CASE REPORT

Successful acute and late management of a chemical burn with primary implantation of Boston type 1 keratoprosthesis

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SUMMARY

A 29-year-old woman presented to our clinic 1 month after an accidental chemical burn with concentrated sulfuric acid, involving her entire face including eyes and neck. She received treatment for her ocular and facial burns, and subsequently underwent Boston type 1 keratoprosthesis in her right eye after 1 year. One week postoperatively, she was diagnosed with advanced disc damage, and was started on topical antiglaucoma medication. Visual field testing was only possible at 2 months postoperative, once visual acuity improved. Subsequently, progression of visual field defect was noted on Humphrey visual field 10-2, needing implantation of an Ahmed glaucoma valve in her right eye. Two years after the Boston type 1 keratoprosthesis implantation, the patient's best-corrected visual acuity was stable at 20/100; intraocular pressure was digitally normal with a stable visual field.

BACKGROUND

Chemical burns constitute between 8% and 18% of all ocular trauma.¹ Severe chemical burn to the eye usually results in an opaque cornea, regardless of medical efforts to prevent such outcome. Surgical rehabilitation with standard penetrating keratoplasty, often repeated, is usually futile in the long run.² Keratoplasty combined with limbal stem cell graft is reported to give a better outcome; however, following allografts, long-term immunosuppression is necessary.³

Boston type 1 keratoprosthesis (KPro) has been increasingly used successfully to manage severe corneal pathologies where conventional keratoplasty has high risk of failure or is not possible. This has shown promise, with reasonable retention rates after chemical burns, although these eyes also face a major challenge in terms of non-corneal complications, including glaucoma.² The current treatment options in these eyes include KPro and topical glaucoma or systemic antiglaucoma medications, and glaucoma drainage implants, notably the Ahmed glaucoma valve.⁴

We report a chemical burn in a patient who presented to our clinic in the acute stage, after conservative management and nil intervention in view of poor prognosis was suggested at various other centres. We managed the patient in the acute phase to retain the ocular anatomy and integrity of the globe and subsequently helped with visual rehabilitation with Boston type 1 KPro implantation, managing her advanced glaucoma with an Ahmed

glaucoma valve (AGV) implantation. This case highlights the importance of using our medical advancements and expertise in providing care to such serious injuries in the acute as well as chronic phases. Meticulous management and perseverance would help many such young patients with serious injuries see a ray of hope in their lives instead of giving up on them.

CASE PRESENTATION

A 29-year-old woman presented to our clinic following an accidental concentrated sulfuric acid facial injury experienced a month earlier while working in her chemistry laboratory. She had facial burns involving the front of the neck with bilateral ocular injury. She consulted locally and was diagnosed as severe chemical injury with total limbal stem cell deficiency in both eyes. An amniotic membrane graft was performed in her eyes and she was started on topical steroids, antibiotics, cycloplegics and lubricants.

When she presented to us, her visual acuity was counting fingers at 1 m in the right eye and perception of light with projection of rays (accurate) in the left eye. Her facial burns involved the eyelids and periocular area of both eyes, her left cheek and her neck. Crusting and discharge with raw areas were seen in the upper and lower eyelids of both eyes (figure 1A). Conjunctival blanching was present with 360° limbal and bulbar ischaemia, corneal subepithelial haze and stromal oedema in both eyes. Intraocular pressure (IOP) was digitally normal. The right eye had a blood-tinged hypopyon. Fundus examination was not possible. On the basis of the clinical findings, the patient was diagnosed with Roper-Hall grade IV chemical injury.

TREATMENT

The patient's facial wounds were cleaned with 5% povidone iodine and crusts were removed. She was started on topical 1% prednisolone acetate eye drops two hourly, ofloxacin eye drops four times per day and lubricating eye drops two hourly in both eyes. Wound debridement, Tenon's advancement with amniotic membrane graft and lateral paramedian tarsorrhaphy were carried out in both eyes. From the first postoperative day, prednisolone acetate 1% eye drops two hourly, homatropine 2% eye drops three times per day, moxifloxacin 0.5% eye drops 4–6 times per day and lubricating eye drops 4–6 times per day were started in both eyes. Oral prednisolone 60 mg once daily, tablet

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Figure 1 (A) Facial burn involving both eyes and face at presentation. (B) Right eye following Boston type 1 keratoprosthesis (KPro) and left eye with ankyloblepharon. (C) Right eye with well-integrated type 1 KPro, clear central cylinder and a bandage contact lens in place.

ranitidine 150 mg two times per day, tablet calcium carbonate 500 mg once daily and tablet vitamin C 500 mg four times per day were given. Fusidic acid skin ointment was prescribed for application over the area of burn. The patient was discharged and called after 1 week. After 1 week, there was conjunctival vascularisation reaching up to the limbus, and no visible area of corneal melting. Oral and topical steroids were tapered.

OUTCOME AND FOLLOW-UP

Topical medications were stopped after a month, except for lubricating eye drops, and oral prednisolone was stopped at 6 weeks in tapering doses. Oral carbonic anhydrase inhibitors were started during the acute phase of the injury and were stopped after 1 month.

Twelve months later, the tarsorrhaphy was released to assess the status of the globe.

Visual acuity was perception of light with accurate projection of rays in the right eye; the left eye showed inaccurate projection of rays in two quadrants. The ocular surface was stable with a vascularised corneal scar. Although the digital IOP noted was in the normal range, the ultrasound B-scan revealed disc cupping in both eyes, with attached retina.

The right eye was thought to have better visual potential due to the accurate light projection, hence a Boston type 1 KPro was planned in that eye after detailed discussion with the patient and her relatives regarding the complexity of the problem, and after apprising them of the close monitoring and care required after the surgery.

Boston type 1 KPro was performed in the right eye along with removal of the crystalline lens and implantation of an intraocular zero diopter lens, in a standard procedure described previously.² On the first postoperative day, the patient's visual acuity was hand movements with accurate projection of rays. There was fibrinous reaction in the anterior chamber with a very hazy view of the fundus. Oral tablet prednisolone 50 mg once daily, tablet ciprofloxacin 750 mg two times per day, tablet ranitidine 150 mg two times per day and tablet calcium carbonate 500 mg once daily was prescribed. Also, topical 1% prednisolone acetate eye drops every one hourly, moxifloxacin 0.5% eye drops four times per day, chloramphenicol 0.5% eye drops

at night time and lubricant eye drops 6–8 times per day were started.

In the first week, a thick membrane was covering the posterior aspect of the optical cylinder. Nd:YAG laser membranotomy was attempted, however, the membrane reappeared within a week. Oral and topical steroids were tapered after 1 week, while topical prednisolone acetate 1% eye drops four times per day, moxifloxacin 0.5% eye drops four times per day, chloramphenicol 0.5% eye drops at night, a combination of brimonidine 0.2% and timolol 0.5% eye drops two times per day and lubricant eye drops every two hourly, were continued. Although the IOP was digitally normal, in view of the pale optic disc with advanced cupping, topical antiglaucoma medications were added to the regimen.

After 2 months of the Boston type 1 KPro implantation, the patient's best-corrected visual acuity (BCVA) was 20/200. IOP was digitally normal, but the pale disc with advanced glaucomatous cupping and Humphrey visual field (HVF 24-2) revealed biarcuate scotoma. The patient developed posterior capsular opacification, which was cleared with Nd:YAG laser. Her visual acuity improved to 20/100 following YAG capsulotomy.

The patient was followed bimonthly for change of bandage contact lens and for monitoring the KPro and IOP. At each visit, her BCVA improved. The IOP was digitally normal, cup–disc ratio was 0.9:1 with significant pallor and her visual fields showed advanced field loss, which was stable.

After 15 months of implantation of the Boston type 1 KPro, the patient's BCVA improved to 20/60. The Boston type 1 KPro was stable. IOP was digitally normal, cup–disc ratio and HVF 10-2 were stable. The left eye had complete ankyloblepharon (figure 1B, C) with digitally normal IOP.

After 18 months of the implantation, the patient's BCVA had stabilised at 20/60. However, HVF 10-2 showed progression in field defect, which was confirmed on repeat HVF. The Boston type 1 KPro was stable with a clear cylinder in the centre (figure 2A). We implanted an AGV in the superotemporal quadrant with a pars plana tube entry and anterior vitrectomy (figure 2B, C).

The patient was regularly followed up every 2 months. Her topical steroid was tapered and discontinued after 4 months. Now, 26 months after the Boston type 1 KPro implantation, her

Figure 2 (A) Stable Boston type 1 keratoprosthesis with clear cylinder in the centre. (B) Scleral patch graft covering the drainage tube in the superotemporal quadrant (black arrow). (C) Tube of Ahmed glaucoma valve behind the cylinder (yellow arrow).

BCVA is 20/100. IOP is digitally normal with stable visual field. She is continued on moxifloxacin 0.5% eye drops four times per day, chloramphenicol 0.5% eye drops at night, dorzolamide 2% eye drops two times per day, a combination of brimonidine 0.2% and timolol 0.5% eye drops two times per day and lubricant eye drops every two hourly.

DISCUSSION

This patient presented to our clinic in an acute stage of chemical injury 1 month after the episode. Although the primary attending ophthalmologist treated her with copious conjunctival irrigation, amniotic membrane transplantation and topical medications, the condition of both eyes continued to deteriorate.

Her facial and neck burns had to be stabilised and the ocular treatment required amniotic membrane transplantation along with lateral paramedian tarsorrhaphy in the right eye and Tenon's advancement with lateral paramedian tarsorrhaphy in the left eye. Intraoperatively, severe ocular ischaemia of the anterior segment was noted in the left eye. The prognosis in the right eye was better compared to the left; this was explained to the family. The patient was kept on medical treatment for about a year. After the ocular surface became stable, a Boston type 1 KPro was implanted in the right eye. Although the BCVA was hand movements in the early postoperative period, it improved to 20/100 in 2 months and further improvement on the subsequent follow-up visits. The cup-disc ratio was 0.9:1 and HVF 10-2 showed progression in the field defect, so an AGV implantation was performed. After 26 months of follow-up, visual acuity was maintained and visual field was stable on three anti-glaucoma medications and prophylactic antibiotics.

Phillips *et al.*⁵ in their series of nine cases of Boston type 1 KPro for chemical injuries, showed that, after a mean follow-up of 40.7 months (range 29–60 months), the median BCVA was 20/60 (range 20/15 to no light perception). In that series, eight of nine patients underwent prior limbal stem cell transplantation or penetrating keratoplasty before Boston type 1 KPro implantation. The initial Boston type 1 KPro retention rate was 77.7%. Magalhães *et al.*⁶ in their series of 10 cases of ocular chemical burn, also showed similar results. In their series, preoperative BCVA varied from counting fingers to light perception. Postoperative BCVA was better than 20/200 in 90% of the patients and better than 20/60 in 60% of the patients. The overall Boston type 1 KPro retention rate was 90%.

In our case, limbal stem cell transplant or keratoplasty was not performed. We waited for the ocular surface to be stable after amniotic membrane transplantation and lateral paramedian tarsorrhaphy, and performed primary Boston type 1 KPro.

Ocular chemical injury is a known risk factor for glaucoma. Eyes with Roper-Hall grade III or IV ocular chemical burns were significantly more likely to need long-term glaucoma medications and glaucoma surgery compared with eyes with Roper-Hall grade I or II ocular chemical burns.¹ Early direct chemical injury may cause tissue shrinkage and disruption of the trabecular meshwork and outflow channels. Subsequent chronic inflammation may lead to synechiae and angle closure.⁷ Other mechanisms, such as long-term use of topical corticosteroids after ocular procedures, also may contribute to later IOP elevation.

Glaucoma development or progression is a frequent complication after Boston type 1 KPro implantation, with up to 100% of patients acquiring postoperative de novo glaucoma and 23% demonstrating glaucoma progression.⁸ Managing glaucoma post-KPro is very challenging, as IOP measurement with

currently available tonometers is not possible in these eyes with artificial corneas. Various tonometers, such as the tonopen and the diaton transpalpebral tonometer, have been tried; however, none provide a reliable measurement. Currently, the tactile estimation of IOP is the most practical method, providing fairly reliable IOP estimation in experienced hands.⁹ The onset or progression of glaucoma in KPro patients should be monitored through visual field testing, direct visualisation and structural imaging of the optic nerve, such as with photos.

Up to 13% of KPro patients have required subsequent surgical interventions for the treatment of glaucoma.¹⁰ Glaucoma drainage implants prevent the severe elevation of IOP that occurs in some patients treated with KPro alone. Although progression of end-stage glaucoma can occur despite use of glaucoma drainage implants, these implants are effective in reducing the IOP and preventing glaucomatous optic nerve or visual field changes in the majority of patients. Netland *et al* studied a cohort of 55 eyes of 52 individuals who underwent Boston type 1 KPro transplantation. Glaucoma was found in 64% of the eyes, either pre-existing or developed after Boston type 1 KPro implantation. Of these 36 eyes treated with glaucoma drainage devices, IOP was controlled in 29 eyes (81%), with 9 eyes (25%) requiring additional medications. Continued progression of glaucoma occurred in 5 (14%) of the 36 eyes with keratoprotheses and glaucoma drainage implants (4 of these eyes had advanced glaucomatous optic nerve damage before surgery).¹¹ In our patient, IOP was under control and the visual field remained stable after implantation of the AGV.

This case highlights the importance of active management of ocular chemical burns in the acute stage and early visual rehabilitative surgical procedures as soon as a favourable ocular condition is achieved. This patient presented to our clinic after being refused intervention at many centres. Although she required multiple interventions to stabilise her eyes, we could rehabilitate her visually with the help of a Boston type 1 KPro and manage her advanced glaucoma with a glaucoma drainage implant. The visual recovery was slow, however, it has been maintained and she is now enjoying a healthy and independent life with ambulatory visual acuity.

Learning points

- ▶ Active management of chemical ocular burns in the acute stage is very crucial.
- ▶ In severe chemical ocular burns, early primary Boston type 1 keratoprosthesis (KPro) implantation after stabilisation of the ocular surface is a viable option for visual rehabilitation.
- ▶ Visual recovery may be delayed after Boston type 1 KPro implantation.
- ▶ Ahmed glaucoma valve implantation helps stabilise the glaucoma even in advanced disease in eyes with Boston type 1 KPro.

Competing interests None declared.

Patient consent Obtained.

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