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ORIGINAL PAPER

Hydration of small leaking corneal perforations with cefuroxime

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Abstract
Purpose To describe a new technique for sealing small corneal perforations after penetrating trauma.
Methods Corneal perforations in six eyes were sealed using a stromal cefuroxime hydration technique. This technique is identical to the current method used to seal leaking incisions upon completion of cataract surgery except for the use of cefuroxime instead of balanced salt solution. Additionally, cefuroxime was intentionally injected into the anterior chamber. A therapeutic contact lens was used after the hydration. Comparison was made in eight eyes with small traumatic corneal perforation that was sealed using therapeutic contact lenses without hydration.
Results This novel technique was applied in six cases, with leakage stopping immediately following hydration in each of these eyes. In cases presenting with a shallow or flat anterior chamber, this maneuver produced immediate reformation of the chamber. Of note, the corneal scars after hydration were minimal with little effect on visual acuity. When compared to eyes with small corneal perforations which were sealed with therapeutic contact lenses without hydration, all cases that were hydrated with cefuroxime were sealed immediately, as opposed to cases treated without hydration. Furthermore, the eyes that underwent hydration with cefuroxime had a worse average visual acuity on admission, a better average visual acuity 1 month post-trauma, and a shorter average length of hospitalization.
Conclusions This new technique offers five major advantages: (1) Immediate sealing of the corneal perforation is achieved. (2) Definitive treatment can be achieved at the slit lamp. (3) Since neither stitches nor glue is applied, healing is achieved with minimal scarring and discomfort. (4) Little equipment is required. (5) Injection of cefuroxime into the anterior chamber provides prophylaxis against infection.

Keywords Corneal perforation · Corneal hydration · Cefuroxime · Corneal scar

Introduction

Corneal perforation secondary to trauma is a serious injury, requiring urgent treatment. Interventions include sealing of the cornea via one or more of the following modalities: stitches, tissue adhesives, therapeutic contact lens, topical antibiotics, and/or aqueous production inhibitors. The case of a central/paracentral corneal perforation is particularly problematic due to the impact of any irregularity in the central cornea on visual acuity and the need to minimize scarring [1–3]. We propose a novel technique for closing small linear corneal perforations

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after penetrating injuries, especially those in a central/paracentral location. Patients included in this study were without concurrent trauma to adjacent tissues in the eye, such as the iris, lens, or posterior segment. Additionally, there was no suspected intraocular foreign body in any of these cases. We used this technique in six eyes of six patients. The first of these cases was published as a letter to the editor [4].

Methods

A review of the hospitals' medical records identified six corneal perforations in six patients who were hydrated via stromal injection of cefuroxime at the site of perforation during the years 2014–2015. This approach is identical to the current method of stromal hydration upon completion of cataract surgery in cases of leaking corneal incisions except for the use of cefuroxime instead of balanced salt solution. Additionally, some of the cefuroxime was intentionally injected into the anterior chamber. Cefuroxime was injected using a 27G cannula on a 1-ml syringe filled with 0.3 ml cefuroxime at a concentration of 1 mg/0.1 ml. The procedure was performed at the slit lamp under sterile conditions, after an application of povidone-iodine 5% onto the eye. Therapeutic contact lens was placed after the hydration.

The six eyes that underwent corneal hydration with cefuroxime were compared to all identified cases of traumatic corneal perforation that were treated in Rambam Healthcare Campus from June 2002 until June 2017 that had perforations that were small and did not require stitches, but yet were not hydrated with cefuroxime (eight in number). Data were analyzed using SPSS. Student's *t* test was performed to compare the visual acuity on admission, the visual acuity 1 month post-trauma, and the length of hospitalization between the two groups. A Fisher's exact test was used for analysis of proportion of the eyes which were sealed immediately between the two groups. Difference was considered significant for a two-sided p value < 0.05.

This retrospective study was approved by the Institutional Ethics Committee of Rambam Healthcare Campus, Haifa, Israel.

Results

In the hydration group, five out of six of the trauma victims were young males. Most of the perforations were paracentral, and most resulted in visual acuity impairment (see Table 1). In all patients with compromised visual acuity, improvement was noted after hydration. At the 1-month follow-up examination, only minimal corneal scarring with improved visual acuity was noted.

All patients in the hydration group were treated immediately with corneal hydration with cefuroxime on admission, except for patient #1 who was first treated with therapeutic contact lens, topical antibiotics, and aqueous production inhibitors for 6 days. Due to the failure of this treatment, patient #1 was treated with corneal hydration with cefuroxime, which succeeded immediately.

All cases in this group had a positive Seidel test before hydration. The leakage stopped immediately after hydration in all cases, with a negative Seidel test. In the two cases in which anterior chamber was flat on admission, the anterior chamber was reformed during the hydration and remained so thereafter.

Figure 1 shows the perforation site of patient #1 who had a 1.5-mm-long central (1-mm off-axis) linear perforation before the hydration, and Fig. 2 shows it after the hydration.

The control group was composed of eight cases of corneal perforation that was treated at Rambam Healthcare Campus from June 2002 until June 2017 that was small enough and hence did not require stitches, but was not hydrated with cefuroxime. All these cases were treated with a therapeutic contact lens (see Table 2). Case #3 was treated using a tissue adhesive before the contact lens. All cases were treated immediately. Upon arrival, the causes of perforation, location of perforation, and the length of perforations were similar to the cases which were hydrated with cefuroxime. The anterior chambers were all deep, but all had a positive Seidel test.

The average visual acuity in LogMAR on admission was worse in the group that was treated with cefuroxime hydration than in the group which was not treated with cefuroxime (0.64 vs. 0.28, $p = 0.21$), but the average visual acuity in LogMAR 1 month post-trauma was better in the group that was treated with cefuroxime hydration than in the group which was not treated with cefuroxime (0.14 vs. 0.01, $p = 0.21$).

Table 1 Hydrated with cefuroxime group

Patient #	Age	Gender	Cause of penetrating trauma	Location of perforation	Length of linear perforation (mm)	Anterior chamber depth on admission	BCVA on admission (LogMAR)	BCVA 1 month post-trauma (LogMAR)	Interval from injury to hydration	Different approach to seal the perforation initially used	Time interval till the leakage stopped after hydration
1	29	M	Wire fence	Central	1.5	Flat	1.3	0	6 days	Yes	Immediately
2	28	M	Metal wire	Central	1	Deep	1.6	0	Immediate	No	Immediately
3	44	M	Piece of wood	Paracentral	2	Flat	0.4	0	Immediate	No	Immediately
4	26	M	Metal wire	Paracentral	1	Deep	0.5	0	Immediate	No	Immediately
5	35	F	Piece of wood	Paracentral	1	Deep	0	0	Immediate	No	Immediately
6	35	M	Piece of wood	Paracentral	1	Deep	0.05	0.05	Immediate	No	Immediately

M male, *F* female, *BCVA* best corrected visual acuity, *LogMAR* logarithm of the minimum angle of resolution

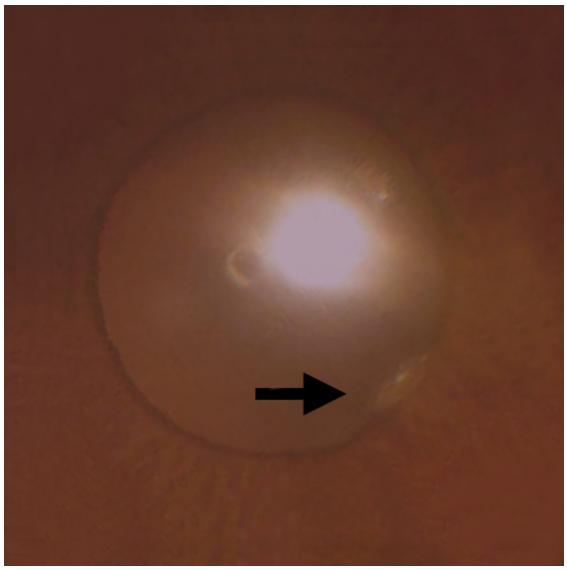

Fig. 1 Perforation site of patient #1 before hydration

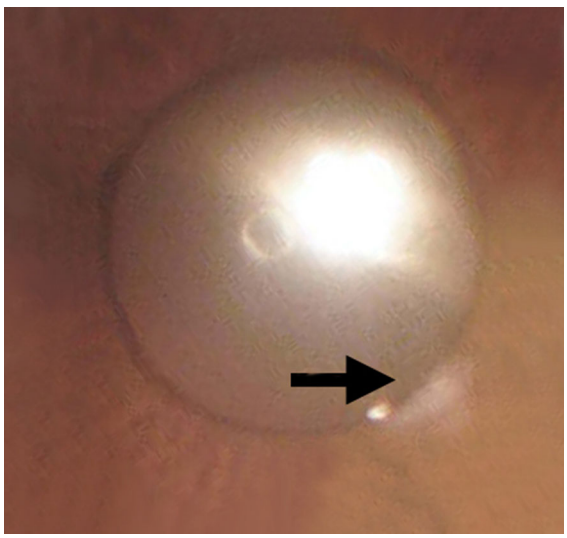

Fig. 2 Perforation site of patient #1 after hydration

There was no statistical significant difference. The average length of hospitalization was shorter in the group of cases which were treated with hydration (4.7 days vs. 7 days, $p = 0.24$). There was no statistical significant difference. The patients were hospitalized for a close follow-up and in order to identify complications such as infection and re-leakage quickly. Only two out of eight eyes in the group that was not treated with hydration sealed immediately as opposed to the hydration group where all six cases sealed immediately ($p = 0.0096$).

We followed all patients for at least a year after hospitalization, and visual acuity was stable in all cases apart from case #4 in the hydration group and case #7 in the contact lens group, who both developed cataract 1 year after the trauma, and both underwent cataract surgery which was complicated by cystoid macular edema following the surgery.

There were no cases of infection or endophthalmitis in the two groups.

Discussion

The current standard of care of corneal penetrating injuries calls for therapeutic modalities that often produce further scarring (e.g., stitching, tissue adhesives). The technique described in the present study is similar to the stromal hydration procedure of clear corneal incisions adopted during conventional cataract surgery that produce little to no inflammation or corneal scarring [5–7]. Injected fluid in the present procedure was a cefuroxime solution in order to achieve two main goals: the sealing of the corneal perforation and the prophylaxis of infections.

Stromal hydration with cefuroxime was found to be safe in mouse corneas [8]. Presumably, the total dosage of antibiotic utilized does not pose a toxicity risk to intraocular tissues [9]. Cefuroxime is potent against some of the bacteria but not against fungal and other infections related to corneal trauma [10, 11].

Of interest, cefuroxime injected into the corneal stroma was previously described as a treatment for infectious crystalline keratopathy [12].

Comparison of the two groups of patients, those treated with hydration and contact lens therapy versus those treated with contact lens therapy only, was performed. The group with the added hydration therapy had an average better long-term visual acuity and an average shorter hospital stay. The immediate sealing by the hydration probably reduced the scarring, and hence caused better visual acuity. No statistical significance was demonstrated between the groups, presumably due to small number of patients, though difference was very consistent. Hydration sealed all cases immediately, while immediate sealing happened only in few cases when hydration was not performed, reaching statistical significance.

Table 2 Therapeutic contact lens (without cefuroxime) group

Patient #	Age	Gender	Cause of penetrating trauma	Location of perforation	Length of linear perforation (mm)	Anterior chamber depth on admission	BCVA on admission (LogMAR)	BCVA 1 month post-trauma (LogMAR)	Interval from injury to contact lens	Different approach to seal the perforation initially used	Time interval till the leakage stopped after contact lens
1	8	M	Piece of glass	Central	1	Deep	0.1	0	Immediate	No	2 days
2	24	M	Metal wire	Central	1	Deep	0	0	Immediate	No	2 days
3	30	M	Piece of wood	Paracentral	1	Deep	0.05	0.05	Immediate	No	3 days
4	60	M	Metal wire	Paracentral	1	Deep	1	0.7	Immediate	No	A day
5	15	M	Piece of wood	Paracentral	2	Deep	0.1	0.1	Immediate	No	Immediately
6	48	M	Metal wire	Paracentral	1	Deep	0.15	0.15	Immediate	No	2 days
7	25	M	Metal wire	Paracentral	1	Deep	0.15	0	Immediate	No	Immediately
8	21	M	Metal wire	Paracentral	1	Deep	0.7	0.1	Immediate	No	Immediately

M male, *BCVA* best corrected visual acuity, *LogMAR* logarithm of the minimum angle of resolution

In conclusion, we can state that this procedure has two positive effects: the immediate sealing of small corneal wounds and the prophylaxis of bacterial infections. Despite the low numerosity of cases and lack of statistical significance, we observed better results in terms of final visual acuity and length of hospitalization in the patients who underwent this treatment.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. For this type of study, formal consent is not required.

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