

Excimer Laser Phototherapeutic Keratectomy for Recurrent Corneal Erosions

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Abstract

The purpose of this paper was to review the Singapore National Eye Centre's (SNEC) experience with excimer laser phototherapeutic keratectomy (PTK) for treating recurrent corneal erosions (RCE).

Thirty-five eyes of 32 patients who had PTK between 1992 and 1997 in SNEC were studied retrospectively. There was a history of previous ocular trauma in 15 eyes. Sixteen eyes had anterior corneal dystrophy. All had received conventional therapy without improvement in symptoms. The mean duration of symptoms prior to PTK was 19 months (range 1 to 71 months). PTK was performed with one of two 193 nm excimer lasers (Summit UV200LA, Summit Technology, Waltham, USA or Visx 20/20B, Visx Corp, Santa Clara, USA). An average of 30 laser pulses were delivered to Bowman's membrane after debridement of the corneal epithelium.

The mean follow-up time was 12 months (range 0 to 56 months). Among those with adequate length of follow-up, 26/27 eyes (96%) were symptom-free for 3 months, 19/22 eyes (86%) were symptom-free for 6 months and 9/13 eyes (69%) were symptom-free for 1 year. Three eyes had repeat PTK. Mild corneal haze was seen in 3 eyes. No visually threatening complications were encountered.

PTK is a safe and effective procedure for RCE refractory to conventional treatment.

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Introduction

Recurrent corneal erosion (RCE) syndrome is a commonly encountered clinical condition which may be difficult to treat. Hansen first described it in 1872.¹ Clinically, the patient experiences recurrent episodes of acute pain, lacrimation and photophobia on waking up from sleep.^{2,4} This may occur following superficial corneal trauma such as a fingernail scratch² or spontaneously, when it is frequently associated with anterior corneal dystrophies,^{3,4} such as map-dot-fingerprint dystrophy, Reis-Buckler's dystrophy, lattice and granular dystrophy.

The basic defect in recurrent erosion syndrome is thought to be a disturbance in the adherence mechanism of the corneal epithelium to the underlying corneal stroma that results in the erosive events. The imperfect adherence is thought to be due to abnormalities in the basement membrane of the corneal epithelium.^{4,6}

The majority of cases responded to conventional therapy with lubricant ointments and/or hypertonic saline eyedrops.^{3,4} Therapeutic contact lenses have been found to be helpful in some cases resistant to lubricants,

especially those with anterior membrane dystrophies and spontaneous recurrent erosion syndrome.⁷ Various surgical techniques such as epithelial debridement, chemical cauterization and anterior stromal micropuncture have been recommended for cases resistant to medical therapy.⁷ However, a significant number of patients may suffer recurrences despite these treatment.

With the advent of excimer lasers in the mid-1980s, excimer laser phototherapeutic keratectomy (PTK) has become a new modality of treatment for superficial corneal pathologies.⁸ Encouraging results have been reported in several series for the treatment of recurrent corneal erosions.⁹⁻¹³ The advantage of this laser derives from its unique ability to remove corneal tissue with extreme precision and minimal collateral damage.^{8,14-16} In addition, large laser beam cross sections, typically several millimetres in diameter, allow simultaneous treatment of wide areas of the cornea.

In this study, we report the Singapore National Eye Centre's (SNEC) experience with excimer laser PTK for the treatment of recurrent corneal erosions in a series of 35 eyes over 4 years from December 1993 to December 1997.

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Patients and Methods

Patients

Thirty-five eyes of 32 patients were treated. The mean age of the patients was 38 years (range 21 to 63 years). Twenty were females and 12 were males. The mean duration of symptoms prior to PTK was 19 months (range 1 to 71 months). All patients had more than one episode of acute erosion despite at least one month of treatment with lubricants and ointments by an ophthalmologist, before PTK was considered. Similar criteria of failed conventional treatment were also used in earlier studies when evaluating alternative modes of therapy such as bandage contact lens⁷ or anterior stromal puncture.¹⁷ All 35 eyes had received lubricant ointments without relief. Some were treated unsuccessfully with other modes of therapy including therapeutic contact lens, epithelial basement membranectomy, cauterization and anterior stromal puncture. More than 10 eyes had received 2 or more forms of conventional treatment without success (Fig. 1). Fifteen eyes had a previous history of superficial ocular trauma, of which 5 also had anterior corneal dystrophy. Eleven eyes had map-dot-fingerprint corneal dystrophy. Three eyes had lattice dystrophy and 2 had granular dystrophy (Fig. 2).

Excimer Laser

PTK was performed by six different surgeons with one of two 193 nm excimer lasers (Summit UV200LA, Summit Technology, Waltham, USA or Visx 20/20B, Visx Corp, Santa Clara, USA). The Summit UV200LA excimer laser was used from December 1993 to December 1994. Thereafter, the Visx 20/20B excimer laser was used. Each surgeon performed PTK on between 1 to 20 of the 35 eyes in this study.

Surgical Technique

Preoperatively, a topical anaesthetic was instilled in the eye. The patient was placed in a supine position under the laser and instructed to look at the fixation

light. A lid speculum was inserted. The corneal epithelium was then removed with a dry sponge to expose Bowman's membrane. This technique had the advantage of identifying areas of abnormal, poorly adherent epithelium and therefore the area to be treated, as the loose epithelium came off easily with the dry sponge. Alternatively, a #64 Beaver blade was used to remove the epithelium. A mean of 30 laser pulses (range 10 to 63) was then applied to Bowman's membrane depending on the extent of pathology. More pulses were used in cases of granular and lattice dystrophies where more extensive areas needed treatment. The diameter of the ablation zone was 5 or 6 mm depending on the excimer laser used. Most surgeons used a "roving" method of laser application. The central cornea was treated with a single ablation zone of 5 to 6 mm to avoid creation of an ablation edge over the visual axis. When required, the corneal periphery was then treated by a "roving" ablation technique using overlapping circular ablation zones of 5 to 6 mm.

Postoperative Management

Postoperatively, all patients received an antibiotic ointment and the eye was padded until complete re-epithelialisation of the cornea. Topical steroid eyedrops were then used from 1 to 4 weeks. In 21 eyes, a bandage contact lens was used to aid re-epithelialisation of the cornea. This was removed once epithelialisation was complete.

Results

The mean follow-up time for our patients was 12 months (range 0 to 56 months). Only 1 patient had less

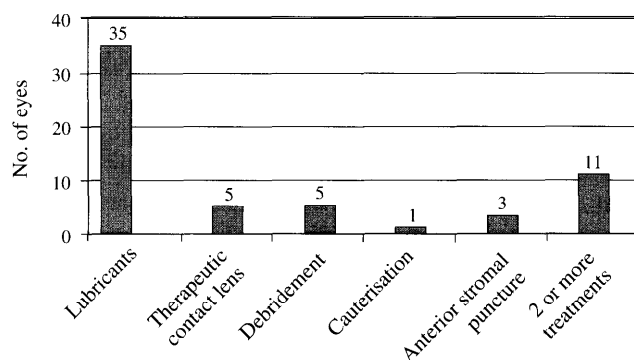


Fig. 1. Number of eyes with conventional therapies before excimer laser phototherapeutic keratectomy. All eyes were previously treated with lubricants, and 11 eyes were given 2 or more other modalities of treatment after lubricant therapy failed.

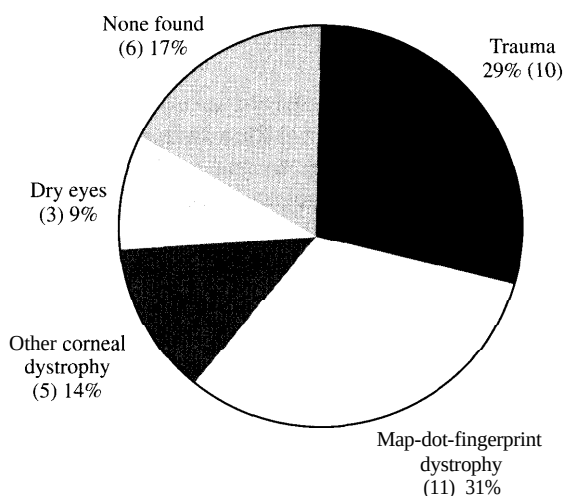


Fig. 2. Underlying causes of recurrent corneal erosions. The majority of eyes had either trauma or map-dot-fingerprint dystrophy as the cause of RCE. Actual number of eyes in brackets.

than a month follow-up as he defaulted 1 week after PTK, after the corneal epithelium had healed. Overall, 74% of eyes (26 of 35 eyes) were free of symptoms of acute recurrent erosions throughout follow-up. For a more stringent assessment of the efficacy of treatment, we evaluated the success rate at various lengths of follow-up postoperatively. Among eyes with adequate follow-up, 26 of 27 eyes (97%) were symptom-free for 3 months postoperatively; 19 of 22 eyes (86%) were symptom-free up to 6 months of follow-up; and 9 of 13 eyes (69%) were symptom-free for 1 year (Fig. 3).

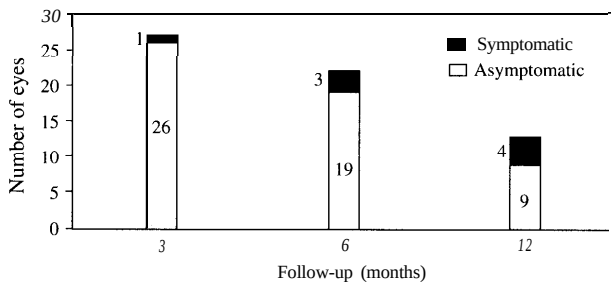


Fig. 3. Outcome of excimer phototherapeutic keratectomy treatment—26 out of 27 (96%) eyes were symptom-free at 3 months after PTK; 9 out of 13 (69%) eyes were symptom-free 12 months after PTK.

Three eyes had a repeat PTK for recurrence of the corneal erosion syndrome. Two of the retreated eyes were symptom-free on follow-up, while 1 had a recurrence at 3 months which responded to ointment and padding in the acute stage, and was symptom-free for the subsequent 10 months of follow-up.

Refraction data did not show any significant change in postoperative manifest refraction exceeding 1 dioptre in spherical equivalent. There was minimal, visually insignificant corneal haze in 3 eyes.

After PTK treatment, some patients had minor early morning irritations that quickly resolved. These were suggestive of micro-erosive episodes and examination of a few of these patients on symptomatic days did not reveal any epithelial defects. Although they did not represent true recurrences, some patients might be mildly symptomatic for a few months postoperatively.

No other complications such as persistent epithelial defects, infective keratitis, iritis or increased intraocular pressure were encountered in our patients.

Discussion

The results of PTK for recurrent corneal erosions on the first 35 eyes performed in our centre were encouraging. This procedure offers great potential in the treatment of cases resistant to conventional therapy. The overall success rate of 74% in our series is similar to those of other authors: Dausch et al⁹ (74%), O'Brart et al¹¹ (76%)

and Fagerholm et al¹⁸ (84%). In Fagerholm's study, all eyes had post-traumatic, therapy-resistant recurrent corneal erosions, while in O'Brart's study, 60% of the patients had post-traumatic erosions and 40% had spontaneous erosions, of which only 1 patient was given the diagnosis of Cogan's map-dot-fingerprint dystrophy. In our study, however, 45% of the patients had anterior corneal dystrophies (Fig. 2) comprising 31% map-dot-fingerprint and 14% granular or lattice dystrophies, and these accounted for 56% of the recurrences. Twenty-two per cent of the recurrences had map-dot-fingerprint dystrophy and 33% of the recurrences had granular or lattice dystrophy, although the latter group comprised only 14% of all study patients. Hence, for post-traumatic erosions, our recurrence rate was actually lower, the overall success being 80%.

In the treatment of recurrent erosions with PTK, laser ablation does not need to extend beyond Bowman's layer as the pathology lies within the epithelial basement membrane. Hence, treatment is limited and more superficial compared to PTK for corneal scars and irregularities, in which the treatment often needs to extend up to the anterior corneal stroma where most of the pathology lies. As a result, PTK for erosions is less likely to cause corneal haze and hyperopic shifts that are associated with greater depths of corneal ablation as in PTK for corneal scars.

Complications in this study were minimal and limited to visually insignificant haze in 3 eyes. Due to the limited ablation depth (average of 30 pulses used in PTK), complications which have been reported after excimer laser keratectomy such as corneal clarity disturbances^{19,20} and refractive shifts^{8,18,21,22} did not occur. Previously reported complications such as reactivation of herpes simplex keratitis,²²⁻²⁴ delayed re-epithelialisation²³ of more than 7 days and bacterial keratitis²² were not encountered in our series.

In the past, commonly used modalities of treatment for RCE not responsive to ocular lubricants included therapeutic contact lenses and anterior stromal puncture. Therapeutic contact lenses are associated with several problems including the small but definite risk of infective keratitis,²⁵ need for frequent change of lenses, recurrence when lens is removed and inability of the patient to tolerate the contact lenses, especially during an acute erosive episode.^{7,25} Anterior stromal puncture with a hypodermic needle^{3,17} or a Nd:YAG laser²⁶ has a high success rate and is easy to perform at very low cost. The microincisions through Bowman's membrane create direct contact between the corneal epithelium and the stroma, leading to the production of new epithelial basement membrane and a fibrotic reaction in the anterior stroma. This results in a stronger adhesion between the corneal epithelium and the stroma.²⁷ However, anterior stromal scars^{26,27} after this procedure may affect

visual acuity especially after extensive treatment in the visual axis. There is also a risk of corneal perforation and localised endothelial damage, particularly with the use of small gauge needles.²⁷

The exact underlying mechanism of action of excimer laser photoablation in the treatment of recurrent corneal erosions is still unknown. However, histological examination of monkey corneas after excimer laser photoablation has shown increased hemidesmosomes and type VII collagen (a major component of anchoring fibrils) along the epithelial basement membrane.²⁸ Re-establishment of the basement membrane of epithelial cells was associated with undulations into the corneal stroma which were retained up to 8 months post-exposure.²⁰ A human study has shown that the basal epithelial layer forms new basement membrane within 2 weeks of photoablation with excursions and undulations of epithelial cells into the corneal stroma,¹⁹ which would greatly increase the surface area of attachment. These ultrastructural changes are believed to result in improved adhesion between the corneal epithelial cells and the underlying stroma, preventing further erosive events.

Excimer laser PTK appears to be safe and effective in the treatment of recurrent corneal erosions. Although the cost of the laser facility is high compared to traditional treatments, the excimer laser is becoming increasingly available in many ophthalmic centres due to its widespread use in refractive surgery. The efficacy and benefits of excimer treatment of RCE significantly outweigh the risks and disadvantages. As such, excimer laser PTK has become our Centre's treatment modality of choice for RCE refractory to primary treatment with ocular lubricants.

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