

Transepithelial phototherapeutic keratectomy for post-traumatic recurrent corneal erosions

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Purpose: To evaluate the outcomes of transepithelial phototherapeutic keratectomy (transepithelial PTK) for treatment of posttraumatic recurrent corneal erosions. **Methods:** Twenty-four eyes of 22 patients with posttraumatic recurrent corneal erosions who were treated with transepithelial PTK from April 2018 to July 2020 were included in this retrospective study. The rates of recurrent erosions and complications were evaluated during the follow-up after surgery. Visual acuity and refraction were recorded preoperatively and 1 year after surgery. Total corneal astigmatism, total corneal irregular astigmatism, and total corneal spherical aberrations were recorded using corneal tomography preoperatively and 1 year after surgery. **Results:** Mean postoperative follow-up was 13 months (range: 12–32 months). None of the patients suffered from any complications or further erosions. Uncorrected distance visual acuity, best-corrected distance visual acuity, spherical equivalent, and cylinder remained stable at 1-year postoperatively compared with the baseline ($P = 0.214$, $P = 0.461$, $P = 0.084$, and $P = 0.879$, respectively). Moreover, there was no significant difference in total corneal astigmatism, total corneal irregular astigmatism, and total corneal spherical aberrations between baseline and 1-year postoperative visit ($P = 0.938$, $P = 0.136$, and $P = 0.981$, respectively). **Conclusion:** Transepithelial PTK was an effective treatment for patients with posttraumatic recurrent corneal erosions.

Key words: Posttraumatic, recurrent corneal erosions, transepithelial phototherapeutic keratectomy

Recurrent corneal erosion syndrome is characterized by a disturbance at the level of the corneal epithelial basement membrane, resulting in poor adhesion and recurrent breakdown of the corneal epithelium.^[1] Patients with recurrent corneal erosions suffer from repeated episodes of sudden severe pain accompanied by tearing, blurred vision, and photophobia, usually at night or upon awakening.^[1] A variety of treatments are available for recurrent corneal erosions. The first line of treatment of recurrent corneal erosions includes lubricating ointments, pressure bandages, or therapeutic contact lenses.^[2,3] In refractory cases, surgical treatments such as epithelial debridement,^[2] anterior corneal stromal puncture,^[4] superficial keratectomy with a diamond burr,^[5] alcohol delamination,^[6] and excimer laser phototherapeutic keratectomy (PTK)^[7] are recommended.

PTK has been performed for more than 20 years.^[8,9] Conventional PTK may lead to a hyperopic shift because of the uniform corneal ablation between central and peripheral zone.^[10] Compared to PTK, transepithelial PTK is an all laser, single-step method to ablate the epithelial and superficial stroma layer without mechanical or chemical debridement techniques.^[11]

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This procedure is performed in “TransPTK” mode using the AMARIS excimer laser system (SCHWIND6.1, GERMANY). The treatment zone is designed as an 8-mm-diameter circle centered on the corneal vertex, and the central of corneal ablation and peripheral ablation was designed for different depths. The software default value used 55 μm in the center and cumulative 65 μm @ 8 mm diameter for epithelial ablation. There are a few reports of transepithelial PTK for treatment of recurrent corneal erosions.^[12,13] The purpose of this study was to evaluate the efficacy of transepithelial PTK for posttraumatic recurrent corneal erosions.

Methods

The study protocol was approved by the Ethics Committee for Human Research at the Joint Shantou International Eye Center of Shantou University and the Chinese University of Hong Kong, which is in accordance with the tenets of the Declaration of Helsinki. The date of the approval is 12/6/2019 and the approval number was EC 20190612 (3)-P08. A total of 24 eyes of 22 patients (male: female ratio = 13:9) with posttraumatic recurrent corneal erosions treated by transepithelial PTK from April 2018 to July 2020 were included in this study. Patients who complained of repeated episodes of sudden severe pain (four or more episodes within 1 year, more than two consecutive

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years) following a past history of trauma with abnormal corneal reepithelialization, and failed pharmacological treatment were included in this study. Patients were excluded during an acute attack of recurrent corneal erosions or suffer from another trauma.^[13]

Follow-up visits were scheduled at the first day and then every other day after the surgery until complete corneal reepithelialization. Subsequent follow-up visits were scheduled on 1 and 2 weeks and 1, 2, 3, 4, 6, and 12 months postoperatively, and every year thereafter. The mean time for corneal reepithelialization was defined as the average number of days required for reepithelialization. The preoperative and 1-year postoperative ophthalmic examination included uncorrected and best-corrected distance visual acuity (BDVA), manifest refraction, intraocular pressure (noncontact tonometer, CANON, JAPAN), slit lamp, and dilated fundus evaluation. Corneal topography (OCULUS PENTACAM, GERMANY) was used to evaluate corneal astigmatism and spherical aberrations.

Transepithelial phototherapeutic keratectomy (transepithelial PTK)

All transepithelial PTK procedures were performed by the same ophthalmologist. Patients underwent transepithelial PTK minimum 1 week after the last erosion healed. Surgery was performed in “TransPTK” mode using the AMARIS excimer laser system (SCHWIND6.1, GERMANY). The central of corneal ablation was designed for about 75 μ m depth, and the maximum peripheral ablation was designed for about 95 μ m depth. The system automatically set different depths of peripheral ablation to fit the cornea surface.

Perioperative management

Topical 0.5% levofloxacin eye drops (four times a day; Santen, Japan) were administered for 3 days before surgery. At the end of the procedure, a bandage soft contact lens was placed on the eye and removed after 1 week. Postoperatively, the patients were treated with topical 0.5% levofloxacin eye drops (four times a day until epithelial closure; Santen, Japan), sodium hyaluronate eye drops (four times daily; Hycosan, EUSAN GmbH, Germany), and 0.1% fluorometholone eye drops (four times daily for the first week, three times daily for the second week, twice daily for the third week, once daily for the last week; Santen, Japan).^[14]

Statistical analysis

All data were tested for normal distribution (Shapiro–Wilks test). The Wilcoxon rank sum test was used for pairwise

analyses. A *P* value less than 0.05 was considered statistically significant. Statistical analyses were performed using SPSS for windows version 22.0 (SPSS Inc., Chicago, IL, USA).

Results

All patients underwent transepithelial PTK for recurrent corneal erosions, with a mean follow-up of 13 months (range: 12–32 months) postoperatively. The mean time until corneal reepithelialization was 4.12 ± 0.95 days. None of the patients had further corneal erosion, or any other complications, especially corneal haze [Fig. 1].

Visual outcomes

Table 1 shows the visual and refractive parameters preoperatively and 1 year after transepithelial PTK. Uncorrected distance visual acuity (UDVA) and BDVA remained stable after transepithelial PTK ($P = 0.214$ and $P = 0.461$, respectively). Spherical equivalent and refractive cylinder did not change significantly 1 year postoperatively ($P = 0.084$ and $P = 0.879$, respectively).

Corneal topography outcomes

Total corneal astigmatism, irregular astigmatism, and corneal spherical aberrations did not increase 1 year after transepithelial PTK. None of the differences between baseline and 1-year postoperatively were statistically significant ($P = 0.938$, $P = 0.136$, and $P = 0.981$, respectively) [Table 2].

Discussion

Recurrent corneal erosions impair the quality of life and ability to work. It is speculated that defect in hemidesmosomes and poor anchoring fibrils formation was the reason of abnormal adhesion between corneal epithelium and epithelial basement membrane.^[1] Reidy *et al.*^[2] reported the recurrence rates of 18, 40, and 25%, after epithelial debridement, anterior stromal puncture, and superficial keratectomy, respectively. These surgeries may induce postoperative scarring with an impact on visual quality.^[5,15] Singh *et al.*^[16] reported 15 eyes of 18 patients (83%) who remained free of symptoms after alcohol delamination. Excimer laser is a known treatment for recurrent corneal erosions. It works by ablation of corneal tissue with minimal adjacent tissue damage.^[1] PTK is performed with manual removal of the loosely adherent epithelium, followed by ablation of the abnormal basement membrane and superficial stroma using excimer laser (193 nm).^[17] A 10-year study showed that recurrence of painful corneal erosions occurred in 6 eyes (23.07%) after PTK, which required a PTK

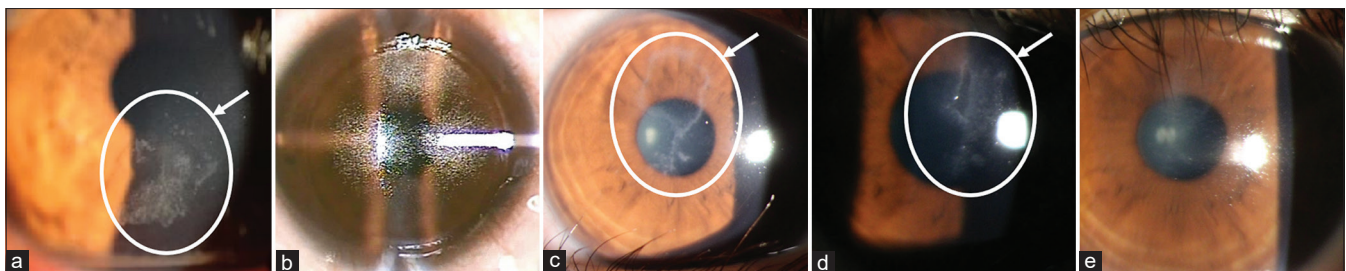


Figure 1: Preoperative and postoperative slit-lamp images of an eye with recurrent corneal erosions. (a) Recurrent corneal erosions during an acute attack, the area with the erosion is marked with a white arrow. (b) First time after the procedure of transepithelial PTK. (c) One day after transepithelial PTK, a white arrow indicates the healing of ablated area toward the center. (d) Three days after transepithelial PTK; the defect area becomes smaller gradually. (e) Five days after transepithelial PTK; the ablated cornea healed without any complications

Table 1: Visual acuity and refraction parameters preoperatively and 1-year after transepithelial phototherapeutic keratectomy [M(Q₁, Q₃)]

Time point	UDVA (LogMAR)	BDVA (LogMAR)	SE (D)	Cylinder (D)
preop	-0.22 (-0.49, -0.10)	0 (-0.03,0)	-0.69 (-1.38, -0.13)	-0.50 (-0.75,0)
1-year	-0.22 (-0.60, -0.02)	0 (-0.05,0)	-0.81 (-1.44, -0.28)	-0.50 (-0.75,0.06)
P	0.214	0.461	0.084	0.879

Note: preop=preoperatively, 1-year=1 year postoperatively, UDVA=uncorrected distance visual acuity, BDVA=best-corrected distance visual acuity, SE=spherical equivalent, Cylinder=refractive cylinder, LogMAR=logarithm of the minimum angle of resolution

Table 2: Corneal topography measurements preoperatively and 1-year after transepithelial phototherapeutic keratectomy [M(Q₁, Q₃)]

Time point	Total corneal astigmatism (D)	Total corneal irregular astigmatism (D)	Total corneal spherical aberrations (D)
preop	-0.60 (-1.35, -0.40)	0.20 (0.16, 0.33)	0.21 (0.09, 0.24)
1-year	-0.80 (-1.15, -0.50)	0.18 (0.14, 0.27)	0.18 (0.07, 0.27)
P	0.938	0.136	0.981

Note: preop=preoperatively, 1-year=1-year postoperatively, total corneal astigmatism (4 mm zone), total corneal irregular astigmatism (6 mm zone), total corneal spherical aberrations (4 mm zone)

retreatment. The mean change in spherical equivalent manifest refraction was $+0.08 \pm 0.30$ D compared to the preoperative refraction.^[17]

The safety and efficacy of transepithelial photorefractive keratectomy has been established for myopia.^[18] Instead of mechanical or chemical epithelial debridement techniques, using an excimer laser to ablate both the corneal epithelium and stroma results in less pain, less postoperative haze, and a shorter healing time.^[19,20] Holzer *et al.*^[13] performed transepithelial PTK in 25 eyes of 25 patients with recurrent corneal erosions. The authors used autologous serum eye drops in the postoperative period. Five eyes had one erosion after surgery. However, the authors did not specify the corneal healing time. In our retrospective study, none of the patients had corneal haze or recurrence of corneal erosion during the follow-up period. Furthermore, the time of corneal epithelial renewal (4.12 ± 0.95 days) in our study was less than 1 week. It was suggested that the short healing time was associated with the use of excimer laser and the absence of alcohol-related surface toxicity.^[20,21] Previous research had compared epithelial healing time of transepithelial photorefractive keratectomy and conventional photorefractive keratectomy (alcohol assisted) for correction of myopia, which found that transepithelial photorefractive keratectomy was associated with shorter epithelial healing time than conventional photorefractive keratectomy (2.5 ± 0.6 days versus 3.7 ± 0.8 days, $P = 0.01$).^[20] In addition, the visual and refractive outcomes in our study population were very predictable. There was no significant hyperopic shift in our patients. The ablation pattern in transepithelial PTK fits the overall anatomic shape of the cornea and minimizes the refractive shift related to the differential ablation in peripheral and central cornea.^[11] Furthermore, in our study, the results of corneal topography revealed no significant increase in corneal spherical aberrations, total corneal astigmatism, or irregularities after transepithelial PTK, which were attributed to regularization of the anterior corneal surface.^[12]

The main limitations in this study include its retrospective design and small sample size. Nevertheless, our results demonstrate that transepithelial PTK is an effective treatment

for recurrent corneal erosions. The role of laser in recurrent corneal erosions has been attributed to stimulation of basal membrane cells to regenerate and strengthen cell adhesions. Another hypothesis is that acoustic shock waves from the laser beam reinforce bindings between epithelial cells and Bowman's layer.^[22] Future studies can compare transepithelial PTK with conventional PTK and other surgical techniques for the management of recurrent corneal erosions.

Conclusion

The results of our study show that no evident complications were observed following transepithelial PTK, and the patients were free of recurrence during the follow-up. Above all, visual acuity, refractive status remained stable after surgery. In conclusion, transepithelial PTK provides an effective treatment option for patients with posttraumatic recurrent corneal erosions.

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Conflicts of interest

There are no conflicts of interest.

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