

Erratum to: Endophthalmitis in Boston keratoprosthesis: case series and review of literature

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Abstract To report the clinical and microbiological characteristics of infectious endophthalmitis after Boston type I keratoprosthesis (B–K-Pro) implantation. Retrospective analysis of 45 eyes that received a B–K-Pro type 1 between 2009 and 2012 was performed. Five eyes with a diagnosis of exogenous endophthalmitis after B–K-pro type 1 were identified and information about demographic data, indication for K-Pro, post-operative bandage contact lens use, post-operative prophylactic antibiotic use, timing and clinical presentation of endophthalmitis, gram stain and culture results of intraocular fluid and preoperative and post-operative visual acuity were collected. The incidence of endophthalmitis was 11.1 % (5 of 45 eyes) and average time to develop endophthalmitis

was 5.62 months (range 2 days to 8 months). Mean patient age was 31.4 years (5 to 65 years). The surgical indications included corneal injury due to chemical burns ($n = 2$), multiple failed grafts secondary to microbial keratitis ($n = 2$) and congenital glaucoma with congenital herpetic keratitis ($n = 1$). Post-Boston K-Pro, the visual acuity ranged from light perception (LP) to 20/50. K-pro was explanted in 4 patients. There was bacterial and fungal growth in two patients each and one vitreous did not grow anything. All the eyes were phthisical at last visit. Infectious endophthalmitis after K-Pro implantation in our study had a higher incidence, early onset and extremely poor visual outcome compared with post-cataract surgery endophthalmitis, as reported in literature. Not only bacterial but also fungal infections are an important etiology for infectious endophthalmitis in these cases.

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Introduction

The Boston type 1 keratoprosthesis (K-Pro), has restored vision in a subset of eyes with multiple failed penetrating keratoplasties (PKs), chemical injuries,

Stevens–Johnson syndrome (SJS) and ocular cicatricial pemphigoid (OCP), that previously had little chance of a successful corneal transplant [1]. But infectious endophthalmitis is a vision-threatening complication in such eyes. Since this device bridges the non-sterile ocular surface with sterile anterior chamber, there is increased risk of rapid invasion of pathogenic organisms through the space between the tissue and the prosthesis [2]. Additionally, infectious endophthalmitis may occur months or years after K-Pro placement [3–6]. We report the clinical characteristics, management and outcomes of five patients who developed endophthalmitis following Boston K-Pro type 1.

Patients and methods

A retrospective chart review of 45 eyes that received the Boston K-Pro type 1 implantation at the L V Prasad Eye Institute, Hyderabad, India between 2009 and 2012 was done. The institutional review board approved the retrospective analysis of charts for the study, and all the procedures adhered to the tenets of the declaration of Helsinki. Five subjects were clinically identified and 4 subjects were microbiologically proven to having developed endophthalmitis after K-Pro implantation. The collected data included patient demography (age at time of implant, gender, and eye laterality) and clinical details (primary indication for K-Pro, associated other ocular comorbidities, past surgical treatments, concurrent surgical procedures, time to develop endophthalmitis, clinical presentation of endophthalmitis, and microbiology) post-operative care (bandage contact lens use, antibiotic regimen during and after surgery), and outcome.

Device implantation was carried out in a standard fashion by single surgeon as previously described without intra operative complications. Standard care included preoperative preparation of the eye with application of 5 % povidone–iodine of periocular skin and lids, subconjunctival injections of cefazolin (25 mg) and dexamethasone (1 mg) at the conclusion of surgery. The post-operative regimen included an extended wear bandage contact lens, topical steroid, and antibiotic. None of the patients had a cicatrizing disease.

Endophthalmitis was defined as sudden decrease in vision associated with severe vitritis seen clinically or on ultrasonography. In 4 of 5 patients keratoprosthesis was explanted, and it was followed by therapeutic penetrating keratoplasty, standard 3-port pars plana vitrectomy, and intravitreal antibiotics injections. Undiluted vitreous sample was sent for microbiological analysis. Culture sensitivity adjusted intraocular antibiotic was repeated 72 h after the first one, when indicated.

Results

The incidence of endophthalmitis was 11.1 % (5 of 45 eyes (43 subjects)) and average time to develop endophthalmitis was 5.62 ± 6.52 months (range 2 days to 8 months). Patient characteristics are summarized in Table 1. Mean patient age was 31.4 years (5–65 years) and there were four male patients. The surgical indications included corneal injury due to chemical burns ($n = 2$), multiple failed grafts secondary to microbial keratitis ($n = 2$) and congenital glaucoma with congenital herpetic keratitis ($n = 1$). Visual acuity following Boston K-Pro surgery ranged from light perception (LP) to 20/50.

Major presenting symptom at the time of diagnosis of endophthalmitis was a rapid decrease in vision. Three patients had red and inflamed eye with a minimal discomfort at the time of presentation, the other 2 patients complained of only reduction of vision. None of them had vitritis before. There was bacterial and fungal growth in 2 patients each and one vitreous did not grow anything. The visual acuity did not improve in any patient despite prompt and aggressive treatment for endophthalmitis; in fact, all eyes were phthisical at last visit.

Brief case studies

Case 1

A 33-year-old woman presented with a history of chemical injury (acid burn) in both eyes and underwent multiple surgical procedures including symblepharon release and cultured conjunctival limbal stem cells autografting. She underwent K-Pro surgery.

Table 1 Characteristics of subjects at the time of diagnosis of endophthalmitis

Age at K-Pro, (Gender)	K-Pro indication	Prior surgery	Visual acuity		Symptom, signs of end	Visual acuity		Culture	Follow-up duration since endophthalmitis
			Before K-Pro	After K-Pro		Before end Rx	After end Rx		
33 F	Vascularised corneal scar post-chemical injury (acid injury)	Conjunctival limbal stem cell biopsy, tarsorrhaphy	LP	LP	Pain, lid edema, and conjunctival congestion with discharge	No LP	No LP	No growth	1 day
10 M	Vascularised corneal scar chemical injury (alkali injury)	Conjunctival resection with amniotic membrane grafting, symblepharon release, COMET with tarsorrhaphy	CF 3 m	CF 2 m	Pain, decreased vision and presence of yellowish infiltrates on cornea	Hand motions	Hand motions	<i>Staphylococcus aureus</i> sensitive to only vancomycin	2 months
44 M	Failed PK for fungal keratitis	Multiple PK	HM	LP	Pain, lid edema, conjunctival congestion with total corneal melt	LP	LP	<i>Escherichia coli</i> sensitive to only imipenem and piperacillin-tazobactam	5 days
65 M	Failed PK for microbial keratitis	PK, ECCE/PCIOL, amniotic membrane grafting, AGV	LP	20/50	Pain and gradual loss of vision	20/400	No LP	<i>Candida glabrata</i> from vitreous, <i>Candida famata</i> from BCL	2 months
5 M	Congenital glaucoma with congenital herpetic keratitis	Multiple trabeculectomy and keratoplasty	LP	20/200	Pain, gradual reduction in vision	LP	No LP	Aspergillus terreus from BCL	20 months

M male, F female, PK penetrating keratoplasty, TSCPC transscleral cyclophotocoagulation, LP perception of light, CF counting fingers, HM hand motions, BCL bandage contact lens, AGV ahmed glaucoma valve, PCIOL posterior chamber intraocular lens ECCE extracapsular cataract extraction, DSAEK descemet’s stripping automated endothelial keratoplasty

Post-operative treatment included topical prednisolone acetate, ciprofloxacin, and vancomycin. Post-surgery visual acuity remained unchanged at LP only. Features of endophthalmitis appeared 2 months later. Her vision at this point of time was no LP. Symptoms and signs included a weeklong pain, lid edema, and conjunctival congestion with discharge. Microbiological smears (Grams and KOH stains) did not show any organism. Cultures did not show any growth. Polymerase chain reaction (PCR) was negative for fungal DNA. No further intervention was done as the vision was no LP and the K-Pro was left in situ.

Case 2

A 5-year-old child presented with a history of chemical injury (alkali burn) in both eyes, and a diagnosis of total limbal stem cell deficiency was made. He underwent multiple surgical procedures to keep the globe tectonically stable. He underwent K-Pro surgery at the age of 10. Three days post-surgery he developed endophthalmitis with complaints of pain, decreased vision and the presence of yellowish infiltrates on cornea. He underwent a K-pro explantation, therapeutic keratoplasty, and vitrectomy. Vitreous grew *Staphylococcus aureus* sensitive to only vancomycin. At last follow-up (2 months), the vision was hand movements and a failed graft.

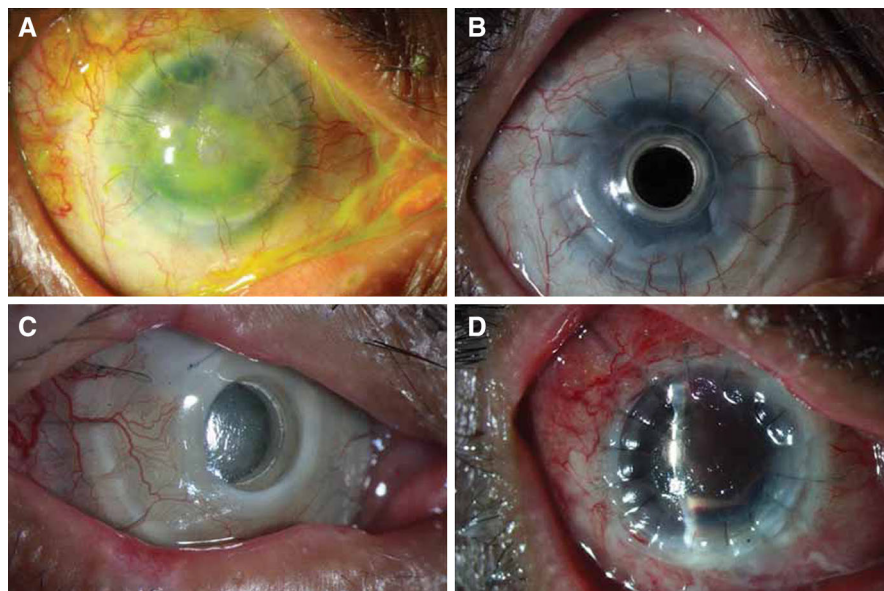
Case 3

A 44-year-old man presented with a perforated corneal ulcer in the left eye. He underwent multiple penetrating keratoplasties, which ultimately led to vascularized scarred cornea. His right eye was enucleated following trauma. His vision was counting fingers at 2 meters and subsequently underwent K-Pro surgery in the left eye. Three days after the surgery, he presented with complaints of pain and sudden reduction in vision. Clinical examination showed lid edema, conjunctival congestion with total corneal melt. K-pro explantation with therapeutic keratoplasty and vitrectomy was done. Vitreous grew *Escherichia coli* sensitive to only imipenem and piperacillin-tazobactam. His vision at the last follow-up was LP.

Case 4

A 65-year-old man who had undergone multiple corneal transplant procedures in the right eye presented with failed graft with glaucoma drainage device and left eye aphakia with fundus coloboma (Fig. 1). His vision was LP in the right eye and counting fingers at 1 meter in the left eye. He underwent K-Pro surgery in right eye. His VA improved to 20/50 after 6 months. Sixteen months after the surgery, he presented with pain and gradual loss of vision. Clinical examination

Fig. 1 **a** Slit lamp photograph under diffuse illumination showing failed graft with vascularization prior to Boston Keratoprosthesis (K-pro) implantation. **b** Five months post K-Pro implantation, the visual acuity was 20/50 **c** 16 months later the visual acuity dropped to hand motions with edematous graft and retro-prosthetic membrane. Diagnosis of endophthalmitis was made. **d** For the management of endophthalmitis, patient underwent K-pro explantation, intravitreal voriconazole, and penetrating keratoplasty



showed lid edema, graft edema and exudates behind the optical cylinder and in the anterior chamber. He received K-Pro explantation, therapeutic keratoplasty, and vitrectomy. Vitreous grew *Candida glabrata* c. At the last follow-up, the eye was phthisical.

Case 5

A 10-day-old child presented with both eyes opaque corneas and increased corneal diameters diagnosed as a case of both eyes congenital glaucoma with congenital herpetic keratitis. He subsequently underwent multiple trabeculectomy and keratoplasty procedures in both eyes. However, his vision did not improve beyond hand movements. He underwent left eye Boston K-Pro with tarsorrhaphy at the age of 5 years. Eight months following surgery his vision was 20/200. Then he presented with a gradual reduction in vision to LP and a weeklong pain

before a diagnosis of endophthalmitis was made with corneal infiltrates and vitreous exudates. He underwent K-Pro explantation, therapeutic keratoplasty, and vitrectomy. Vitreous grew *Aspergillus terreus*. Vision did not improve and eye became phthisical.

Discussion

We observed two patterns of endophthalmitis; one that appeared early after K-pro and the other that appeared late. But the common factor was the symptom of pain in all cases compared to only 25 % patients complaining pain in post-cataract surgery endophthalmitis in the endophthalmitis vitrectomy (EVS) study [7].

The incidence of endophthalmitis at 11.1 % in our study was between other reported incidences in literature (11.4 % and 12 [5, 6]–2.5 % and 2.4 %

Table 2 Summary of presenting features in reported cases of infectious endophthalmitis after Boston K-Pro implantation

Study	Year	Number (Incidence in percentage)	Mean duration of endophthalmitis after K-pro surgery	Culture	Final outcome
Fintelmann et al. [5]	2009	4 (11.4 %)	5–9 months	2/4 MRSA 1/4 <i>Pseudomonas aeruginosa</i> 1/4 no growth	All had 20/200 to 20/60
Nouri et al. [6]	2001	13 (12 %)	3 years 4 months	3/13 <i>Streptococcus pneumonia</i> 3/13 <i>Streptococcus viridians</i> 3/13 <i>Staphylococcus aureus</i> 2/13 <i>Streptococcus epidermidis</i> 1/13 group B <i>Streptococci</i> 1/13 group A <i>Streptococci</i>	10/13 lost vision, 3 eyes had 20/400 to 20/200
Ramchandran et al. [9]	2012	10 (7.1 %)	9.8 months	7/10 Coagulase negative <i>Staphylococcus</i> 1/10 <i>Providencia rettgeri</i> 2/10 no growth	5/10 eyes had bare or no light perception, rest had ambulatory vision
Chan et al. [8]	2012	3 (2.4 %)	16.6 months (4–35 months)	1/3 <i>Staphylococcus aureus</i> 1/3 <i>Candida parapsilosis</i> 1/3 <i>Candida albicans</i>	2 eyes had light perception, one had 20/60
Current study	2013	5 (11.1 %)	5.62 months	1/5 <i>Staphylococcus aureus</i> 1/5 <i>Escherichia coli</i> 1/5 <i>Candida glabrata</i> 1/5 <i>Aspergillus tereus</i> 1/5 no growth	All eyes blind

PK penetrating keratoplasty, *PBK* pseudophakic bullous keratopathy, *HSK* herpes simplex keratitis, *LASIK* laser-assisted in situ keratomileusis, *OCP* ocular cicatricial pemphigoid, *SJS* stevens johnson syndrome, *MRSA* methicillin resistant staphylococcus aureus

[3, 5, 6, 8, 9]), but 158-fold higher than the incidence of endophthalmitis after cataract surgery in our institute (0.07 % culture proven endophthalmitis [10]) and 55-fold higher than penetrating keratoplasty (0.2 %). Other differences included equal distribution of bacterial and fungal infection; but this cannot be concluded emphatically due to small numbers (Table 2). But it suggests that one should include intravitreal anti fungal antibiotics along with anti bacterial antibiotics as the standard of care in K-Pro endophthalmitis. There are a few challenges in post K-Pro endophthalmitis. One is the diagnosis of endophthalmitis in K-Pro eyes. The classical signs of endophthalmitis such as hypopyon may not be present and vitritis may be difficult to record.

In conclusion, in eyes prone to corneal graft failure, K-Pro surgery is a promising and sometimes the only option for sight restoration. However, the high incidence of endophthalmitis and extremely poor visual prognosis present a challenge and requires careful attention. We wonder if one should consider additional prophylaxis in K-Pro surgery such as pre operative topical/systemic antibiotic, and/or intra operative Intravitreal antibiotics as often practiced in care of traumatic endophthalmitis [11]. Two patients in this series (patients # 4, 5) had regained navigational to functional vision before endophthalmitis set in. In view of the fact that it is quite difficult to salvage once the eyes are infected, it is necessary to take adequate measures to prevent the infection later.

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