Special Focus, Retina

Clinical profile, visual outcome and root cause analysis of post-operative cluster endophthalmitis due to *Burkholderia cepacia* complex

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Purpose: To present varied clinical presentations, surveillance reports, and final visual outcomes of a rare outbreak of cluster endophthalmitis caused by gram-negative, opportunistic bacilli, *Burkholderia cepacia* complex (Bcc). **Methods:** Details of five patients who developed postoperative cluster endophthalmitis were collected. For each patient, an undiluted vitreous sample was collected during vitreous tap. Bacterial culture from the vitreous sample in each case had grown Bcc. Surveillance investigations for root cause analysis (RCA) were performed in the operating room (OR), admission, and day-care wards to localize the source. **Results:** Four patients had undergone phacoemulsification surgery, and one patient had undergone penetrating keratoplasty. Each patient received an initial dose of empiric intravitreal ceftazidime and vancomycin. The organism isolated in each case was sensitive to ceftazidime, cotrimoxazole, and meropenem and resistant to other antibiotics. Core vitrectomy was done after 48–60 hours in four patients along with intravitreal imipenem injection. One patient did not provide consent for core vitrectomy and subsequently developed phthisis bulbi. Three patients had subsequent recurrences. Two patients had a final BCVA of 20/60, two had BCVA better than 20/200, while one patient had no perception of light. None of the surveillance samples from the OR complex could isolate *Burkholderia*. **Conclusion:** Extensive OR surveillance should be done to identify the potential source of infection. However, the source may not be identifiable in few instances like in our case. Longer follow-up is recommended in cases of Bcc endophthalmitis due to the persistent nature of the infection.

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Endophthalmitis is a dreaded and visually debilitating complication following any intraocular surgery. Post-cataract surgery endophthalmitis has been reported in approximately 0.04%–0.2% cases. Conjunctival flora is the most common source of sporadic postoperative endophthalmitis. Cluster infections are rare and have been associated with exogenous sources such as contaminated ophthalmic solutions.[1,2] Cluster endophthalmitis is described as "simultaneous occurrence of two or more endophthalmitis cases, or higher incidence of endophthalmitis compared to the local pattern, or repeated cases occurring in the same operation room (OR) under similar circumstances – same surgeon, same OR assistant, etc."[3] Outbreak of cluster endophthalmitis is distressing to the patients due to the associated poor visual outcome and often with added economic and emotional burdens. It is equally alarming for the surgeons, clinics, or hospitals involved as well. It is, therefore, extremely important to identify the potential infection sources and establish measures to prevent further recurrences.[4] Cluster endophthalmitis outbreaks are mainly associated with contaminated irrigating solutions, anesthetic eyedrops, viscoelastics, intraocular dyes, fluids in phacoemulsifier or vitrectomy tubings, phaco probe, etc. *Pseudomonas sp*. are most commonly implicated in cluster endophthalmitis. Other rare organisms associated with cluster infections include *Stenotrophanomas sp*. and *Burkholderia cepacia* complex (Bcc).[1,5]

Bcc are gram-negative, opportunistic bacilli. They are commonly isolated from respiratory infections in cystic fibrosis patients and from contaminated nasal sprays, nebulization and mouthwash solutions, ultrasound gel, etc. They can rarely cause postoperative endophthalmitis. *Burkholderia* accounted for around 1.8% of cases of all culture-proven endophthalmitis in a study by Sachdeva *et al*.[6] It is one of the most versatile groups of gram-negative bacteria with a unique and challenging antimicrobial profile and is highly transmissible and inherently resistant to multiple antibiotics.[1,6] Here, we report such a rare

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outbreak of cluster endophthalmitis caused by Bcc, its varied clinical presentations, surveillance reports, and final visual outcomes.

Methods

This study consists of a series of five cluster endophthalmitis cases diagnosed over a six-week time period between July 2019 and August 2019 in a tertiary care hospital in South India. Retrospective analysis of the medical records of these five patients and the microbiology laboratory records were done to obtain the clinical details, microbiology culture reports, and antimicrobial sensitivity patterns. Written informed consents were obtained from all the patients. The study adhered to the tenets of the declaration of Helsinki, and approval for the study was obtained from the institute's ethics committee. This series also involves reporting the results of a prospective environmental surveillance that was carried out to identify the common source of infection. All patients underwent slit-lamp examination, fundus examination with indirect ophthalmoscopy, and ultrasound (USG) B scan at presentation by a retina surgeon. Endophthalmitis was diagnosed in the presence of a) decreased vision; b) anterior chamber cells and flare with or without hypopyon; c) vitreous exudates and thickening of retina-choroid complex on USG-B scan; and with or without d) eye pain, lid edema, conjunctival congestion, etc., Each patient received one dose of intravitreal ceftazidime (2.25 mg/0.1 ml) and vancomycin (1 mg/0.1 ml) on the day of presentation. The further course of treatment was decided based on the subsequent clinical outcome and culture reports in each case discussed below under the results section.

For each patient, an undiluted vitreous sample was collected by a vitreous tap in a 1-ml syringe before giving intravitreal injection. The sample was sent to the microbiology laboratory for Gram stain, KOH stain, and bacterial and fungal cultures. Bacterial culture from the vitreous sample in each case had grown Bcc within the first 24–36 hours of the vitreous tap, which was further confirmed using matrix-assisted laser desorption ionization-time of flight mass spectrometry (MALDI-TOF MS). Antibiotic susceptibility testing (AST) was done using the disk diffusion (Kirby–Bauer) method and following the Clinical and Laboratory Standards Institute (CLSI) guidelines.[7] Due to the isolation of the same organism in all vitreous samples and due to the close temporal association of the occurrence of these cases, an outbreak of cluster endophthalmitis was suspected. Necessary precautions were taken and further surveillance investigations for root cause analysis (RCA) were carried out in the operating room (OR), admission wards, and day-care wards in an attempt to localize the common infection source. Medical records of all patients operated over the two months were screened. The data collected included the total number of surgeries performed during the outbreak, demographic information of the five patients, clinical features at presentation and at follow up of the eye affected, type of surgery done along with details of the surgeon and OR table, batch of intraocular lens (IOL) used, batch of visco-elastic, ringer lactate solution used, batch of eyedrops used, time from surgery to presentation, details of other environmental specimens sent for culture from the OR, antibiotic susceptibility report, treatment administered for each patient, recurrences in each patient along with the clinical features and subsequent treatment given, and visual and anatomic outcomes at final follow-up.

Results

Case series

A total of five patients were diagnosed with postoperative endophthalmitis during the period. Three were males and two females. The mean age was 62.20 ± 6.45 years. The mean number of days from surgery to presentation was 14 ± 8.15 days. Four patients had undergone uneventful phacoemulsification cataract surgery with implantation of acrylic foldable IOL by two surgeons while one patient underwent penetrating keratoplasty (PK). All the surgeries were performed in the same OR complex in two tables placed in two adjacent rooms with a communicating door between the two rooms for the surgeons and nursing assistants. Entry into and exit from both the rooms for the patients were separate and there was no movement of patients in between the two rooms.

None of the cataract surgery patients had incision site corneal infiltrates. Post-PK patient had infiltrates along the sutures at presentation. Two patients (patient 1 and patient 2) had hypopyon at the time of presentation [Fig. 1a and b] while patient 4 and patient 5 had no hypopyon [Fig. 1c and d]. Fundus could be visualized hazily in two patients with indirect ophthalmoscopy (IO), while three patients had a dull fundal glow. Endophthalmitis was confirmed in all the patients based on clinical examination followed by USG B scan [Fig. 2].

Each patient received one dose of intravitreal ceftazidime (2.25 mg/0.1 ml) and vancomycin (1 mg/0.1 ml) on the day of presentation. Additionally, they were started on 0.5% moxifloxacin eye drops hourly, 1% prednisolone eye drops hourly, and 2% homatropine eye drops thrice a day. Vitreous tap sample in each patient isolated Bcc within the first 24–36 hours of the vitreous tap. The organism was sensitive to ceftazidime, cotrimoxazole, and meropenem and resistant to other antibiotics. Antibiotic susceptibility was tested by the disk diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines.[7] The initial intravitreal antibiotic injection was followed by core vitrectomy after 48–60 hours in four post-cataract surgery patients as there was poor response to the initial intervention as per the endophthalmitis vitrectomy study (EVS) protocol and our institute protocol. All patients were observed for at least 48 hours after the initial vitreous tap and intravitreal injections of vancomycin (1 mg/0.1 ml) and ceftazidime (2.25 mg/0.1 ml) to look for any signs of clinical improvement. Worsening of pain, worsening of media opacity on IO, drop in visual acuity compared to the initial presentation, increase in the vitreous echogenicities on repeat USG B scan after 48 hours, and increase in hypopyon height were considered as signs of poor response. All the five patients in our series had shown poor response to the initial intervention [Table 1]; thus, four of them underwent subsequent core vitrectomy. Intravitreal imipenem (100 μg/0.1 ml) was injected at the end of vitrectomy in four patients based on the sensitivity reports obtained within 48–60 hours of the first vitreous tap. In addition, they were started on fortified 5% (50 mg/ml) ceftazidime eye drops hourly and intravenous meropenem (1 gm IV 8 hourly × 7 days) in the postoperative period. Further, 1% prednisolone eye drops hourly and 2% homatropine eye drops thrice a day were continued for each patient. Endolaser and silicone oil implantation was done in one patient due to

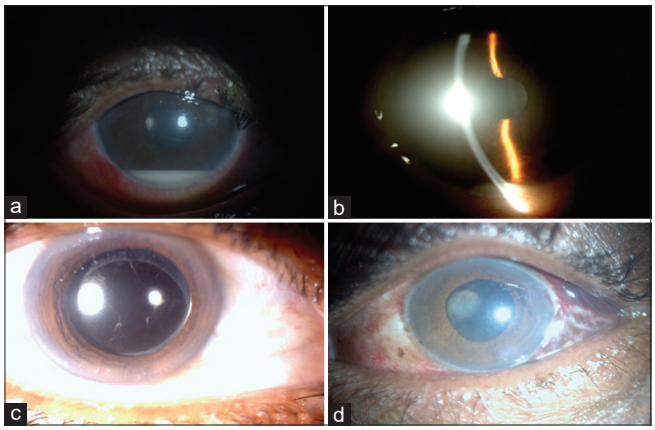

Figure 1: Slit-lamp images showing (a) and (b) Hpopyon at presentation in patient number 1 and 2, respectively, while (c and d) showing no hypopyon at presentation in patient number 4 and 5, respectively

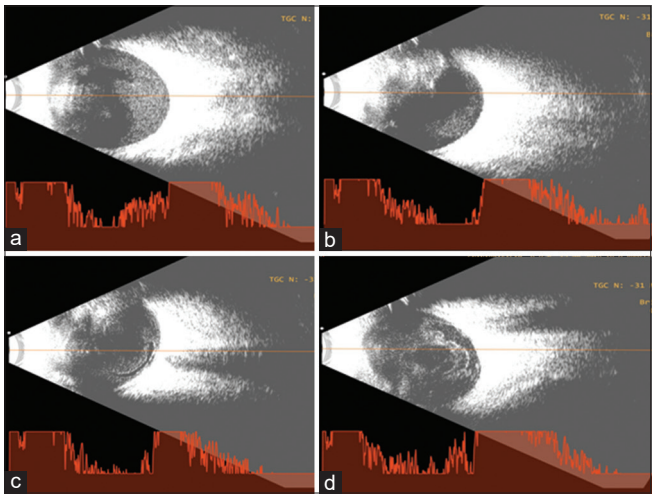

Figure 2: Ultrasound B scan images at presentation (a-d) showing vitreous echogenicities suggestive of endophthalmitis in patient number 1, 2, 4, and 5, respectively

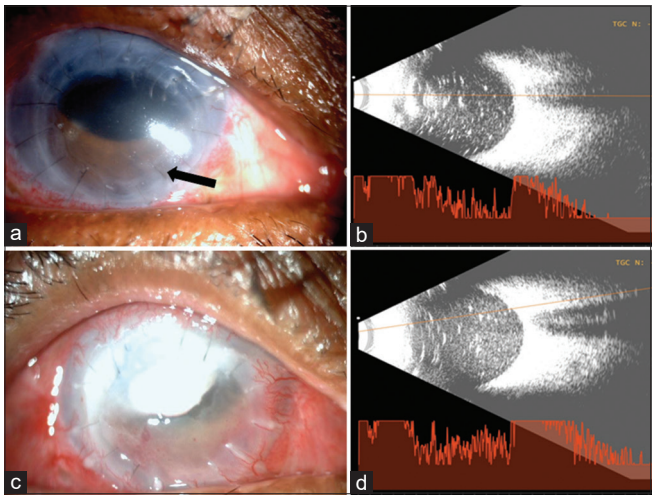

Figure 3: Images of patient number 3 post penetrating keratoplasty showing (a) corneal edema of both graft and host tissues with few suture infiltrates (arrow mark) at presentation and no hypopyon seen in slit lamp, (b) ultrasound B scan at presentation with vitreous echogenicities suggestive of endophthalmitis, (c) worsening of clinical features at 1 week seen in slit lamp with subsequent progression to Phthisis bulbi, and (d) ultrasound B scan at 1 week with increased vitreous echogenicities suggestive of worsening of endophthalmitis

documentation of a retinal break during vitrectomy above the supero-temporal arcade. One patient (post-PK) did not consent for core vitrectomy. He received one dose of intravitreal imipenem after 48 hours of presentation. There was no further improvement in his clinical condition and he subsequently developed phthisis bulbi in the affected eye [Fig. 3a-d].

Three patients had subsequent recurrences [Fig. 4a and b] and were treated with intravitreal imipenem, intravenous meropenem (×7 days), and topical fortified ceftazidime eyedrops (8–12 weeks) at each recurrence. One patient underwent an additional core vitrectomy. Two patients had developed new vessels on the iris (NVI) [Fig. 4a and b]; one patient received intravitreal avastin (1.25 mg/0.05 ml) while the second patient had silicone oil-filled globe and, therefore, received intracameral avastin (2.5 mg/0.1 ml) injection. NVI resolved subsequently in both the cases following a single avastin injection. One patient developed cystoid macular edema [Fig. 5a] and was treated with topical 0.1% nepafenac eyedrops. One patient had undergone additional aurolab aqueous drainage implant (AADI) [Fig. 5b] for secondary open-angle refractory glaucoma. Silicone oil removal (SOR) was done in one patient nine months later. Two patients had a final BCVA of 20/60, two patients had BCVA better than 20/200, while one patient had no perception of light [Table 1].

Clinical presentation, clinical course, treatment details, and final outcome of the cases are described in Table 1.

Root cause analysis (RCA) of the outbreak

All suspected areas from OR and Ophthalmology wards were swabbed. All ophthalmic solutions, dyes, tubings, instruments, etc., used in ORs and wards were also sent for culture testing [Table 2].

Patient 1 and patient 2 were operated by surgeon 1 on the same day (July 9, 2019) in the same OR. Each case was operated using a new set of instruments and new visco-elastic. The surgeon as well as the assistant had changed gloves in between the cases. However, phaco-emulsification tubings used in both cases were the same. Phaco-emulsification and irrigation-aspiration hand-piece and tips were changed between the cases. Patient 3 was again operated by surgeon 1 on July 11, 2019. Patient 4 was operated by surgeon 2 on July 17, 2019, while patient 5 was operated by surgeon 3 on July 23, 2019. First case of *Burkholderia* endophthalmitis was reported on July 12, 2019; second case on July 17, 2019; third case on August 1, 2019; fourth case on August 9, 2019; and the fifth case on August 10, 2019. The total number of cases operated during the time was 150. Therefore, a diagnosis of cluster endophthalmitis was made and samples for RCA were taken on August 12, 2020.

Burkholderia was not isolated from any of the samples collected. OR tap water had grown *Pseudomonas* while phaco tubing (irrigation aspiration port) had grown *Coagulase-negative staphylococci* and spore-bearing organisms. OR surface cleaning followed by fumigation with 2% bacillocid was done three times. OR was reopened after three consecutive negative swabs. Infected phaco tubings were discarded. OR tank was cleaned and chlorinated, and water was used after negative culture of water. Continuous surveillance of the hospital water supply was done. There was no further recurrence of endophthalmitis till date, that is, one and half years from the cluster outbreak.

Table 1: Demographic data, clinical presentations, clinical course, and final outcome of *Burkholderia cepacia* complex (Bcc) endophthalmitis patients

Parameters	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age/Gender	69/F	58/M	69/M	55/F	60/M
Type of surgery	Phaco-emulsification + foldable acrylic IOL	Phaco-emulsification + foldable acrylic IOL	Penetrating keratoplasty	Phaco-emulsification + foldable acrylic IOL	Phaco-emulsification + foldable acrylic IOL
Days after surgery to onset of symptoms (surgery date, presentation date)	3 days (9th July, 12th July 2019)	8 days (9th july, 17th july 2019)	20 days (11th july, 1st August 2019)	22 days (17th july, 9th august 2019)	17 days (23rd july, 10th august 2019)
Visual acuity at presentation	HMCF	20/60	PL	20/120	HMCF
Anterior chamber reaction (cells)	3 +	2+	3+	2+	3+, mutton fat kps
Hypopyon	+	+	+	_	+
Corneal edema/lid edema	+ / +	-/-	+/+	+/-	+/+
Conjunctival congestion	+	_	+	_	+
Membrane over IOL	_	+	_	+	+
Vitritis/RCS thickening	+	+	+	+	+
Surgical ntervention at presentation	Vitreous tap + IVAB (vancomycin + ceftazidime)	Vitreous tap + IVAB (vancomycin + ceftazidime)	Vitreous tap + IVAB (vancomycin + ceftazidime)	Vitreous tap + IVAB (vancomycin + ceftazidime)	Vitreous tap + IVAB (vancomycin + ceftazidime)
VA after 48 hours	HMCF	20/1200 after 24 h and FC after 48 h	PL	20/400	PL
Surgical intervention after 48-60 h	Core vitrectomy + IVAB (imipenem) after 48 h	Core vitrectomy + IVAB after 54 h	repeat IVAB (imipenem)	Core vitrectomy + IVAB (imipenem) after 60 h	Core vitrectomy + IVAB (imipenem) after 48 h
Best visual acuity during follow up	20/80 at 2 months	20/60	PL	20/32 at 2 months	20/120 at 3 months
Recurrence	Twice (at 3rd and 5th month)	None	_	Once (at 3rd month)	Twice (4th and 6th months)
Additional clinical features during follow-up	NVI (3rd month), CME (3rd month)	_	_	Secondary open-angle refractory glaucoma (5th month)	NVI (4th month), iris bombe, Fibrinous membrane over IOL
Additional intervention	Intravitreal avastin (1.25 mg/0.05 ml) at 3rd month, Nepafenac 0.1% eyedrops from 3rd month	_	_	Second Core vitrectomy at 3rd month, AADI at 6th month	Intracameral avastin (2.5 mg/0.1 ml) at 4th month, Silicone oil removal at 9th month
Final Visual acuity	20/120	20/60	PL negative	20/60	20/200

HMCF=hand movements close to face, CF=Counting fingers, PL=perception of light, IVAB=intravitreal antibiotic, NVI=New vessels on the iris, CME=cystoid macular edema, AADI=Aurolab aqueous drainage implant

Discussion

Incidence of post-cataract surgery endophthalmitis ranges from 0.04% to 0.20%, while culture-proven endophthalmitis incidence ranges from 0.02% to 0.09%.[2,8] Common isolates in sporadic postoperative endophthalmitis include gram-positive cocci (44%–64%; commonly, Staphylococcus species), and gram-negative bacilli (26%–43%; commonly Pseudomonas species).[8] On the other hand, most common isolate in postoperative cluster endophthalmitis is the gram-negative organism, *Pseudomonas aeruginosa*.[5] Very few reports of cluster endophthalmitis due to *Burkholderia* species have been described in the literature. Lalitha *et al*.[1] reported a case series of 13 cases of *Burkholderia*-associated post-cataract surgery cluster endophthalmitis. Contaminated anesthetic eye drop was the source of infection. Okonkwo *et al*.[9] reported five consecutive cases of *Burkholderia* associated post-pars plana vitrectomy endophthalmitis where the organism had colonized the tamponading agent, silicone oil. In the present study, we report a similar series of a rare cause of postoperative cluster endophthalmitis secondary to *Burkholderia* infection. However, the source of infection was not identifiable in our case series despite extensive surveillance investigations.

Bcc are gram-negative, nonfermenting, oxidase-positive bacilli. They cause infection in patients with immunosuppression and chronic granulomatous diseases. Whenever *Burkholderia* is isolated from ocular specimens, it has to be considered to be either a nosocomial infection or an infection acquired from the surrounding environment as it is not a commensal.[10] Most cases of Bcc-related endophthalmitis present acutely with decreased vision and severe intraocular inflammation. Rarely, they can cause delayed postoperative endophthalmitis.[6,10] In our case series, three cases had presented within a week while two cases

Table 2: Surveillance samples and culture results

Samples	Culture results
Irrigating fluids, distilled water	No growth
OR tap water from sinks	*Pseudomonas*
Anesthetic drops, Betadine drops, Antibiotics drops, Miochol, trypan blue dye, aurocort	No growth
Phaco tubing: I/A ports	*Coagulase-negative staphylococci* and aerobic spore-bearing bacilli
Phaco handpiece	No growth
Instrument trolleys, Syringes, Surgeon's gown, slit lamps, IV sets	No growth
OR walls, Surfaces of operating tables, Air condition system, Microscopes, admission ward swabs, pre-scrub areas	No growth

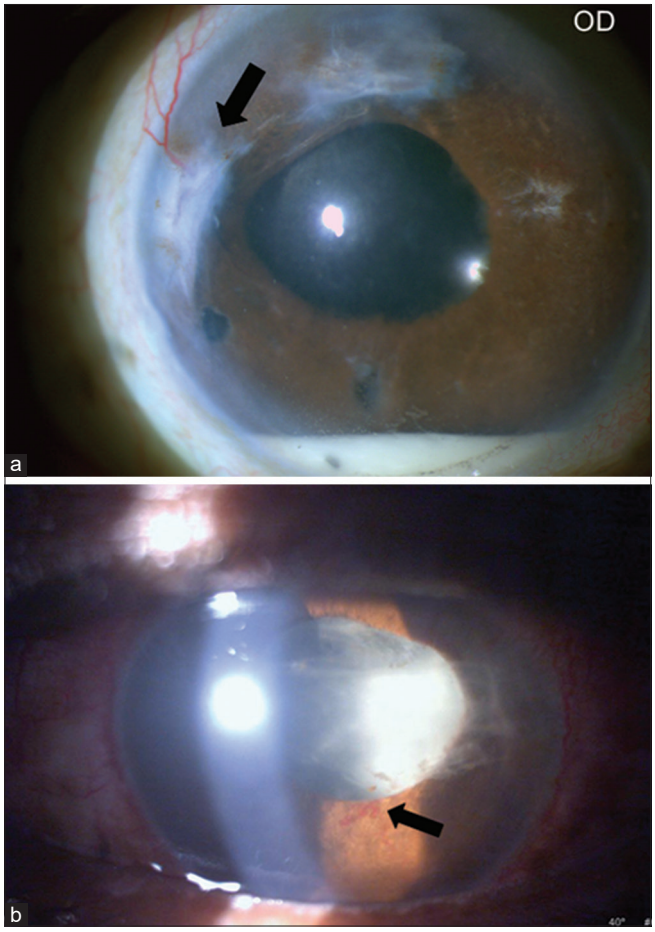

Figure 4: Slit-lamp images showing (a) recurrence of endophthalmitis with hypopyon in patient number 1 during follow up along with the development of new vessels on the iris (arrow), and (b) recurrence of endophthalmitis with a dense fibrinous membrane in the anterior chamber in patient number 5 along with the development of new vessels on the iris (arrow)

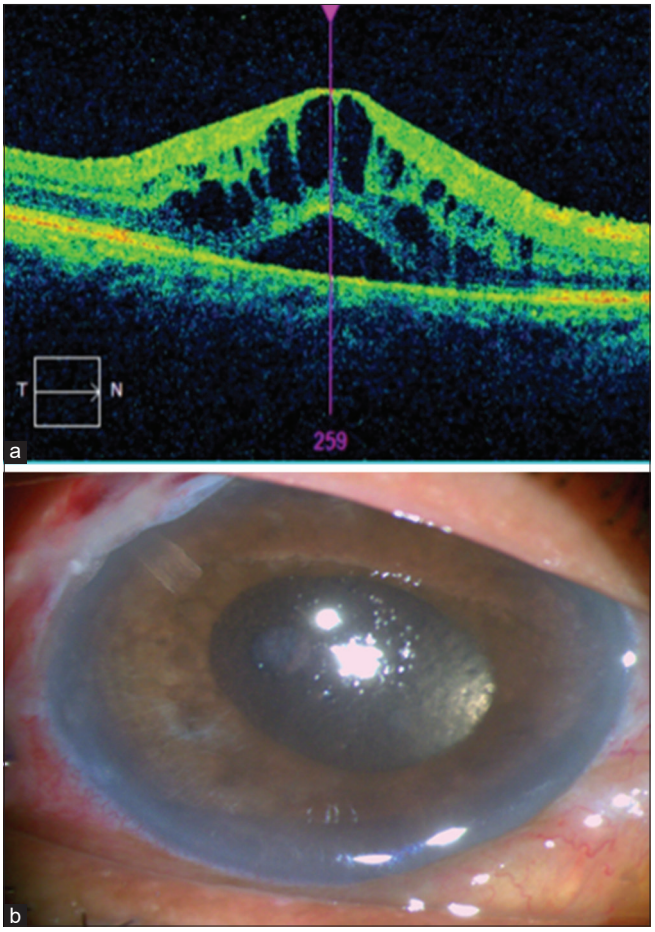

Figure 5: Images showing (a) development of Cystoid macular edema in patient number 1 during follow up as seen on optical coherence tomography, and (b) placement of aurolab aqueous drainage implant in the anterior chamber in patient number 4 during follow-up to treat refractory secondary glaucoma

had presented between two and four weeks after surgery. The clinical presentations may also differ considerably from patient to patient, ranging from an initial mild cellular reaction to severe anterior chamber reaction with or without hypopyon. Corneal involvement can also vary from mild edema to severe keratitis or corneal abscess.[6,10,11] Two cases in our series presented with hypopyon, three had fibrinous membrane over the intraocular lens (IOL), two cases had relatively white eye at presentation, and one patient developed severe corneal infiltrates. *Burkholderia* is also known for recurrence and persistent inflammation despite treatment, as reported by many authors.[6,9-11] This is due to multidrug resistance, or insensitive antibiotics given at the initial treatment, or an inadequate exposure time to antibiotics. Disease recurrence can occur within days or weeks of starting therapy.[9,10] Three of our cases had recurrences between one and six months of starting treatment; two of them had two recurrences each. Topical ceftazidime was continued for 8–12 weeks at the initial presentation and during each recurrence. One patient developed dense fibrinous membrane over the IOL during the episode of disease recurrence. Visual

acuity in these three patients deteriorated following each recurrence, as shown in Table 1. *Burkholderia* isolates in various reports have demonstrated resistance to a wide variety of antibiotics, such as quinolones, ceftriaxone, tobramycin, amikacin, gentamicin, and vancomycin, as reported in our study as well. On the other hand, it has shown sensitivity and good response to treatment with ceftazidime, cotrimoxazole, meropenem/imipenem, piperacillin/tazobactam, etc. Isolates in this current study were also sensitive to ceftazidime, meropenem, and cotrimoxazole. Multidrug resistance is seen due to the large genetic makeup and microbiological versatility of the organism and production of lipopolysaccharide and β lactamase, which render some antibiotics ineffective against it. There is a lack of specific evidence and knowledge related to the treatment strategy of *B. cepacia* endophthalmitis. Treatment options include initiation of topical antimicrobials along with intravitreal antibiotics, with or without steroids at the earliest. Multiple intravitreal injections may be often required along with core vitrectomy for successful treatment. Systemic antibiotics may also be needed in some cases.[1,9-11] All our cases had received intravitreal vancomycin and ceftazidime as initial intervention followed by intravitreal imipenem after 48–60 hours based on the sensitivity reports. Core vitrectomy was done in four patients. Additionally, they received intravenous meropenem, topical steroids, and topical fortified ceftazidime eyedrops at presentation and at the time of recurrence.

Visual prognosis in *Bcc* postoperative endophthalmitis is usually guarded. Causes of poor visual recovery include the effect of toxins on the retina, direct effect of the microorganism on the retina, toxicity of intravitreally injected drugs, and finally due to associated intraocular inflammation. In a study by Okonkwo *et al*.,[10] more than 40% of patients had final visual acuity of less than 20/200. Three out of a total of eight patients progressed to phthisis bulbi. In another study by Sachdeva *et al*.,[6] only six eyes out of a total of fourteen eyes (41%) had favorable visual outcome of BCVA 20/200 or better. In a similar study by Okonkwo *et al*.,[9] four eyes out of total of five cases had poor visual outcome due to either phthisis or hypotony or advanced proliferative vitreoretinopathy changes. In our case series as well, one patient progressed to phthisis bulbi; one patient developed CME; two patients developed NVI requiring intraocular avastin injection; and one patient developed secondary open-angle refractory glaucoma requiring AADI surgery. In the three patients with recurrences, the visual acuity worsened with each recurrence. Therefore, the persistent and refractory nature of the organism and the resultant poor visual outcome are quite evident from the clinical course of our patients.

Cluster endophthalmitis outbreak has been attributed to contamination of various sterile products used peri-operatively and intra-operatively. IOL solution was linked to a *P. aeruginosa* endophthalmitis outbreak in a report by Ramappa *et al*.[12] Other contaminated products implicated in cluster endophthalmitis include balanced salt solution, viscoelastics, trypan blue, miochol, contaminated phacoemulsification tubings and handpiece, anesthetic eyedrops, silicone oil, etc.[1,9,12-16] Akçakaya *et al*.[13] reported cluster endophthalmitis associated with *Cellulosimicrobium cellulans* and *Stenotrophomonas maltophilia*. *S. maltophilia* had grown in samples obtained from unused irrigating solution bottles. However, there may be instances where it may be still difficult to ascertain the infection source despite widespread environmental surveillance.

Burkholderia species also can rarely cause outbreaks of various infections. Most of them have immediate environmental surroundings as their sources of origin, such as contaminated respiratory therapy devices, medications, mouthwash, and sink tap water.[1,17-19] In a report by Jimenez *et al*.,[20] *Pseudomonas sp., Burkholderia sp*., and *Ralstonia picketti* were isolated from contaminated pharmaceutical products. Similar to these reports on outbreaks of *Burkholderia*-associated systemic infections, Lalitha *et al*.[1] reported *Burkholderia*-associated post-cataract surgery cluster endophthalmitis due to contaminated anesthetic eye drops, while Okonkwo *et al*.[9] reported *Burkholderia*-associated post-pars plana vitrectomy endophthalmitis due to contaminated silicone oil. *Burkholderia* has also been isolated from contaminated povidone-iodine solutions. Therefore, pre-operative povidone-iodine prophylaxis may be of limited value in such a scenario in preventing *Bcc* infection.[1]

Therefore, root cause analysis (RCA) for cluster endophthalmitis outbreak requires extensive sample collection and testing from all possible peri-operative and intra-operative sterile consumables and nonconsumables, OR water source, ventilation system, OR walls, etc. Source of the cluster infection needs to be identified with all possible efforts and resources available. However, these efforts alone do not prove a definite cause-effect relationship. The offending microorganism isolated from the patients and from the suspected environmental sources should further be established as the same by any of the molecular identification methods, such as polymerase chain reaction, high sequence genotyping, random amplification of polymorphic DNA (RAPD) assay, and pulsed-field gel electrophoresis. These molecular identification methods do unequivocally confirm the infection source and help in undertaking adequate steps for prevention of recurrence.[3,12,21-23] Such extensive OR and environmental surveillance necessitates the constitution of a surveillance team comprising of ophthalmologists, microbiologists, and OR staff. The team carries out investigations that include collections of all medical records of the patients and sample collection from the operating room, preoperative/postoperative/sterilization areas, central stores, etc.[3] Based on the number of endophthalmitis cases encountered, alerts are issued for further running of the OR complex; the color-coded alerts can be graded as below:

Green: 1 in ≥100 cases or 2 in ≥ 600 cases;

Amber: 1 case in 75 cases, 2 cases in 300–500 cases, 3 cases in 700–800 cases

Red: 2 cases in ≤200 cases, 3 cases in ≤600 cases, 4 cases in ≤800 cases.

"Green alert" means need for increased vigilance, whereas an "amber" or "red alert" requires shutting of the OR to facilitate further investigation of the cause of the outbreak.[3] In our study, five endophthalmitis cases were encountered within 6 weeks and in less than 200 cases, which categorizes the outbreak in the "red alert" category. Therefore, the OR complex was temporarily closed for 10 days pending the surveillance investigation results. We constituted a multidisciplinary team comprising of the hospital quality control members, ophthalmologists, microbiologists, and OR nurses. Extensive search for the possible source of infection was carried out from the OR complex, admission wards, consumables and

nonconsumables, equipment used for surgery, etc. However, *Burkholderia* could not be isolated from any of the samples collected. OR tap water had grown *Pseudomonas* while phaco tubing (irrigation aspiration port) had grown *Coagulase-negative staphylococci* and spore-bearing organisms. In a similar report by Maltezou *et al*.[16] on postcataract surgery endophthalmitis outbreak due to multidrug-resistant *P. aeruginosa*, the surveillance team could not trace the common source of infection. Molecular identification methods were not conducted in our study as the environmental source of infection could not be determined, which is a limitation of our study. However, all the cases had grown Bcc in their vitreous samples on bacterial culture, which was further confirmed by MALDI-TOF MS. Although the inciting source could not be identified in our study, it was indirectly addressed by extensive OR surveillance, sterilization of the OR surfaces, disposing of the old phacoemulsification tubings, etc. There has been no further incidence of endophthalmitis in our OR till date (one and half years follow up) since the outbreak of the cluster infections.

Conclusion

Therefore, Bcc are rare opportunistic pathogens responsible for causing outbreaks associated with contaminated pharmaceutical products, respiratory devices, etc. This report describes one of the rare instances of *Bcc*-associated post-cataract surgery cluster endophthalmitis. *Burkholderia* endophthalmitis is a visually devastating postoperative complication and often refractory to treatment. It is also notorious for multiple recurrences despite all possible interventions. Because the visual recovery is guarded, strategies should be formulated for early suspicion, early detection, and optimum treatment. All consumables and nonconsumables used in the OR should be investigated to identify the potential source of infection. However, despite extensive surveillance, the source may not be identifiable in few instances as seen in our case. Ophthalmologists ought to be aware of this possibility as well. Last but not the least, due to the persistent nature of the infection, longer follow-up is recommended in cases of Bcc endophthalmitis.[1,6,9,11]

Statement of ethics

Written informed consent for publication (including the images) has been obtained from the parents of the patient. All procedures carried out were in accordance with the tenets of the Declaration of Helsinki.

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Conflicts of interest

There are no conflicts of interest.

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