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Effects and risks of 3.2-mm transparent corneal incision phacoemulsification for cataract after radial keratotomy

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Abstract

Objective: This study was performed to analyze the visual outcomes and complications of phacoemulsification using a 3.2-mm transparent corneal incision in eyes with cataract after radial keratotomy (RK).

Methods: We retrospectively reviewed cases of lens phacoemulsification and intraocular lens implantation after RK. The main measurement results were postoperative best-corrected visual acuity (BCVA), endothelial cell density, and complications.

Results: Overall, 19 eyes of 12 patients with 8 (n = 6), 12 (n = 7), and 16 (n = 6) RK cuts were included in the study. Intraoperative wound dehiscence occurred in two eyes with 16 RK cuts. Successful phacoemulsification with intraocular lens implantation was performed in all eyes. The mean BCVA at the last follow-up (0.19 ± 0.13 LogMAR) was significantly better than the preoperative BCVA (0.72 ± 0.54 LogMAR). However, there was a significant reduction in the corneal endothelial cell density after surgery ($2384.0 \pm 833.4/mm^2$ vs. $1716.95 \pm 906.79/mm^2$).

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Conclusions: Surgeons should be aware of the risk of wound dehiscence in patients who undergo phacoemulsification after RK. A small transparent corneal incision or scleral tunnel incision is recommended.

Keywords
Radial keratotomy, cataract, transparent corneal incision, phacoemulsification, intraocular lens, wound dehiscence

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Introduction

Radial keratotomy (RK) involves the creation of radial incisions on the cornea, leading to flattening of central cornea. Sato et al.[1] first reported RK in 1953. The surgical procedure became popular during the 1970s and 1980s and was introduced to China in 1987.[2] However, because of the adverse effects associated with RK, most commonly irregular astigmatism and keratectasia, RK was replaced by corneal laser refractive surgery. Although RK is no longer performed, we continue to see patients with a history of RK who have now developed age-related cataract. Cataract surgery after RK poses a challenge to the surgeon. First, the change in the corneal curvature after RK affects the calculation of the intraocular lens (IOL) power.[3–5] Second, RK incisions undermine the integrity of the cornea. The energy needed for ocular dehiscence after RK surgery is significantly lower than that for the normal eye.[6] Animal experiments have shown that in rabbits, the energy needed for corneal scar dehiscence within 90 days after RK surgery is only half that of the normal eye.[7] The conventional transparent corneal incision performed for phacoemulsification may lead to dehiscence of the RK incision.[8–12] Once RK incision dehiscence has occurred, phacoemulsification can be continued after suturing the dehiscence.[8,10] It has been suggested that when the spacing between two adjacent RK incisions is large enough to exceed the width of the transparent corneal incision, a transparent corneal incision can be considered for cataract surgery; otherwise, a scleral tunnel incision is recommended to avoid intersecting the RK incisions.[8,10] Although the scleral tunnel incision is located farther away from the RK incisions, it is more time-consuming and often requires retrobulbar anesthesia. Because most patients with myopia have posterior scleral staphyloma, a scleral tunnel incision is associated with a risk of puncturing the eyeball. In this study, we retrospectively analyzed patients with a history of RK who underwent phacoemulsification with a 3.2-mm transparent corneal incision.

Methods

This study complied with the tenets of the Declaration of Helsinki and was approved by the Ethics Board of Beijing Tongren Hospital. Written informed consent was obtained from all patients before cataract surgery. The study included patients with a history of RK who later underwent phacoemulsification with a 3.2-mm transparent corneal incision from January 2011 to October 2014 in Beijing Tongren Hospital.

Preoperatively, A-scan ultrasound biometry and keratometry were used to measure the corneal curvature and axial length in 10 of the 19 eyes in this study. The SRK/T formula was used to calculate the IOL power in these 10 eyes. The IOLMaster (ZEISS, Oberkochen, Germany) was used to measure the corneal curvature and axial length in nine eyes. The HOFFER-Q formula was used to calculate the IOL power in these nine eyes.

Surgical procedure

Standard phacoemulsification (power, 60%; vacuum, 400 mmHg; bottle height, 90 cm) and IOL implantation were performed by a single surgeon (W.X.) using the Stellaris machine (Bausch & Lomb, Rochester, NY, USA) with surface anesthesia. All eyes underwent a 3.2-mm transparent corneal incision. The phacoemulsification wound was created without intersecting the RK cuts in eyes with eight RK cuts. In eyes with 12 previous RK cuts, the 3.2-mm incision intersected 1 RK cut. In eyes with 16 previous RK cuts, the 3.2-mm incision intersected 2 RK cuts (Figure 1). Postoperative follow-up was scheduled at 1 day, 1 week, and 1, 3, 6, 12, 24, and 36 months after the procedure. All operated eyes were observed for integrity of the RK incision, complications, and postoperative recovery of visual acuity.

Statistical analysis

Statistical analysis was performed using IBM SPSS for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). The paired *t*-test was used to compare the preoperative and postoperative best-corrected visual acuity (BCVA), corneal endothelial cell density, and change of corneal astigmatism. *P*-values represent results for two-sided tests, and *P*-values of <0.05 were considered statistically significant.

Results

This study included 12 patients (19 eyes) with a mean age of 53.25 ± 6.23 years (range, 41–60 years). All patients had nuclear opalescence (NO) 2 or nuclear color (NC) 2 and NO3 or NC3 based on the Lens Opacities Classification System III criteria.[13] Three patients (6 eyes) had 8 RK cuts, five patients (7 eyes) had 12 RK cuts, and four patients (6 eyes) had 16 RK cuts. The mean interval between RK and cataract surgery was 19.9 ± 0.74 years (range, 19–21 years).

In the eyes with 8 and 12 RK cuts, no intraoperative or postoperative dehiscence of the RK cuts was observed. Two eyes with 16 RK cuts had intraoperative RK cut dehiscence. The dehiscence did not affect the surgery. The anterior chamber was stable during the surgery. At the end of the surgery, a sterile air bubble was injected into the anterior chamber with or

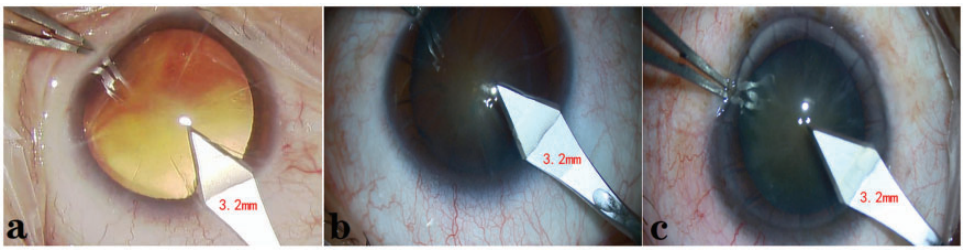

Figure 1. A 3.2-mm transparent corneal incision for phacoemulsification in eyes with (a) 8 previous radial keratotomy (RK) incisions, (b) 12 previous RK incisions, and (c) 16 previous RK incisions.

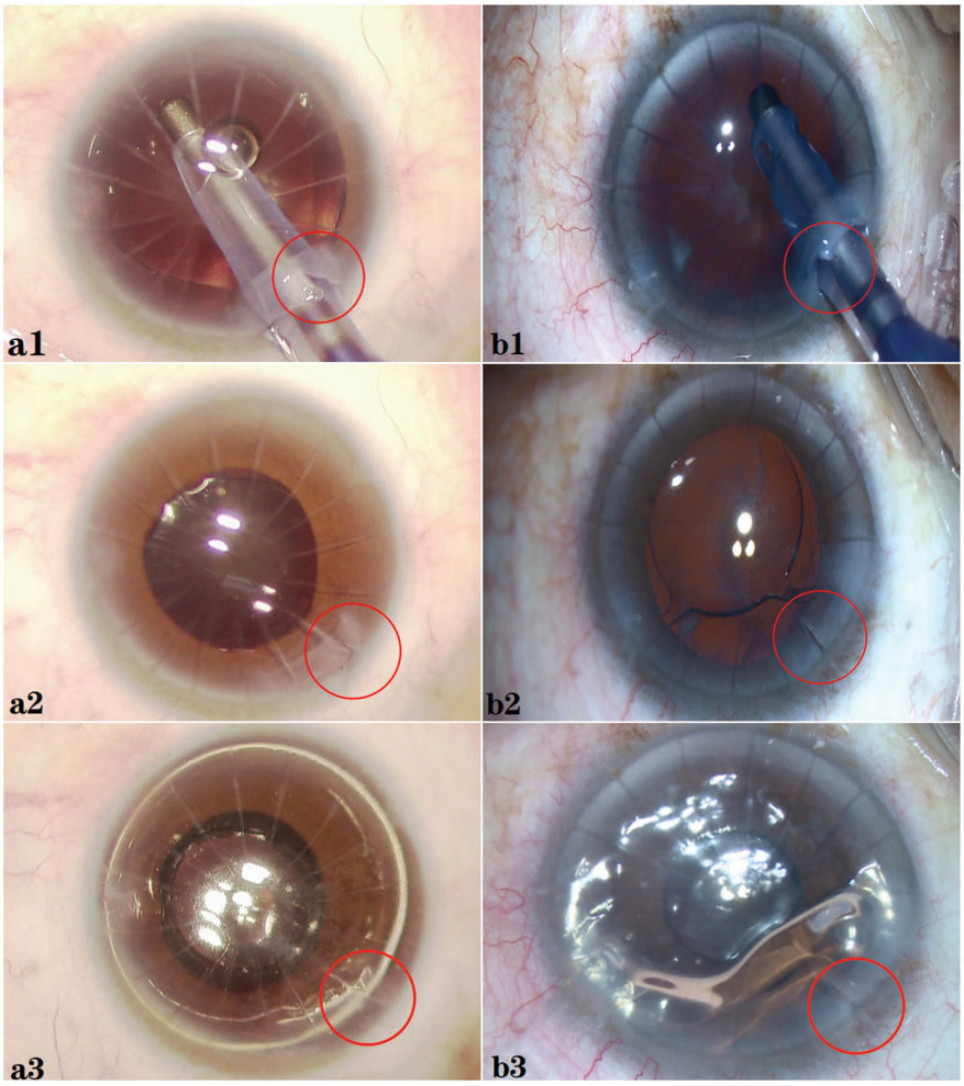

Figure 2. (a1, b1) Radial keratotomy (RK) incision dehiscence during the surgery. (a2, b2) Corneal RK incision dehiscence after the device exited the anterior chamber. RK incision dehiscence managed with (a3) intracameral air bubble injection and with (b3) air bubble injection through a lateral incision after intracameral viscoelastic agent injection through the main incision.

without a viscoelastic agent (Figures 2 and 3). No new RK cut dehiscence occurred during the follow-up period.

Preoperatively, the mean uncorrected visual acuity was 1.23 ± 0.61 LogMAR (range, 0.4–2.7), and the mean BCVA was 0.72 ± 0.54 LogMAR (range, 0.4–1.3) (Table 1). The mean spherical equivalent was -12.81 ± 6.58 D (range, -20.00 to -2.00 D). The mean corneal astigmatism was 1.28 ± 0.78 D (range, 0.46–2.87 D). The mean corneal endothelial cell density was $2384.0 \pm 833.4/mm^2$ (range, 725.5–$3374.3/mm^2$). At 1 month postoperatively,

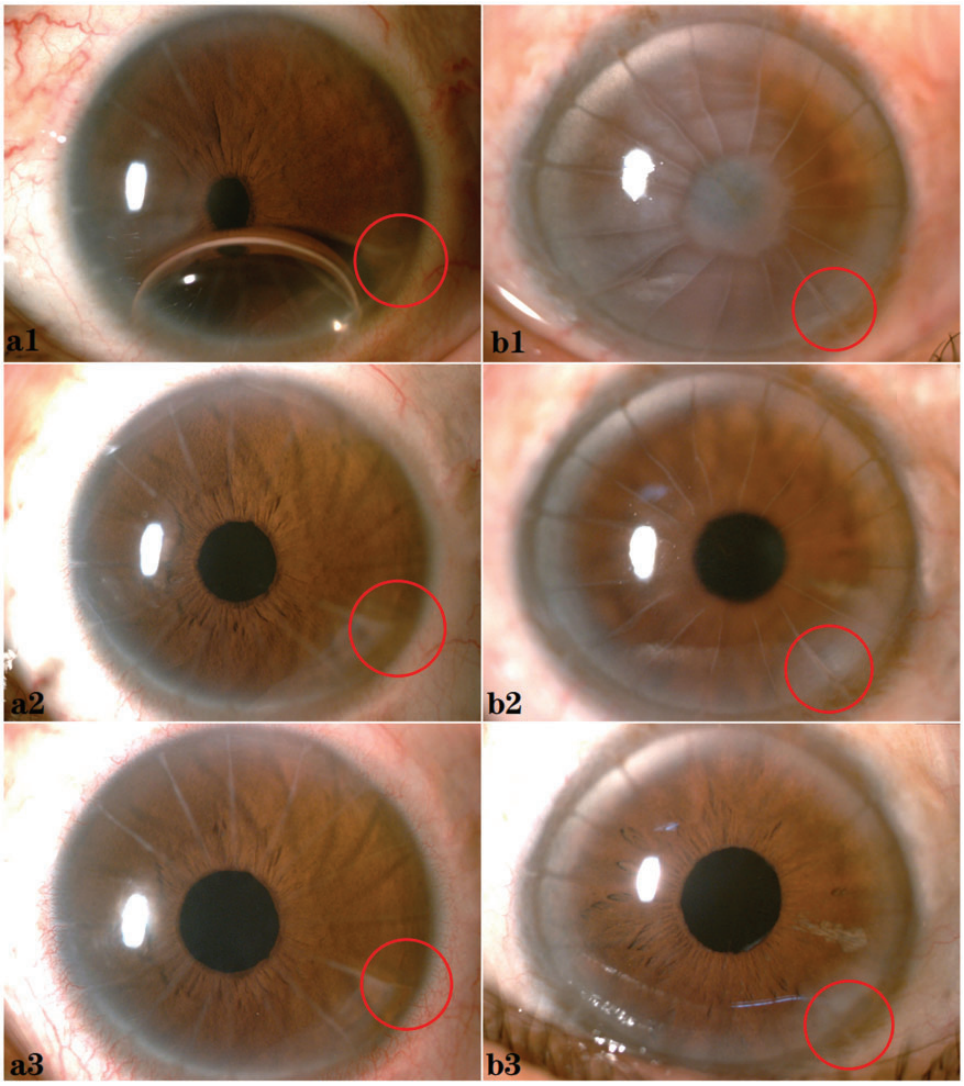

Figure 3. Follow-up on (a1, b1) first postoperative day, (a2, b2) first week, and (a3, b3) first month

the BCVA improved to 0.16 ± 0.12 LogMAR (range, 0.0–0.4) ($P < 0.001$). The mean spherical equivalent was -0.44 ± 1.10 D (range, -2.00 to 1.00 D). The mean postoperative corneal astigmatism increased to 2.29 ± 0.74 D ($P = 0.007$). The corneal endothelial cell density was $1670.51 \pm 919.76/mm^2$ ($P = 0.01$).

At the final follow-up (1–36 months postoperatively; mean, 13.4 ± 11.7 months), the uncorrected visual acuity was 0.3 ± 0.17 LogMAR (range, 0.1–0.7) ($P < 0.001$). The BCVA was 0.19 ± 0.13 LogMAR (range, 0.0–0.4) ($P < 0.001$). The spherical equivalent was -0.55 ± 0.94 D (range, -2.00 to 1.00 D). The corneal endothelial cell density ($1716.95 \pm 906.79/mm^2$) was significantly lower than the mean preoperative value ($P = 0.01$). The mean postoperative corneal astigmatism

Table 1. Visual outcome after transparent corneal phacoemulsification and intraocular lens implantation in patients with a history of radial keratotomy.

	Preop	One month postop	*P* value (vs. preop)	Final visit (mean, 13.4 months postop)	*P* value (vs. preop)
UCVA (LogMAR)	1.23 ± 0.61	0.33 ± 0.15	<0.001	0.3 ± 0.17	<0.001
BCVA (LogMAR)	0.72 ± 0.54	0.16 ± 0.12	<0.001	0.19 ± 0.13	<0.001
Astigmatism (D)	1.28 ± 0.78	2.29 ± 0.74	0.007	1.69 ± 1.23	0.47
Corneal endothelial cell density (/mm^2)	2384.0 ± 833.4	1670.51 ± 919.76	0.01	1716.95 ± 906.79	0.01

Data are presented as mean ± standard deviation.
Preop, preoperative; Postop, postoperative; UCVA, uncorrected visual acuity; BCVA, best-corrected visual acuity.

(1.69 ± 1.23 D) was comparable with the preoperative value.

Discussion

The results of the present study suggest that phacoemulsification can be successfully performed through a transparent corneal incision in eyes with previous RK cuts. In the present case series, two patients with 16 RK cuts developed wound dehiscence. No patient developed postoperative wound leakage.

Budak et al.[8] described a patient with eight previous RK incisions in which phacoemulsification with a 3-mm transparent corneal incision was performed consecutively on both eyes 9 to 10 months after a bilateral RK procedure. Interestingly, the surgery was uneventful in one eye, while the fellow eye developed intraoperative RK incision dehiscence. Behl and Kothari[9] also reported a case of intraoperative dehiscence of an RK incision during a 3.2-mm transparent corneal phacoemulsification procedure 11 years after a bilateral RK procedure, while the clinical course of the fellow eye was uneventful. Freeman et al.[10] reported another case of intraoperative RK incision dehiscence during transparent corneal phacoemulsification 14 years after an RK procedure, while the clinical course in the fellow eye was uneventful. Song and Tang[12] reported a case of intraoperative RK incision dehiscence during a transparent corneal phacoemulsification 20 years after a bilateral RK procedure with 18 to 20 cuts. In the fellow eye, a corneoscleral incision phacoemulsification was performed with no complications. Zhang et al.[14] reported one case with intraoperative RK incision dehiscence during a 3-mm transparent corneal phacoemulsification procedure 30 years after RK. Day and Seward[11] reported a case with no intraoperative dehiscence of the RK incisions during transparent corneal phacoemulsification 9 years after the RK procedure. However, wound leakage was observed in two RK incisions on the first postoperative day.

Wound dehiscence in post-RK eyes may be related to the main phacoemulsification wound intersecting the RK incisions. Another possible factor is the interval between RK and cataract surgery. Corneal wound healing after RK can take up to 47 months.[15–18] In our cases, the mean interval between RK and cataract surgery was well beyond 47 months.

Nevertheless, we noted dehiscence in two eyes with 16 previous RK incisions. The leaks were managed with intracameral air and viscoelastic agent injections. We believe that this is a new treatment method for incision dehiscence in cataract surgery in eyes

with a history of RK. RK incision dehiscence can be treated by an intracameral air bubble with or without viscoelastic agent injection and does not require sutures. This method has a shorter operation time than suturing and avoids the uncomfortable feeling and potential corneal astigmatism caused by sutures after surgery.

We also observed a decrease in the endothelial cell density. This is similar to routine phacoemulsification,[19] and several possible reasons are as follows. First, all patients with previous RK had high myopia, which itself might damage the endothelium. Second, the RK procedure might have affected the endothelium before cataract surgery. Third, the duration of the cataract surgery was relatively long because of the corneal incision dehiscence. All of these factors might contribute to endothelial cell loss in eyes with a history of RK.

Based on our experience with the patients in this case series, we recommend that for patients with a history of RK, the transparent corneal incision should be performed between two RK incisions and as far as possible from the RK incisions. The anterior chamber should not be overfilled with ophthalmic viscoelastic agent to avoid the risk of dehiscence of the RK cuts. High pressure should be avoided during hydrodissection, and the bottle height should be monitored.

The results from our case series showed that a 3.2-mm transparent corneal phacoemulsification incision can be safely performed for post-RK eyes with good recovery of visual acuity. Transparent corneal incision placement is a safe treatment option if the transparent corneal incision does not intersect two adjacent RK incisions. Intersecting the RK cuts with a phacoemulsification incision may result in wound dehiscence. RK incision dehiscence can be treated by intracameral sterile air injection with or without viscoelastic agent injection and does not require suturing. In eyes with 12 or more RK cuts, a smaller transparent corneal incision may be more effective.[20]

Conclusion

The phacoemulsification wound should be carefully positioned in eyes with a history of RK. Surgeons should be aware of the risk of wound dehiscence in these patients. RK incision dehiscence can be treated by an intracameral sterile air bubble with or without viscoelastic agent injection and does not require suturing. A small transparent corneal incision or scleral tunnel incision is also recommended.

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Data availability

All original clinical data from this study can be found in the medical records room of Beijing Tongren Hospital.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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