

Isolates and antibiotic susceptibilities of endophthalmitis in postcataract surgery: a 12-year review of culture-proven cases

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Abstract The purpose of this study was to investigate the spectrum of organisms causing endophthalmitis after cataract surgery in a tertiary medical center in Taiwan and the antibiotic susceptibilities. This was a retrospective case series study. Patients with endophthalmitis after cataract surgery from January 2004 to July 2015 were reviewed. The outcome measures included the identification of isolates, antibiotic susceptibilities, and final visual outcomes. Twenty-one organisms were isolated from 19 cases. The most common organisms were *Enterococcus* in 38.1 %, especially *Enterococcus faecalis*, followed by *Staphylococcus epidermidis* in 28.6 % and *Staphylococcus aureus* in 9.5 %. All of the Gram-positive isolates tested were susceptible to vancomycin (100 %), and ceftazidime and amikacin were susceptible for Gram-negative organisms. The Gram-positive organisms remain to be the predominant cause of postoperative endophthalmitis, and *Enterococcus* species has had an increasing incidence. Vancomycin is still the most powerful antibiotic for Gram-positive

organisms, while ceftazidime and amikacin are effective for Gram-negative bacteria.

Keywords Microorganisms · Antibiotic susceptibilities · Postoperative endophthalmitis · Endophthalmitis

Introduction

Cataract surgery is one of the most frequent ophthalmology procedures performed worldwide. Endophthalmitis is the most devastating complication after cataract surgery, with a reported incidence of 0.04–0.2 % [1]. Visual outcomes after endophthalmitis are often poor. To prevent the occurrence of endophthalmitis and to allow further treatment when it occurs, it is important to identify the causative organisms and any antibiotic sensitivities against possible causative organisms in every clinic.

In this study, causative organisms of endophthalmitis and antibiotic sensitivities after cataract surgery were investigated in a single medical center over a 12-year time period from January 2004 to July 2015.

Materials and methods

This was a retrospective, non-comparative, consecutive case series study. Patients with endophthalmitis

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after phacoemulsification and intraocular lens implantation performed in Kaohsiung Chang Gung Memorial Hospital from January 2004 to July 2015 were reviewed. Either vitreous or aqueous intraocular specimens were collected using needle aspiration and cultured on blood agar, chocolate agar, fastidious anaerobic thioglycolate broth, and Sabouraud agar to test for aerobic and anaerobic bacteria, mycobacteria, and fungi. Antibiotic susceptibility testing was performed using the paper disk method. The outcome measures included the identification of isolates, antibiotic susceptibilities, and final visual outcomes that were defined as poor (visual acuity [VA] worse than 20/100) or good (VA better than 20/40). Statistical analyses were performed using SPSS software, version 20 (IBM, Armonk, New York, USA). A Chi-square test was used, and a P value <0.05 was considered statistically significant.

Results

The culture reports showed bacterial growth in 19 cases out of 32 cases, with an incidence of 0.13 % and a culture rate of 59.4 %. A total of 21 organisms were isolated from these 19 eyes. Two samples had polymicrobial infections with two different isolates. The most common organisms identified were *Enterococcus* in 38.1 % (8/21), especially *Enterococcus faecalis* (7/21), followed by *Staphylococcus epidermidis* in 28.6 % (6/21) and *Staphylococcus aureus* in 9.5 % (2/21). Coagulase-negative staphylococcus (CONS), *Corynebacterium*, *Stenotrophomonas maltophilia*, Gram-negative bacilli-glucose non-fermentin, and Viridans streptococcus were all identified once (Table 1).

Table 1 The list of isolated organisms

<i>Enterococcus</i> spp.	38.1 % (8/21)
<i>Enterococcus faecalis</i>	33.3 % (7/21)
<i>Staphylococcus epidermidis</i>	28.6 % (6/21)
<i>Staphylococcus aureus</i>	9.5 % (2/21)
Coagulase-negative <i>Staphylococcus</i> (CONS)	4.8 % (1/21)
<i>Corynebacterium</i>	4.8 % (1/22)
<i>Stenotrophomonas maltophilia</i>	4.8 % (1/23)
Gram-negative bacilli-glucose non-fermentin	4.8 % (1/24)
Viridans streptococcus	4.8 % (1/24)

The antibiotic susceptibilities of the organisms are shown in Table 2. All of the Gram-positive isolates tested were susceptible to vancomycin (100 %), and ceftazidime and amikacin were susceptible for Gram-negative organisms. In addition, Gentamycin was tested in nine organisms and showed susceptibility in only 33.3 % of the cases.

In a total of 19 cases, four cases (21.1 %) achieved a final visual acuity (VA) of 20/40 or better (good visual outcome), and eleven cases (57.9 %) had a final VA of 20/100 or worse (poor visual outcome).

In the *S. epidermidis*-infected group (six cases), all three cases achieved a good visual outcome, while in the non-*S. epidermidis*-infected group (13 cases), only one case had a good visual outcome, and eleven cases had poor visual outcomes, P value <0.05 .

All of the eight eyes infected with *Enterococcus* had a VA of 20/100 or worse (poor visual outcome), but in the non-*Enterococcus*-infected eyes, four cases had a good visual outcome, and three cases had a poor visual outcome, P value <0.05 .

In these 19 cases with postoperative endophthalmitis, six patients (31.6 %) had perioperative complications such as posterior capsule rupture or vitreous loss. Seven patients (36.8 %) had systemic diseases such as diabetic mellitus or end-stage renal disease under regular hemodialysis. There were seven patients (36.8 %) without systemic disease who had received smooth cataract surgery but still suffered from postoperative endophthalmitis.

Discussion

Postoperative endophthalmitis is a nightmare for most ophthalmologists. The strategies for reducing the incidence of postoperative endophthalmitis include careful preoperative preparation with povidone iodine and good preoperative hand scrubbing and maintenance of a sterile operative field [2–4]. However, there have still been some cases that could not be prevented. There are several methods typically used to prevent postoperative endophthalmitis through the use of antibiotics, including preoperative, perioperative topical, subconjunctival, intracameral, or periocular antibiotic usage, and postoperative topical antibiotic usage [5, 6]. The ESCRS study, a prospective, randomized, placebo-controlled trial of a prophylactic antibiotic used in cataract surgery, showed that the

Table 2 Antibiotic susceptibility of isolated organisms

	Organisms	Ampicillin	Clindamycin	Erythromycin	Penicillin	Sufamethoxazole– trimethoprim	Gentamycin
Organism 1	<i>Enterococcus</i>	S					R
Organism 2	<i>Enterococcus faecalis</i>	S					R
Organism 3	<i>E. faecalis</i>	S					S
Organism 4	<i>E. faecalis</i>	S			S		R
Organism 5	<i>E. faecalis</i>	S			S		R
Organism 6	<i>E. faecalis</i>	S			S		S
Organism 7	<i>E. faecalis</i>	S			S		R
Organism 8	<i>E. faecalis</i>	S			S		R
Organism 9	<i>Staphylococcus epidermidis</i>	S	S	R	S	S	
Organism 10	<i>S. epidermidis</i>	R	S	S	R	R	
Organism 11	<i>S. epidermidis</i>		S	R	R	S	
Organism 12	<i>S. epidermidis</i>		R	R	R	S	
Organism 13	<i>S. epidermidis</i>		S	S	R	S	
Organism 14	<i>S. epidermidis</i>		R	R	R	R	
Organism 15	<i>Staphylococcus aureus</i>		R	R	R	R	
Organism 16	<i>S. aureus</i>		S	S	R	S	
Organism 17	<i>Stenotrophomonas maltophilia</i>					S	
Organism 18	Gram (–) bacilli– glucose nonfermentin				S		S
Organism 19	Viridans streptococcus	S	S	S	S		
Organism 20	CONS		R	R	R	R	
Organism 21	Corynebacterium	S	R	I	S	R	
	Organisms	Teicoplanin	Vancomycin	Oxacillin	Ciprofloxacin	Amikacin	Ceftazidime
Organism 1	<i>Enterococcus</i>	S					
Organism 2	<i>Enterococcus faecalis</i>	S					
Organism 3	<i>E. faecalis</i>	S	S				
Organism 4	<i>E. faecalis</i>	S	S				
Organism 5	<i>E. faecalis</i>	S	S				
Organism 6	<i>E. faecalis</i>	S	S				
Organism 7	<i>E. faecalis</i>	S	S				
Organism 8	<i>E. faecalis</i>	S	S				
Organism 9	<i>Staphylococcus epidermidis</i>	S		S	S		
Organism 10	<i>S. epidermidis</i>	S		S	S		
Organism 11	<i>S. epidermidis</i>	S	S	R			
Organism 12	<i>S. epidermidis</i>	S	S	R			
Organism 13	<i>S. epidermidis</i>	S	S	R			
Organism 14	<i>S. epidermidis</i>	S	S	R			
Organism 15	<i>Staphylococcus aureus</i>	S	S	S			
Organism 16	<i>S. aureus</i>	S	S	S			
Organism 17	<i>Stenotrophomonas maltophilia</i>						

Table 2 continued

	Organisms	Teicoplanin	Vancomycin	Oxacillin	Ciprofloxacin	Amikacin	Ceftazidime
Organism 18	Gram (–) bacilli-glucose nonfermentin				I	S	S
Organism 19	Viridans streptococcus		S				
Organism 20	CONS	S	S	S			
Organism 21	Corynebacterium	S					

S sensitive, *R* resistant, *I* intermediate, *Space* not tested

incidence rate of endophthalmitis was nearly five times higher in groups that did not receive cefuroxime prophylaxis as compared with groups receiving cefuroxime intracameral injections [7]. However, cefuroxime was not demonstrated to be foolproof and might not be effective with regard to preventing endophthalmitis caused by some bacteria, such as *Enterococcus* [8]. Therefore, successful prevention and treatment of postoperative endophthalmitis depends on prompt use of an antimicrobial regimen [9, 10], and it is important to identify the current bacteria most likely to cause endophthalmitis and to develop a thorough understanding of the antibiotic sensitivities against possible causative organisms.

In the current study, the spectrum of organisms causing endophthalmitis after phacoemulsification with intraocular lens implantation as well as the antibiotic sensitivity at a single medical center in Taiwan over a 12-year period was reviewed. In this study, Gram-positive organisms were predominant (identified in 90.5 % of the overall cases). This proportion was similar to the data reported in the endophthalmitis vitrectomy study (EVS) [11], in which 94 % of the isolates were Gram positive, and in several other studies [12–14]. The most common organisms identified in this study included *Enterococcus* in 38.1 % (8/21) of the cases, especially *E. faecalis* (7/21), followed by *S. epidermidis* in 28.6 % (6/21) of the cases and *Staphylococcus aureus* in 9.5 % (2/21) of the cases. *Enterococcus* species only accounted for 2.4 % of overall cases in the endophthalmitis vitrectomy study (EVS) [11]; however, it made up the majority of postoperative bacterial endophthalmitis cases in the current study, as much as 38.1 %. This increasing incidence of *Enterococcus* endophthalmitis was reported in a prospective multi-center postoperative endophthalmitis study in Sweden [8] and a retrospective study in Korea [15]. In the

study in Sweden [8], *Enterococcus* accounted for 31.1 % of all endophthalmitis cases, while in Korea [15], it accounted for 20.8 %. In this study, it was found in an even higher proportion, 38.1 %.

It is difficult to provide a valid explanation for the increasing incidence of *Enterococcus* endophthalmitis, although frequent usage of fluoroquinolone may play some role [15]. Fluoroquinolone is a popular antibiotic eye solution used both before and after intraocular surgery. It shows high activity against *Staphylococci*, but it has poor activity against *E. faecalis*. As a result, frequent usage of Fluoroquinolone may cause overgrowth of *E. faecalis*. However, fluoroquinolone was not routinely used before and after the operations under consideration in this study.

Intravitreal injection of antibiotics remains the gold standard for postoperative endophthalmitis. Compared with the cases in the EVS and in other previous studies [11, 19], all of the Gram-positive organisms identified in this study were susceptible to vancomycin. Although endophthalmitis resulting from *E. faecalis* resistant to vancomycin has been reported in some studies [16–18], all the *E. faecalis* tested in the current study were susceptible to vancomycin. Only one Gram-negative organism was isolated in this study, and it was susceptible to ceftazidime and amikacin. Therefore, it seems to be reasonable to treat postoperative endophthalmitis with an intravitreal injection of vancomycin combined with ceftazidime or amikacin as empirical antibiotics. In addition, gentamycin was tested on nine organisms, and only three cases showed susceptibility. As the result, gentamycin should play a less important role in prophylactic antibiotic usage.

The final visual outcome data in this study showed that only 21.1 % of cases had a good visual outcome (VA, 20/40 or better), and up to 57.9 % patients had a

poor visual outcome (VA, 20/100 or worse). These results were worse than those reported in the EVS (53 % with a VA of 20/40 or better) and in other studies [12, 20]. This might be related to the high proportion of *Enterococcus* infections in this study. In a subgroup analysis, endophthalmitis cases caused by *S. epidermidis* had better visual outcomes than cases caused by other bacteria, $P < 0.05$, while in this study, it was shown that *Enterococcus*-infected eyes had worse visual outcomes than non-*Enterococcus*-infected eyes, $P < 0.05$. All of the eight cases infected with *Enterococcus* did not reach a VA of 20/100, including five patients without light perception. Bacterial virulence is an important prognostic factor of final visual function [17], and it has been reported in other studies [15, 20, 22] that endophthalmitis caused by *Enterococcus* results in poor visual outcomes. Despite prompt intravitreal vancomycin injection with or without vitrectomy, eyes infected by *Enterococcus* still exhibited poor visual outcomes in the current and previous studies [16, 21, 22]. As a result, further studies are necessary for better prevention and management of endophthalmitis caused by *Enterococcus*, such as other antibiotics strategies for endophthalmitis prevention or more aggressive surgical intervention for endophthalmitis management.

There were limitations to this study, including its retrospective design; small sample size and the fact that only culture-proven cases were included, which might exclude cases with false-negative culture results. Nevertheless, this study still provides important information about organisms causing endophthalmitis and its antibiotic sensitivities.

Conclusions

In conclusion, the Gram-positive organisms remain to be the predominant cause of postoperative endophthalmitis, and *Enterococcus* species has had an increasing incidence in recent years with poor visual outcomes. Vancomycin is still the most powerful antibiotic for most Gram-positive organisms, while ceftazidime and amikacin are effective for Gram-negative bacteria. As a result, combination therapy generally is recommended as the initial empirical treatment of postoperative endophthalmitis. However, because of the increasing number of enterococcus endophthalmitis cases, further studies are necessary in

order to more effectively prevent and treat endophthalmitis in the future.

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References

1. Miller JJ, Scott IU, Flynn HW Jr, Smiddy WE, Newton J, Miller D (2005) Acute-onset endophthalmitis after cataract surgery (2000–2004): incidence, clinical settings, and visual acuity outcomes after treatment. *Am J Ophthalmol* 139: 983–987
2. Speaker MG, Menikoff JA (1991) Prophylaxis of endophthalmitis with topical povidone-iodine. *Ophthalmology* 98(12):1769–1775
3. Ciulla TA, Starr MB, Masket S (2002) Bacterial endophthalmitis prophylaxis for cataract surgery: an evidence-based update. *Ophthalmology* 109(1):13–24
4. Packer M, Chang DF, Dewey SH et al (2011) Prevention, diagnosis, and management of acute postoperative bacterial endophthalmitis. *J Cataract Refract Surg* 37(9):1699–1714
5. Vazirani J, Basu S (2013) Role of topical, subconjunctival, intracameral, and irrigative antibiotics in cataract surgery. *Curr Opin Ophthalmol* 24:60–65
6. Keating GM (2013) Intracameral cefuroxime prophylaxis of postoperative endophthalmitis after cataract surgery. *Drugs* 73:179–186
7. Barry P, Behrens-Baumann W, Pleyer U, et al. ESCRS guidelines on prevention, investigation and management of post-operative endophthalmitis: version 2. 2007. http://www.es CRS.org/vienna2011/programme/handouts/IC-100/IC-100_Barry_Handout.pdf. Accessed 3 Dec 2012
8. Friling E, Lundstrom M, Stenevi U, Montan P (2013) Six-year incidence of endophthalmitis after cataract surgery: Swedish national study. *J Cataract Refract Surg* 39:15–21
9. Endophthalmitis Vitrectomy Study Group (1996) Microbiologic factor and visual outcome in the endophthalmitis vitrectomy study. *Am J Ophthalmol* 122:830–846
10. Roth DB, Flynn HW Jr (1997) Antibiotic selection in the treatment of endophthalmitis: the significance of drug combinations and synergy. *Surv Ophthalmol* 41:395–401
11. Han DP, Wisniewski SR, Wilson LA et al (1996) Spectrum and susceptibilities of microbiologic isolates in the endophthalmitis vitrectomy study. *Am J Ophthalmol* 122:1–17
12. Lalwani GA, Flynn HW, Scott IU et al (2008) Acute-onset endophthalmitis after clear corneal cataract surgery (1996–2005). Clinical features, causative organisms, and visual acuity outcomes. *Ophthalmology* 115:473–476
13. Pijl BJ, Theelen T, Tilanus MAD et al (2010) Acute endophthalmitis after cataract surgery: 250 consecutive cases treated at a tertiary referral center in the Netherlands. *Am J Ophthalmol* 149:482–487
14. Schimel AM, Miller D, Flynn HW (2013) Endophthalmitis isolates and antibiotic susceptibilities: a 10-year review of culture-proven cases. *Am J Ophthalmol* 156:50–52

15. Kim HW, Kim SY, Chung IY et al (2014) Emergence of *Enterococcus* species in the infectious microorganisms cultured from patients with endophthalmitis in South Korea. *Infection* 42:113–118
16. Rishi E R, Nandi K, Shroff D, Therese KL (2009) Endophthalmitis caused by *Enterococcus faecalis*: a case series. *Retina* 29(2):214–217
17. Khera M P, Jindal A et al (2013) Vancomycin-resistant Gram-positive bacterial endophthalmitis: epidemiology, treatment options, and outcomes. *J Ophthalmic Inflamm Infect* 3(1):1–4
18. Tang C, Cheng C, Lee T (2007) Community-acquired bleb-related endophthalmitis caused by vancomycin-resistant Enterococci. *Can J Ophthalmol* 42(3):477–478
19. Benz MS, Scott IU, Flynn HW Jr, Unonius N, Miller D (2004) Endophthalmitis isolates and antibiotic sensitivities: a 6-year review of culture-proven cases. *Am J Ophthalmol* 137(1):38–42
20. de Lambert AC, Campolmi Nelly, Cornut Pierre-Loic et al (2013) Baseline factors predictive of visual prognosis in acute postoperative bacterial endophthalmitis in patients undergoing cataract surgery. *JAMA Ophthalmol.* 131(9): 1159–1166
21. Kuriyan AE, Sridhar J, Flynn HW et al (2014) Endophthalmitis caused by *Enterococcus faecalis*: clinical features, antibiotic sensitivities, and outcomes. *Am J Ophthalmol* 158:1018–1023
22. Chen K-J, Lai C-C, Sun M-H et al (2009) Postcataract endophthalmitis caused by *Enterococcus faecalis*. *Ocular Immunol Inflamm* 17(5):364–369