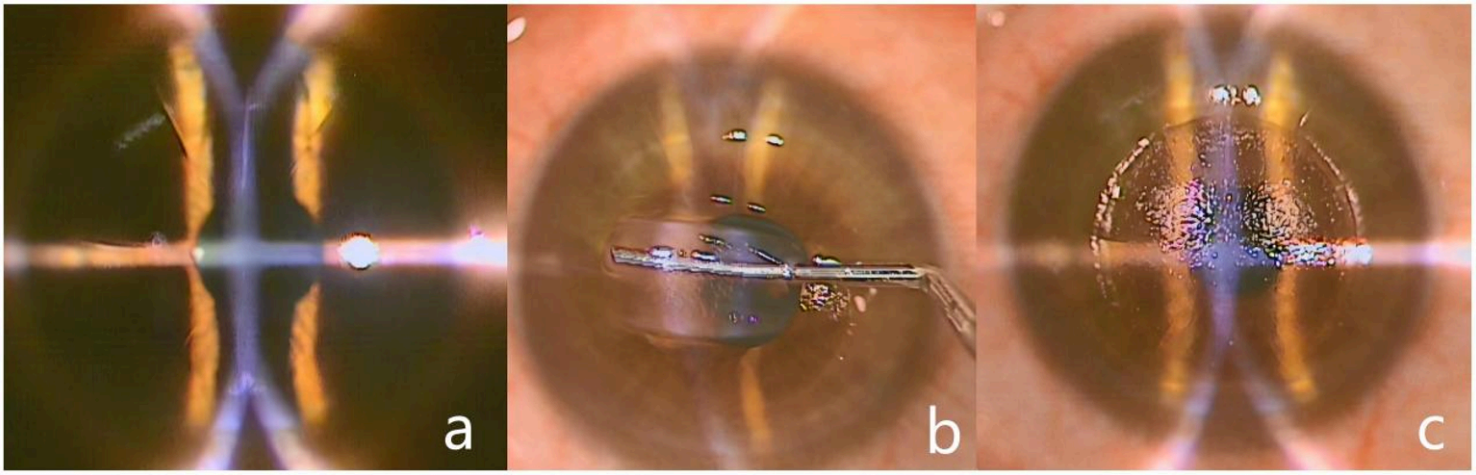


Figure 4

shows the patient's condition during the operation. a The patient underwent PTK laser to remove the corneal epithelium; b. Place the corneal stromal lenticule flat on the corneal stromal bed; After placing the corneal stromal lenticule, allow it to fully dry the moisture.

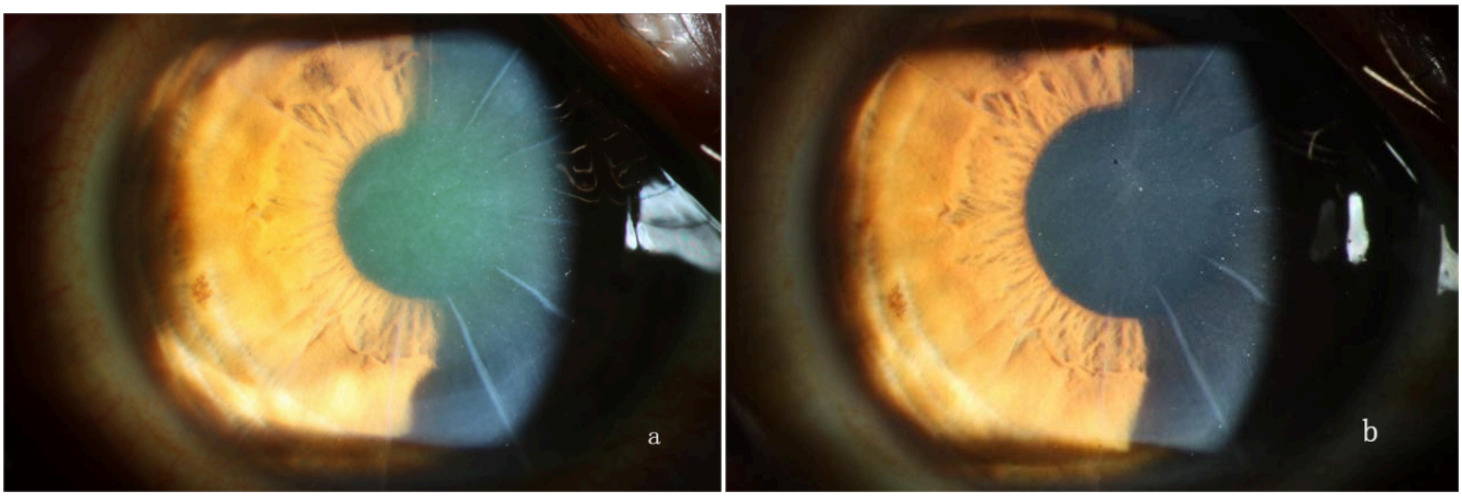


Figure 5

shows the early postoperative recovery of the patient. (a) This is the examination result on the day after the surgery. The treatment bandage contact lens is in place, the corneal epithelium is missing, the cornea has a slight yellowish tint, and the corneal stroma lenticule is adhered well.(b) On the 7th day after the surgery, the corneal epithelium had healed, the corneal stromal lenticule was in place, and the corneal transparency was good.