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Clinical course and risk factors of recurrent corneal erosion

Observational study

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Abstract

Recurrent corneal erosion (RCE) is a common disorder causing ocular pain, tearing, photophobia, and visual impairments. Various factors such as ocular trauma, ocular surgery, corneal dystrophy, contact lens wear, and diabetes mellitus (DM) can cause RCE. The purpose of this study was to determine the causative factors and clinical course of RCE.

We retrospectively examined 21 eyes of 21 patients with RCE and investigated the patients' background, type of treatments, and clinical course after the treatments. All patients were treated with eye drops, ocular lubrication, or contact lens bandage for the RCE.

Among the 21 patients with RCE, 9 were caused by trauma (Trauma group), 8 by DM (DM group), 1 by bacterial corneal ulcer, 1 by lagophthalmus and bacterial corneal ulcer, 1 by bandkeratopathy, and 1 by eyelid tumor (one eye). The mean age of the patients was 57.8 years with a range 34–91 years. The mean duration from the trauma to the onset of RCE was 5.2 ± 5.0 months (mean ± SD). The time required for a complete recovery of RCE was longer in the DM group (10.3 ± 3.1 weeks) than in the Trauma group (2.7 ± 1.1 weeks, $P < .01$). The presence of DM was significantly associated with the recovery duration of RCE ($r = 0.72$; $P < .01$). Multivariate analyses showed that the recovery duration of RCE was associated with the presence of DM (odds ratio = 139.8, $P = .04$). On the other hand, the type of treatments had no effect on the recovery duration of RCE.

These findings suggest that trauma and DM are important causes of RCE. Wound recovery after RCE may be delayed in patients with DM.

Abbreviations: AGEs = advanced glycation end products, DM = diabetes mellitus, ECM = extracellular matrix, OCT = optical coherence tomography, OR = odds ratio, RCE = recurrent corneal erosion, SCL = soft contact lens.

Keywords: diabetes mellitus, recurrent corneal erosion, trauma

1. Introduction

The recurrent corneal erosion (RCE) syndrome is a relatively common disorder worldwide. RCE is characterized by recurrent detachments of the corneal epithelium from damaged epithelial basement membranes. Patients with RCE experience repeated episodes of sudden onset unilateral ocular pain usually upon awakening or at night. This is because the adhesions between corneal epithelium and basement membrane may be weak. Epithelial basement membrane dystrophy, diabetes mellitus (DM), focal mechanical trauma to the corneal epithelium, and surgical trauma of the corneal epithelium are important risk factors for RCE.

Editor: Jui-Yang Lai.

The authors have no commercial or proprietary interest in the product or company described in the current article.

Study setting: Department of Ophthalmology, Teikyo University School of Medicine, Tokyo, Japan and Department of Ophthalmology, Tokyo Women's Medical University Medical Center East, Tokyo, Japan.

Sources of funding: This work was partly supported by a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

Conflicts of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and for writing this paper.

Trial Registration: This trial was approved by the regional ethics committee (2612) and was registered with the UMIN Clinical Trials Registry (UMIN000031421).

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Medicine (2019) 98:16(e14964)

Received: 14 September 2018 / Received in final form: 22 January 2019 / Accepted: 2 March 2019

http://dx.doi.org/10.1097/MD.0000000000014964

Table 1

Clinical profile of the patients with recurrent corneal erosion (RCE).

Patient	Age (yrs)	M/F	R/L	Ocular history	Systemic	Initial factor	Recurrence Duration	Recovery Duration	Medication
1	28	F	L	Trauma*	–	Fingernail	3M	2W	HA0.3 ABO
2	32	F	R	Trauma*	–	Fingernail	2M	2W	HA0.3 ABO
3	34	M	R	Trauma*	–	Metallic corneal foreign body	1M	1W	AT ABO SCL
4	37	F	R	Trauma*	–	Paper cut	6M	4W	HA0.3 ABO
5	38	F	R	Bandkeratopathy /FEVR	–	Band-keratopathy	1–3M	12W	HA0.3 ABO
6	39	F	L	Lagophthalmus Bacterial corneal ulcer	Facial palsy	Lagophthalmus	2–3M	8W	HA0.1 ABD ABO
7	42	M	R	Trauma*	–	Corneal abrasion by baseball	6M	4W	HA0.3 SCL
8	47	F	L	Trauma*	–	Tree branch	4M	3W	HA0.3 ABO
9	51	M	L	Bacterial corneal ulcer	Brain surgery/ Depression	Bacterial corneal ulcer	13M	3W	HA0.1 ABD
10	54	F	R	Trauma*	–	Eyelash extensions	1M	2W	AT ABO SCL
11	54	M	R	DR/PPV	DM	DM	3–6M	12W	HA0.3 ABO
12	56	M	L	Trauma*	–	Fingernail	3M	2W	AF ABO SCL
13	56	M	L	Trauma*/DR	DM/Angina pectoris	Trauma DM	3–6M	6W	ABD ABO
14	61	F	L	DR	DM	DM	4–6M	12W	HA0.3 SCL
15	66	M	R	DR	DM	DM	4–6M	8W	HA0.3 SCL
16	69	M	R	Trauma*	RA	Trauma	6–12M	4W	ABO
17	71	F	L	DR	DM	DM	2–5M	12W	HA0.1 ABO
18	75	M	R	DR	DM	DM	2–4M	8W	HA0.1 ABO
19	76	M	L	DR/PPV	DM	DM	4–6M	8W	HA0.3 ABO SCL
20	79	M	L	IOL	–	Corenalabration by eyelid tumor	12M	3W	ABO ABD
21	91	M	L	DR	DM	DM	2–4M	16W	HA0.1 ABO

Trauma* = Corneal erosion after trauma.

M/F = male/female; R/L = right eye/left eye; Recovery duration = duration of time for recovery (months); Recurrence duration = time to recurrence after recovery from corneal ulcer. ABD = antibiotic eye drops, ABO = antibiotic ophthalmic ointment, AT = artificial tear drops, DM = diabetes mellitus, DR = diabetic retinopathy, HA0.1 = hyaluronic acid 0.1% eye drops, HA0.3 = hyaluronic acid 0.3% eye drops, IOL = intraocular lens, M = month/months, PPV = after pars plana vitrectomy, RA = rheumatoid arthritis, SCL = use of bandage disposable soft contact lens, W = week/weeks.

A variety of treatment options are available for the management of RCE. The common management options for RCE are topical ointment, topical artificial tears, and therapeutic bandage contact lenses. There are also surgical options such ascorneal debridement, anterior stromal puncture, and amniotic membrane transplantation. There are many studies[1–3] and literature reviews[4–6] dealing with the RCE treatments. However, there have been few reports on the duration of symptoms and recovery of RCE.

Therefore, the purpose of this study was to determine the background factors associated with the development of RCE and the factor associated with the duration of recovery and recurrence of RCE for each causative factor.

2. Patients and methods

2.1. Study design

This was a review of the medical records of 21 patients who were diagnosed with RCE at the Tokyo Women's Medical University Medical Center East Hospital and the Teikyo University Medical Hospital. The procedures used in this study conformed to the tenets of the Declaration of Helsinki, and they were approved by the Institutional Review Board of Tokyo Women's Medical University (2612). All patients gave written informed consent for this study and publication.

2.2. Patients

Twenty-one eyes of 21 patients with a clinical diagnosis of RCE were enrolled when they presented to hospitals associated with Teikyo University School of Medicine or the Tokyo Women's Medical University Medical Center East. Their mean age was 57.8 ± 1.2 years (mean ± SD) with a range of 34–91 years (Table 1). The patients were evaluated daily until complete corneal reepithelialization was achieved. The RCE recovery duration was defined as the time from the onset of RCE to the complete resolution of RCE. The RCE recurrence duration was defined as the average recurrence interval of the time to recurrence after recovery from corneal ulcer including past episodes.

2.3. Statistical analyses

Student's unpaired *t*-tests were used to determine the significance of differences in the mean values between two groups, and Fisher's exact tests were used to determine the significance of differences in the frequencies of the different causes of RCE. The correlations were determined by Pearson's correlation analysis. Factors associated with the duration of time for recovery of RCE were investigated by multivariate logistic regression analysis. Statistical analyses were performed with SAS System software version 9.1 (SAS Institute Inc., Cary, North Carolina, USA), and a $P < .05$ was considered significant.

Table 2

Comparison between trauma and DM groups.

	Trauma group	DM group	*P* value
Number of patients	9	8	–
Male/female	4/5	6/2	.2178*
Age	44.3 ± 12.6 yr	68.8 ± 11.4 yr	.0007†
Duration of DM	–	17.9 ± 9.0 yr	–
Duration from trauma to the first RCE	5.2 ± 5.0 mo	–	–
Recurrence duration	3.9 ± 2.5 mo	4.2 ± 0.8 mo	.3789†
Recovery duration	2.7 ± 1.1 wk	10.3 ± 3.1 wk	.0001†

* Fisher's exact test.

† Student's unpaired *t*-test.

Duration from trauma to the first RCE: The duration from the first episode of trauma to the first onset of RCE (months).

Recovery duration: Duration of time for recovery (months).

Recurrence duration: Time to recurrence after recovery from corneal ulcer (months).

3. Results

The demographics of the patients with RCE are shown in Table 1. Among the 21 patients, 9 patients (42.9%) had a history of corneal erosion after minor trauma (Trauma group), and 8 patients (38.1%) had diabetes mellitus (DM group). There were no patients with epithelial basement membrane dystrophy or spontaneous recurrent corneal erosion. Comparisons of the clinical profiles between the Trauma and DM groups are shown in Table 2. The mean age was higher in the DM group than in the Trauma group (68.8 ± 11.4 vs. 44.3 ± 12.6, $P = .0007$, unpaired *t*-test). The mean interval between the trauma and the onset of RCE was 5.2 ± 5.0 months. There was no significant difference in the mean duration of each recurrence between the Trauma and DM groups (3.9 ± 2.5 months vs. 4.2 ± 0.8 months, $P = .3789$). On the other hand, the duration of the time for recovery was longer in the DM group (10.3 ± 3.1 weeks) than in the Trauma group (2.7 ± 1.1 weeks, unpaired *t*-test, $P = .0008$). The mean numbers of episodes of RCE per patient were 4.1 ± 1.3 (range 2–6) in the Trauma group and 5.8 ± 3.1 (range 3–11) in the DM group, and there was no significant difference between the two groups ($P = .1101$).

The type of eye drops and ointments were artificial tear drops ($n = 3$), hyaluronic acid 0.1% eye drops ($n = 5$), hyaluronic acid 0.3% eye drops ($n = 10$), antibiotic eye drops (Levofloxacin or moxifloxacin, $n = 4$), and antibiotic ophthalmic ointment (Ofloxacin ophthalmic ointment 0.3%, $n = 16$). Bandage disposable soft contact lens (SCLs) were used in 7 patients. The type of SCLs were 2-week disposable contact lenses (medalist plus, Bausch Health Companies Inc., Japan). We used Group 1 lenses, because Group 1 lenses (low water and non-ionic) are less likely to attract tear film debris. Oral doxycycline or corticosteroids eye drops were not used. Fundamentally, eye drops and antibiotic ophthalmic ointment were used. If the RCE did not improve within 1 week, SCL was used to treat prolonged RCE instead of ointment. The average time for SCL use was 3.1 ± 2.2 weeks.

The relationship between the recovery duration of RCE and the different background factors of the patients are shown in Table 3. The age of the patients and presence of the DM were significantly correlated with the recovery duration of RCE ($r = 0.49$, $P = .0115$, and $r = 0.72$, $P = .0001$, respectively; Table 3). Multivariate analysis showed that the duration of recovery of RCE was associated with the presence of DM (odds ratio (OR) = 139.8, $P = .0352$).

The correlation between the recovery duration of RCE and the selected treatments was not significant. Multivariate analyses showed no significant association between the recovery duration of RCE and the treatment protocols (Table 3).

3.1. Case presentations

3.1.1. Case 1. A 34-year-old male was injured in his right eye with a metallic corneal foreign body (Fig. 1A). The metal foreign body was completely removed using a 27-gauge needle and forceps under a surgical microscope (Fig. 1B). After the trauma, the patient experienced a sudden onset of severe ocular pain in the morning on a monthly basis for three months (Fig. 1C, D). Patient was treated with artificial tear drops and antibiotic ophthalmic ointment and a therapeutic SCL. The symptoms were ameliorated within 7 days. The patient continued to use artificial tear drops in the morning and antibiotic ophthalmic ointment at night. Then, he had no further episodes of RCE over a follow-up period of 12 months.

Table 3

Correlations and multivariate analysis of potential risk factors for recovery duration of RCE.

	Correlation analysis		Multivariate analysis		
Variable	***R* value**	***P* value**	**OR**	**(95% CI)**	***P* value**
Patients' backgrounds					
Age	0.49	.0115	1.0	(0.9–1.2)	.3666
Gender (Mail)	0.00	.5000	0.1	(0.0–1.3)	.0733
Bacterial corneal ulcer	0.13	.2916	24.2	(0.1–8244.7)	.2626
Trauma	−0.75	.9999	0.1	(0.0–10.6)	.3113
DM	0.72	.0001	139.8	(1.5–13201.5)	.0352
Treatments					
AT	−0.45	.9790	0.0	(0.0–57412.2)	.6342
HA0.1/HA0.3	0.34	.0657	2.0	(0.0–6884.8)	.8570
ABD	−0.14	.7271	0.1	(0.0–3183.8)	.6902
ABO	−0.30	.9097	0.0	(0.0–139.4)	.4151
SCL	−0.17	.7747	0.2	(0.0–762.9)	.6999

Pearson correlation and multivariate analysis of variance were used in the data analysis.

R value = two-tailed Pearson's correlation coefficient.

ABD = antibiotic eye drops, ABO = antibiotic ophthalmic ointment, AT = artificial tear drops, CI = confidence interval, HA0.1 = hyaluronic acid 0.1% eye drops, HA0.3 = hyaluronic acid 0.3% eye drops, OR = odds ratio, SCL = use of bandage disposable soft contact lens.

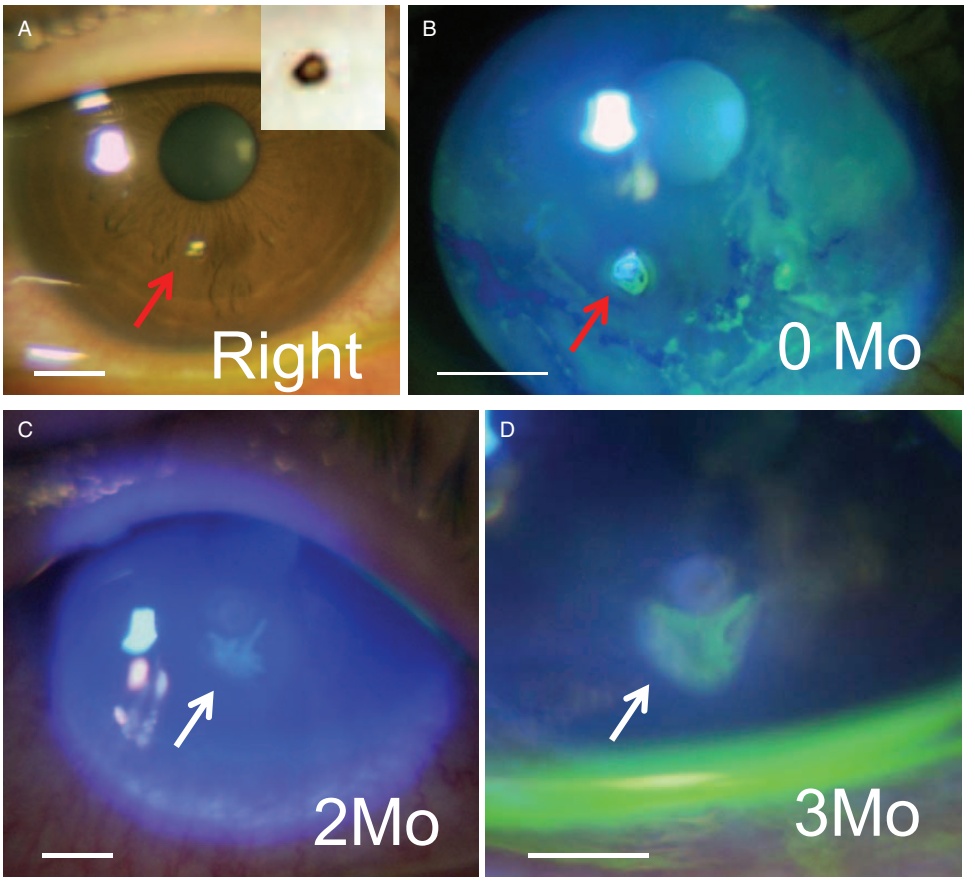

Figure 1. Case 1 (No. 3 in Table 1) was a 34-year-old male. Slit-lamp images of the left eye shows recurrent corneal erosion (RCE) by a foreign body. (A) and (B) A metallic foreign body can be seen embedded in the inferior cornea of the left eye. The foreign body was removed. Two (C) and three (D) months after the trauma. Thecorneal epithelial defectsare seen in the inferior cornea of the left eye. The corneal erosion is the same size and pattern. Bars = 2.0 mm.

3.1.2. Case 2. A 39-year-old woman presented with lagophthalmos in the left eye due to facial nerve palsy of 5 years duration. She experienced ocular pain, foreign body sensation, and blurred vision in her left eye in the mornings every 1–3 months for 2–8 weeks. She was diagnosed with RCE in the left eye (Fig. 2A). Bacterial cultures from corneal scrapings revealed *Moraxella lacunata*. She was treated with topical 0.1% hyaluronic acid, antibiotics (0.5% Vigamox; Alcon/Novartis, Tokyo, Japan), and antibiotic ophthalmic ointment (Tarivid ophthalmic ointment 0.3%, Santen Pharmaceutical Co., Ltd., Tokyo, Japan). The RCE gradually improved, and it was completely resolved 8 weeks after the therapy. However, a corneal opacity was still present (Fig. 2B).

3.1.3. Case 3. A 54-year-old woman had received eyelash extensions on both eyes for the first time at a beauty salon. On the next day, she complained of ocular pain and tearing along with photophobia in her right eye and visited our department. Slit-lamp examination revealed deep corneal abrasions on the temporal side of the right cornea (Fig. 3A) suggesting that the sharp eyelash extensions might have scratched the corneal surface. She was treated with topical 0.3% hyaluronic acid, and her symptoms subsided within 1 week. However, one month later, she was admitted to our hospital in the early hours of the morning complaining of ocular pain. Slit-lamp examination showed a large corneal epithelial defect stained with fluorescein in the superior paracentral surface of the cornea of the right eye (Fig. 3B). We diagnosed her with corneal erosion due to RCE. The eyelash extensions were removed from the upper eyelid of both eyes, and she was treated with a bandage SCL and antibiotic ophthalmic ointment. The RCE healed within 2 weeks. No new episodes of the disease have been reported 13 months after the treatment (Fig. 3C). However, the patient suffered from RCE in her right eye again, and she visited our hospital 24 months after the first RCE. Slit-lamp examination revealed deep corneal erosion on the temporal upper side of the right cornea (Fig. 3D). She was treated with antibiotic ophthalmic ointment and the RCE healed within 2 weeks.

3.1.4. Case 4. A 56-year-old male police officer had been injured in the left eye by a fingernail of a criminal suspect at the time of arrest and occasionally experienced ocular pain and tearing upon awakening. One month after the injury, the patient suddenly felt an ocular pain during judo practice and visited our hospital due to the ocular pain and tearing in the left eye. A large central corneal erosion was observed (Fig. 4A). He was treated with artificial tears and lubricating ointment at bedtime, and the symptoms subsided rapidly and almost disappeared after two weeks. However, he reported four episodes of RCE in the left eye for 12 months after the trauma and symptoms such as ocular pain and photophobia were ameliorated within 2 weeks by artificial tears. One year after the first trauma, the patients visited our

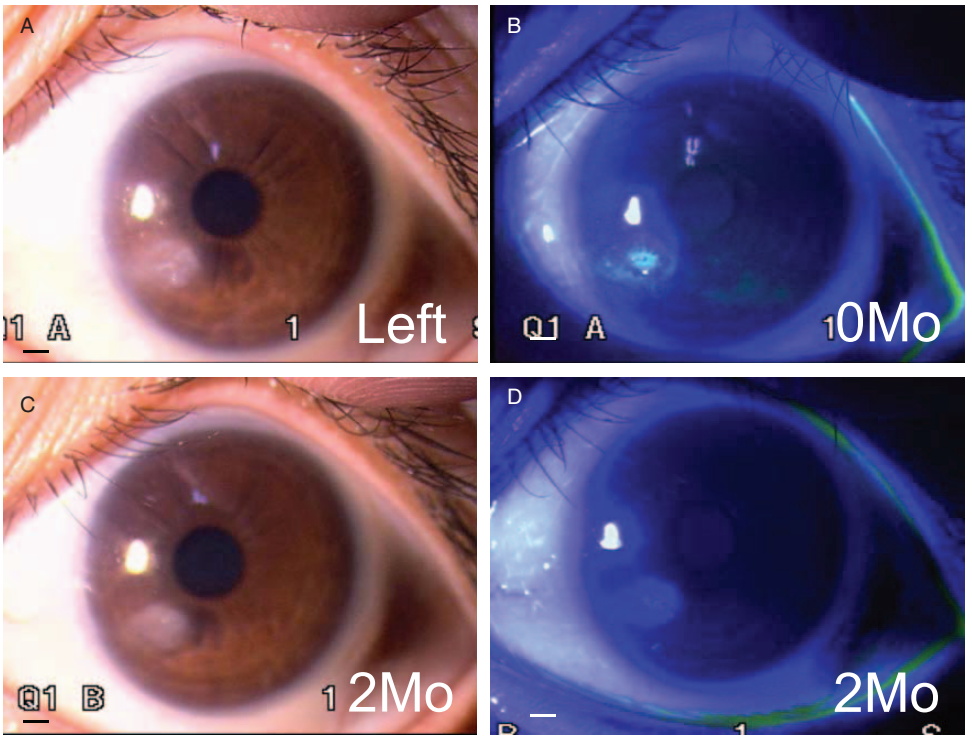

Figure 2. Case 2 (No. 6, Table 1) was a 39-year-old woman. Slit-lamp image of the left eye shows RCE associated with lagophthalmos. (A) and (B) RCE is seen in the nasalinferior cornea with a corneal ulcer caused by *Moraxella lacunata* infection. The eye was treated with antibiotic eye drops and ophthalmic ointment. (C) and (D) Left eye shows complete resolution of the RCE 2 months after beginning the treatment although the corneal opacity remains in the nasal inferior area of cornea. Bars = 2.0 mm.

hospital and sought medical consultation because of intolerable ocular pain in the right eye of 2 days duration. Biomicroscopy of the anterior segment showed a large central corneal abrasion in the right eye (Fig. 4B). He was treated with a bandage SCL and antibiotic ophthalmic ointment for RCE in the right eye and the RCE healed within 2 weeks. The patient continued to use the artificial eye drops for the prevention of RCE and was also symptom-free for 12 months after the last treatment (Fig. 4C).

3.1.5. Case 5. A 75-year-old male was treated at our hospital for RCE for 3 years. The patients had developed DM before 50-years-of-age. Each episode of RCE occurred suddenly on awakening and the symptoms lasted for about 2 months. The patient experienced about 10 similar episodes over a period of 3 years (Fig. 5). He was treated with topical 0.1% hyaluronic acid and antibiotic ophthalmic ointment for the RCE. Although the treatments were continued, the patient still experienced similar episodes of RCE at 2–4-month intervals.

4. Discussion

Our study is the first report, to our knowledge, on the relationship between the risk factors for RCE and the duration and recovery of RCE. The 9 patients with trauma and 8 patients with DM accounted for 81% of all of the case of RCE in our group of 21 patients. The duration for recovery was longer in the DM group than in the Trauma group, and the recovery duration of RCE was significantly associated with the presence of DM.

We used SCL and antibiotic ophthalmic ointment for four patients. The two patients were first treated with ophthalmic ointment. However, the ointment was discontinued and SCL was secondary used to treat RCE because the RCE did not improve within 2–3 days. The other two patients were treated with both ophthalmic ointment and SCL. Application of ointment over SCL may cause the bandage SCL to dislodge; however, SCL's dislodge was not seen in our patients.

The trauma-induced RCE was seen in 9 patients with only trauma and 1 patient with both trauma and DM, accounting for more than 47% of the total number of patients studied. The leading causes of traumatic RCE were fingernail scratches, paper cuts, corneal foreign body, and blow to the eye by a baseball and by a tree branch (Table 2). Diez-Feijóo et al. reported that the most common cause was due to fingernail scratches (45.2%) especially in children.[3] Other ocular trauma-causing objects include paper, tree branch, plastic objects, a metal, a stone, a toy, and a baseball.[3] Thus, any small object that can fly into eyes can cause ocular trauma.

Interestingly, the cornea retains its transparency in the area of the RCE after its resolution. The reason may be that the normal corneal epithelial cells, not fibroblasts, regenerate from the normal corneal epithelium around the wound resulting in a clear cornea. In addition, RCE recurred in the same place on the corneal surface each time in our patients (Figs. 1 and 4). An earlier study showed that the basement membrane was defective beneath the traumatized area of the cornea in eyes with RCE.[7] Thus, the corneal epithelial cells can easily separate and peel away

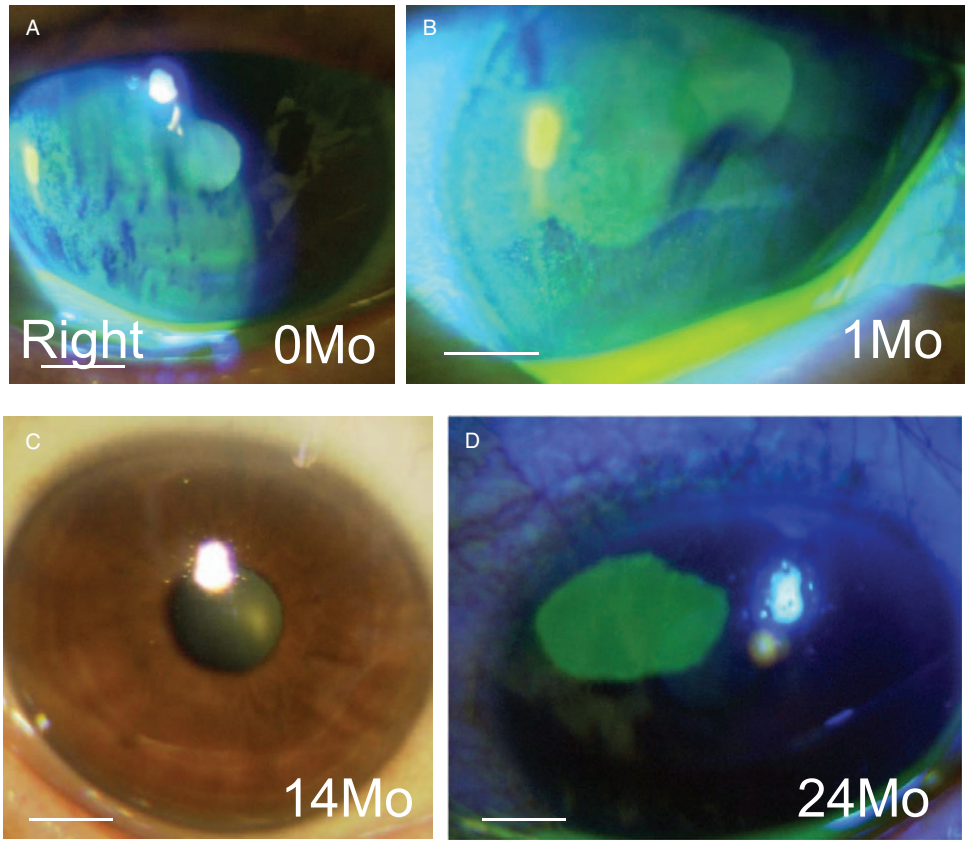

Figure 3. Case 3 (No. 10 in Table 1). Slit-lamp images of RCE caused by eyelash extensions in the right eye of a 54-year-old woman. (A) Eyelash extensions caused corneal erosions that can be seen over the corneal surface in the right eye at the initial visit. (B) RCE developed one month after the erosion. A 3 × 4 mm-epithelial defect with a rough surface can be seen at the superior temporal cornea. (C) After removal of the eyelash extensions, no RCE was observed for 14 months after the treatment. Bars = 2.0 mm.

from the damaged basement membrane underlying the site of the trauma which is probably due to poor adhesion.

The recovery time of RCE was strongly correlated with the age and the presence of DM. Multivariate analysis showed that the presence of DM was the factor correlated with the recovery time of RCE (Table 3). We found that most of patients in the Trauma group were relatively young with no systemic diseases compared with those in the DM group (Table 1). The interval between the recurrences of RCE in the Trauma group was not significantly different from that in the DM group, while the interval from beginning the treatment to the complete recovery of RCE was shorter in the Trauma group than in the DM group (Table 2). The reason for this may be that the proliferative capacity of the migrating epithelial cells is higher in younger patients than in the older patients in the DM group.[8]

The majority (17 of 21 patients; 81%) of our patients had trauma or DM but all patients showed typical RCE regardless of the different causes. This would indicate a common pathogenesis for the RCE in these patients. Goldman et al. reported that the basement membrane was absent and intraepithelial edema was present in the area of the RCE.[9] Later, several studies reported that cystic changes in the epithelial layer and absence of the basement membrane were seen over the traumatized area of the cornea.[7,10,11,12] Recently, Diez-Feijóo et al. examined the

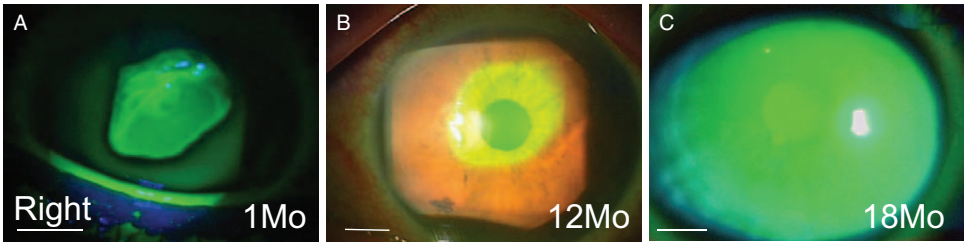

Figure 4. Case 4 (No. 12 in Table 1) was a 56-year-old male police office. Slit-lamp images of the right eye show RCE caused by fingernail scratch of the cornea. (A) RCE is seen at the center of cornea one month after the trauma. (B) RCE occurs at the same area as previous RCE 12 months after the first RCE episode. (C) After the treatment by a bandage soft contact lens and continuous use of eye drops, the cornea had no recurrences of RCE for 12 months. Bars = 2.0 mm.

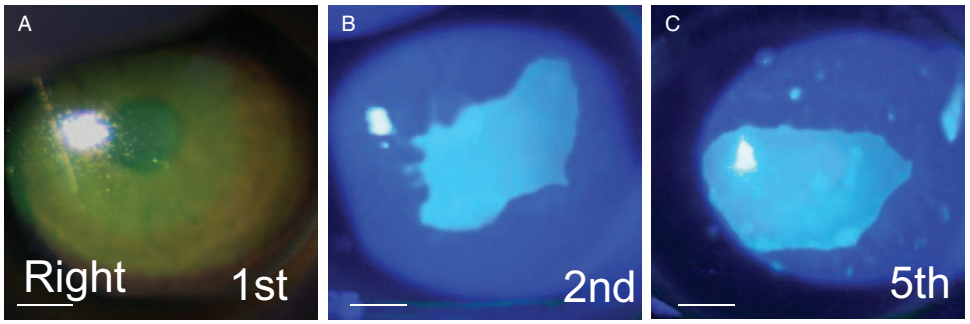

Figure 5. Case 5 (No. 18 in Table 1) was a 75-year-old male with diabetes mellitus (DM). Slit-lamp image of the right eye with DM induced-RCE without trauma. The patient experienced about ten episodes of RCE over a period of 3 years. Photographs show the 1st (A), 2nd (B), and 5th (C) episodes of RCE in the acute phase, which show a variety of surface shapes of erosion. The form of erosion changes for each episode of RCE. Bars = 2.0 mm.

morphology of corneal epithelial layers by optical coherence tomography (OCT) in patients with RCE.[3] They reported that corneal stromal hyperreflectivity, epithelial edema, and irregular breaks in the epithelium were commonly seen in the cornea during the acute period of RCE.[3] Furthermore, the epithelial basement membrane was not detected, and an anterior stromal hyperreflectivity was also seen in patients with previous RCE even after recovery of the RCE.[3] Fraunfelder et al. showed that hemidesmosomes were also perturbed and their number was significantly reduced in the areas of RCE. In addition, the epithelial basement membrane was not detected in these areas.[13] Studies on the role of enzymes in the pathogenesis of RCE showed that matrix-degrading enzymes degraded the collagen and other proteins of the extracellular matrix (ECM) of the epithelial basement membrane.[12,14] Chen et al. also reported that the collagen-anchoring fibrils that pass through the basement membrane were absent in patients with traumatic RCE.[15]

The current study demonstrated that the recovery time of RCE is strongly correlated with the age and the presence of DM. Delayed wound healing is a major complication associated with diabetes. Several review articles have shown that the patients with DM suffer from corneal complications, such as RCE, delayed wound healing, RCE, persistent epithelial defects, corneal ulcers, and neurotrophic keratopathy.[16,17] In patients with DM, diabetic corneal neuropathy induced the development of persistent corneal epithelial defects.[18] Kaji et al. reported that the accumulation of advanced glycation end products (AGEs) in the epithelial basement membrane induced the epithelial defects in patients with DM.[19,20] The majority of serious diabetic RCE occurred on the damaged epithelial membrane *due* to blunt force trauma and direct surgical corneal invasion such as that during vitrectomy. These pathologic findings suggest that hemidesmosomes are not restored in RCE even after recovery which induces an epithelial detachment with a slight stimulus even in a stable corneal epithelium in patients with traumatic or diabetic RCE.

Next, we examined the relationship between the duration of recovery and type of therapy. Our results did not show any significant correlation between the recovery duration and the treatment modality (Table 3). We usually treated RCE with artificial tear drops and ophthalmic ointment. For prolonged RCE, we used bandage contact lenses. In the majority of patients, RCE was improved rapidly and healed completely by these therapies. Other surgical treatment options include anterior stromal puncture,[21] mechanical debridement of the epithelium,[22] and phototherapeutic keratectomy.[23,24]

Our study had several limitations. First, this was a retrospective study with different follow-up periods. Thus, we could not determine the exact number of recurrences after the treatments. Second, we could not randomly choose the treatment for each patient. Thus, we cannot verify that the treatment options used were appropriate for each case. Third, there are few patients with anterior basement membrane dystrophy (ABM) in Japan. We confirmed that our patients with DM or trauma have no ABM. Thus, we could not entry the patients with ABM. Furthermore, our findings were limited by the small patient population. Thus, confounding bias could not be excluded due to the small patient population.

In summary, we retrospectively analyzed the clinical findings of 21 patients with RCE. Trauma and DM were two major factors that caused the RCE. Wound recovery is more delayed in elderly patients and patients with DM. RCE was successfully treated with protective ophthalmic drops and ointments, while the use of bandage SCL and surgical treatments may be helpful for the recovery of prolonged RCE.

Author contributions

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