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**Pei-Chang Wu**
**Hsi-Kung Kuo**
**Mien Li**
**Ing-Chou Lai**
**Po-Chiung Fang**
**Sue-Ann Lin**
**Shyi-Jang Shin**
**Yung-Jen Chen**
**Mei-Ching Teng**

# Nosocomial postoperative endophthalmitis: a 14-year review

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P.-C. Wu · H.-K. Kuo · M. Li · I.-C. Lai · P.-C. Fang · S.-A. Lin · Y.-J. Chen · M.-C. Teng (✉)
Department of Ophthalmology,
Kaohsiung Chang Gung Memorial Hospital,
123, Ta–Pei Road, Niao-Sung Hsiang,
Kaohsiung Hsien, 883, Taiwan,
e-mail: d2767@adm.cgmh.org.tw
Tel.: +886-7-7317123
Fax: +886-7-7318762

P.-C. Wu · S.-J. Shin
Graduate Institute of Medicine,
Kaohsiung Medical University,
Kaohsiung, 807, Taiwan,

**Abstract** *Background:* The objective of this study was to evaluate the incidence, predisposing surgery, management and final visual outcome of postoperative endophthalmitis over a 14-year period at one institute. *Methods:* This retrospective study reviewed all intraocular operations performed between 1 January 1991 and 31 August 2004 at Chang Gung Memorial Hospital, Kaohsiung Medical Center, to determine the incidence of nosocomial postoperative endophthalmitis and the characteristics of patients who developed this condition. *Results:* The overall incidence of postoperative endophthalmitis after intraocular surgery was 0.19% (56 out of 30,219). Postoperative endophthalmitis developed in 56 eyes in 56 patients during the study period. The condition developed after cataract surgery in 46 eyes, after penetrating keratoplasty in 6 eyes, after filtering surgery in 2 eyes, after secondary intraocular lens implant in 1 eye, and after vitrectomy in 1 eye. Postoperative endophthalmitis was culture-positive in 31 cases (55%). The most frequent organism isolated was coagulase-negative *Staphylococcus*. Factors associated with better visual acuity outcomes included low virulence of isolated pathogen, initial visual acuity of counting fingers or better, and history of cataract surgery compared with other intraocular surgery. *Conclusion:* The overall incidence of endophthalmitis after intraocular surgery was 0.19%. The results of this 14-year review from a local medical center may serve as a source of comparison for other centers and future studies.

**Keywords** Endophthalmitis · Infection · Ocular surgery · Postoperative

## Introduction

Postoperative endophthalmitis is uncommon, but is one of the most devastating complications following intraocular surgery. The symptoms and signs typically present with reduced or blurred vision, ocular pain, conjunctival hyperemia, lid swelling, and hypopyon [5]. Although rare, fulminate intraocular infection and inflammation often rapidly lead to poor vision or blindness. Despite aggressive management, postoperative endophthalmitis resulted in poor visual outcome in up to 15% of patients with acuity worse than 5/200 [5].

Although the trend in postoperative endophthalmitis incidence rates over the past 20 years is not apparent, varying reported incidence rates of endophthalmitis in recent years have raised a number of questions and concerns regarding preventative measures, surgery types and techniques, and postoperative approaches to infection risk reduction [18]. However, due to the improvements in microsurgery, aseptic technique, and the use of povidone-iodine and antibiotics, the incidence of postoperative endophthalmitis has declined [4, 13]. Prompt diagnosis and early adequate treatment can successfully restore visual acuity in some cases.

This study investigated the incidence, predisposing surgery, clinical course, and final outcome of postoperative endophthalmitis over a 14-year period at one institution.

## Materials and methods

A total of 58,063 ocular surgical procedures were performed between 1 January 1991 and 31 August 2004 at Chang Gung Memorial Hospital, Kaohsiung Medical Center. We retrospectively reviewed the medical records of all patients who received intraocular surgical procedures and had a clinical diagnosis of postoperative endophthalmitis. The intraocular operations were categorized as cataract surgery, pars plana vitrectomy (PPV), glaucoma surgery, penetrating keratoplasty, secondary intraocular lens implants, and others. Cataract surgery included intracapsular cataract extraction, extracapsular cataract extraction, and phacoemulsification. Glaucoma surgery included trabeculectomy and trabculotomy. Cases of postoperative endophthalmitis were excluded under the following conditions: surgery performed at the referring hospital; endogenous endophthalmitis; trauma-associated endophthalmitis; and therapeutic ocular surgery for recent corneal or scleral ulcer. Patients who had received scleral-buckling procedures, strabismus surgery or other extraocular operations, or traumatic ocular penetrating wound operations were also excluded during the study period.

### Perioperative prophylaxis

The eyelid and surrounding facial skin were routinely prepared with povidone-iodine. Patients with inflammation of the lid margin such as blepharitis did not undergo cataract surgery and received medical treatment. Preoperative prophylactic topical antibiotics were not used. Intraocular prophylactic antibiotics were not used either, except for irrigating solution in patients receiving pars plana vitrectomy (PPV) , who received intraocular irrigation with gentamycin (3.2 μg/ml) in balanced salt solution (Alcon, Fort Worth, TX, USA). In cataract surgery, the intraocular irrigation solution was balanced salt solution (Alcon). During the surgery, viscoelastic substances such as Helon (Pharmacia & Upjohn, Stockholm, Sweden) or Viscoat (Alcon) were used. All patients received a subconjunctival antibiotic injection of gentamicin at the end of the procedure.

### Microorganism culture

Intraocular specimens were collected by vitreous needle aspiration or vitrectomy and cultured on blood agar, chocolate agar, fastidious anaerobic thioglycolate broth, and Sabouraud agar for aerobic and anaerobic bacteria, mycobacteria, and fungi. Gram stain and acid-fast stain were performed immediately. A positive culture was defined as either separate colonies of the same organism on two or more separate culture plates or confluent growth at the site of inoculation. Bacterial antibiotic sensitivities were tested using the paper disc method. Aerobic and anaerobic bacteria, fungus, and mycobacterium cultures were discarded after 3 days, 5 days, 1 month, and 3 months respectively.

### Data collection

Data collected for patients who developed postoperative endophthalmitis included age, gender, medical history, type of surgery, duration of operative time, perioperative complications, type of intraocular lens (IOL) if used, pre- and perioperative antibiotics, intraocular antibiotics, postoperative antibiotics, interval to diagnosis of endophthalmitis, culture results, visual acuity at the time of symptom onset, type of management, final visual acuity, postoperative complications, and timing and duration of follow-up.

Acute postoperative endophthalmitis was defined as clinical diagnosis within 7 days of the intraocular procedure. Delayed-onset postoperative endophthalmitis was defined as clinical diagnosis more than 6 weeks after an intraocular procedure [6]. Endophthalmitis diagnosed at any time between 7 days and 6 weeks was defined as subacute endophthalmitis.

The statistical procedures used included the chi-squared test, Fisher's exact test, Student's *t* test and analysis of variance (two-tailed). All statistical analyses were performed with SPSS 10.0 for Windows (SPSS, Chicago, IL, USA).

Visual acuities were converted to the logarithm of the minimum angle of resolution (logMAR) scale for statistical analyses. Visual acuities of counting fingers (CF), hand motions (HM), light perception (LP), and no light perception (NLP) were assigned logMAR values of 2.3, 2.6, 3.0, and 4.0 respectively. This scale was similar to the one reported by Scott and associates [24].

## Results

### Incidence

A total of 30,219 intraocular operations were performed in this institute during the 14-year study period. Postoperative endophthalmitis was diagnosed in 56 of these cases. Out of the total 30,219 patients, 21,562 received cataract operations, 3,547 received pars plana vitrectomy (PPV), 2,298 received glaucoma surgery, 976 received penetrating keratoplasty, and 543 patients received secondary IOL implants. Out of the 56 patients with postoperative endophthalmitis, the condition developed after cataract surgery in

46 cases, after penetrating keratoplasty in 6, after glaucoma surgery in 2, after PPV in 1, and after secondary IOL implants in 1. There were 24 women and 32 men with ages ranging from 21 to 81 (mean 64) years. All patients had unilateral endophthalmitis, with 31 right eyes and 25 left eyes affected. Sixteen (28.6%) of the 56 patients had diabetes mellitus. The mean follow-up was 18 months (range 1 month to approximately 7 years). The overall incidence of postoperative endophthalmitis after intraocular surgery was 0.19% (56 out of 30,219). The incidence of endophthalmitis was highest after penetrating keratoplasty (0.61%), followed by cataract surgery (0.21%), secondary IOL implant (0.18%), glaucoma surgery (0.09%), and PPV (0.03%; Table 1). There were no cases of endophthalmitis after intracapsular cataract extraction, or air–fluid exchange after vitrectomy. Table 2 shows the clinical and demographic characteristics of the 56 patients with postoperative endophthalmitis.

Out of the 56 patients with postoperative endophthalmitis, 46 (82%) cases occurred after cataract surgery procedures including ECCE in 17 cases and phacoemulsification in 29 cases. The overall incidence of endophthalmitis after phacoemulsification (0.35%, 29 out of 8,150) was higher than after ECCE (0.13%, 17 out of 13,395; $p<0.01$, Chi-squared test). However, this 14-year review was divided into approximately 5-year periods with the last 4 years being in the new millennium. There were differences in the rates of endophthalmitis over time for cataract operations using ECCE and phacoemulsification (Table 3). Both in the first 5-year period and the second 5-year period, the ECCE group had a significantly lower incidence of endophthalmitis than the phacoemulsification group. While in the most recent 4-year period, there was no significant difference between the infection rates in the ECCE and phacoemulsification groups (0.30% vs. 0.27%, $p=0.704$). Out of a total of 46 endophthalmitis cases after cataract surgery, complicated cataract extraction (defined as posterior capsular rupture with vitreous loss) was noted in 8 of the 46 cases (17%; 2 in ECCE and 6 in phacoemulsification). Out of the 29 cases of postoperative endophthalmitis after phacoemulsification, 16 patients had a scleral tunnel wound and 13 had a clear cornea incision wound. During the surgery, 9 patients (9 out of 16, 56%) had a sutureless scleral wound and 12 (12 out of 13, 92%) had a sutureless corneal wound.

The interval between surgery and the onset of endophthalmitis ranged from 1 to 177 days (median 6 days). Endophthalmitis was classified as acute in 29 of the 56 cases (52%), subacute in 23 cases (41%), and as delayed-onset in 4 cases (7%). In the delayed-onset group, 3 patients received phacoemulsification and 1 patient received ECCE. No wound leak or suture abscess was noted in these cases. Phacoemulsification with sutureless scleral tunnel wound was performed in 3 cases. Microleakage of the sutureless scleral wound may have occurred in these cases.

## Microorganism culture

A positive culture result was found in 31 out of 56 patients (55%). The bacteria isolated in each group were listed by surgical procedure in Table 4. The most commonly isolated organism was coagulase-negative *Staphylococcus* (14 out of 31, 45%), among which *Staphylococcus epidermis* was the most common species.

## Management

After the diagnosis of endophthalmitis, 48 patients (86%) underwent vitreous needle aspiration and 8 (18%) underwent PPV due to severe vitritis. Antibiotics were administered intravitreally in 52 cases (92%), with the triad of vancomycin(1 mg/ml), amikacin (0.4 mg/ml), and dexamethasone (0.4 mg/ml) being the most common treatment. Almost all patients received intravenous systemic antibiotics with cefazolin and gentamicin for the first few days before the results of the cultures were obtained.

## Visual outcome

visual outcome included visual acuity of 20/40 or better in 21% of patients, 20/100 or better in 55%, and worse than 5/200 in 35%. Fourteen percent of patients had visual acuity of NLP at the final follow-up visit. Table 5 showed the visual acuity results arranged according to potential risk factors including diabetes mellitus, initial visual acuity, management, culture result, microorganism virulence, timing of onset, and surgical procedures. Patients with initial visual acuity of CF or better at the onset of endophthalmitis had better visual outcome ($p=0.006$, $t$ test). Infection with an organism of low Final virulence

**Table 1** Intraocular procedures over a 14-year period at the Chang-Gung Memorial Hospital, Kaohsiung Medical Center. *PK* penetrating keratoplasty with or without intraocular lens (*IOL*), *PPV* pars plana vitrectomy, *2nd IOL implant* secondary intraocular lens implantation, *Other* pupillary membrane removal, IOL removal or repositioning, and air–fluid exchange after vitrectomy

| Surgery | Number of cases/total | Incidence (%) | $p$ value |
|---|---|---|---|
| Cataract | 46/21,562 | 0.21 | |
| PK | 6/976 | 0.61 | 0.025* |
| 2nd IOL implant | 1/543 | 0.18 | 1.000 |
| Glaucoma | 2/2,298 | 0.09 | 0.321 |
| PPV | 1/3,547 | 0.03 | 0.011* |
| Other | 0/1,292 | 0 | |
| Total | 56/30,219 | 0.19 | |

$p$ value according to Fisher's exact test between incidence of endophthalmitis after cataract surgery and incidence after other surgical procedure. *means statistically significant difference ($p<0.05$)

**Table 2** Clinical features in patients with postoperative endophthalmitis. *PK* penetrating keratoplasty, *ECCE* extracapsular cataract extraction, *PHACO* phacoemulsification, *PPV* pars plana vitrectomy, *2nd implant* secondary intraocular lens implant, *Vit. tap* vitreous tapping, *HT* hypertension, *HR* heart disease, *DM* diabetic mellitus, *Staph. epi* Staphylococcus epidermis, *Staph. coagulase (–)* coagulase negative staphylococcus other than Staphylococcus epidermis, *P. a* Pseudomonas aeruginosa, *Strept. pneumo* Streptococcus pneumoniae, *CF* counting fingers, *HM* hand motion, *LP* light perception, *NLP* no light perception, *VM* vancomycin, *AM* amikacin, *Dexa* dexamethasone, *Cefa* cefazolin

| Case number | Age (years)/ sex | Initial operation | Underlying illness | Days until diagnosis | Culture result | AC/Vittap (times) | Vision in initial vit. tap | PPV (times) | Vision in PPV | Intravitreous drug(mg) | Final acuity | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 30/woman | PK | – | 4 | No growth | 1/0 | | | | None | CF | 1 |
| 2 | 69/man | ECCE | HT, HR | 4 | Staph. coagulase(–) | 0/0 | | 1 | CF | None | 0.5 | 9 |
| 3 | 62/woman | PHACO | – | 8 | Staph. epi | 0/2 | CF | 1 | CF | VM (1), AM (0.4), Dexa (0.4) | 0.3 | 4 |
| 4 | 32/man | PK | – | 1 | P. a* | 0/1 | LP | | | VM (1), AM (0.5), Dexa (0.4) | NLP | 2 |
| 5 | 63/man | ECCE | – | 1 | No growth | 0/1 | HM | | | Cefa (2), AM (0.5), Dexa (0.3) | 0.8 | 84 |
| 6 | 65/woman | ECCE | DM | 9 | No growth | | | 1 | No data | Cefa (2), AM (0.5), Dexa (0.3) | NLP | 26 |
| 7 | 50/woman | PK | – | 2 | Candida tropicalis* | 1/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | LP | 9 |
| 8 | 72/man | PHACO | HT | 7 | No growth | 0/2 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.8 | 8 |
| 9 | 65/woman | Trabculectomy | – | 28 | Enterococcus | 0/1 | NLP | | | Cefa (2), AM (0.5), Dexa (0.3) | NLP | 56 |
| 10 | 59/man | ECCE | DM, HT | 41 | No growth | 0/1 | CF | | | VM (1), AM (0.4), Dexa (0.4) | CF | 7 |
| 11 | 67/woman | ECCE | – | 117 | No growth | | | 1 | CF | Cefa (2), GM (0.4) | 0.2 | 43 |
| 12 | 77/woman | PHACO | – | 38 | Staph. epi | 1/1 | 0.02 | | | VM (1), AM(0.4), Dexa (0.4) | 0.01 | 2 |
| 13 | 63/woman | ECCE | HR | 3 | No growth | 0/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.03 | 60 |
| 14 | 78/woman | ECCE | DM | 2 | Enterococcus | 0/1 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.3 | 15 |
| 15 | 57/man | ECCE | DM | 2 | Enterococcus | 0/2 | 0.03 | 1 | CF | Cefa (2), AM (0.4)/VM (1), GM (0.2), Dexa (0.4) | NLP | 62 |
| 16 | 59/woman | PPV | DM | 2 | Enterococcus | 0/1 | | | | Cefa (2.6), AM (0.65), Dexa (0.39) | NLP | 7 |
| 17 | 65/man | PK | – | 35 | Strept. pneumo | 0/1 | HM | | | Cefa (2), GM (0.4) | NLP | 8 |
| 18 | 76/man | PHACO | – | 50 | No growth | 0/1 | 0.01 | 1 | CF | VM (1), AM (0.4), Dexa (0.4) | 0.01 | 3 |

**Table 2** (continued)

| Case number | Age (years)/ sex | Initial operation | Underlying illness | Days until diagnosis | Culture result | AC/Vittap (times) | Vision in initial vit. tap | PPV (times) | Vision in PPV | Intravitreous drug(mg) | Final acuity | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 63/man | PHACO | HT | 29 | Staph. coagulase(–) | 0/1 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 1 | 3 |
| 20 | 61/woman | ECCE | HT | 8 | Staph. epi | 0/1 | CF | 1 | HM | Cefa (2), AM (0.5), Dexa (0.3) | 0.5 | 2 |
| 21 | 48/woman | PK | – | 11 | P.a, Enterococcus, Candida | 0/1 | | | | | 0.2 | 33 |
| 22 | 63/woman | ECCE | – | 5 | No growth | 0/1 | CF | | | Cefa (2), AM (0.5), Dexa (0.3) | 0.6 | 10 |
| 23 | 73/man | PK | HT | 22 | Staph. aureus | 1/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | LP | 17 |
| 24 | 71/woman | ECCE | HT | 19 | No growth | 0/0 | 0.03 | | | | 0.3 | 19 |
| 25 | 60/man | PHACO | – | 4 | No growth | 0/1 | HM | | | VM (1), AM (0.5), Dexa (0.4) | 0.1 | 61 |
| 26 | 64/woman | ECCE | – | 4 | Staph. epi | 0/1 | HM | | | VM (1), AM (0.5), Dexa (0.4) | 0.3 | 11 |
| 27 | 69/woman | ECCE | DM, HT | 8 | No growth | 0/2 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 0.9 | 27 |
| 28 | 75/woman | PHACO | – | 2 | Enterococcus | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | HM | 15 |
| 29 | 66/man | PHACO | DM | 3 | No growth | 0/2 | LP | | | VM (1), AM (0.5), Dexa (0.4) | CF | 15 |
| 30 | 59/man | ECCE | DM | 14 | No growth | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 15 |
| 31 | 50/man | PHACO | DM | 77 | No growth | | | 1 | HM | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 9 |
| 32 | 73/man | PHACO | – | 16 | Staph. epi | 0/2 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 1 | 7 |
| 33 | 21/woman | PHACO | – | 5 | No growth | 0/2 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 12 |
| 34 | 58/man | PHACO | – | 4 | Staph. epi | 0/1 | 0.7 | | | VM (1), AM (0.4), Dexa (0.4) | 1 | 11 |
| 35 | 70/man | PHACO | DM, HT | 9 | Staph. epi | 0/2 | 0.04 | | | VM (1), AM (0.4), Dexa (0.4) | 0.3 | 27 |
| 36 | 77/woman | ECCE | – | 29 | No growth | 0/1 | 0.05 | 1 | HM | VM (1), AM (0.4), Dexa (0.4) | NLP | 23 |
| 37 | 63/woman | PHACO | DM, HT | 4 | Staph. epi | 0/1 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.05 | 2 |

**Table 2** (continued)

| Case number | Age (years)/ sex | Initial operation | Underlying illness | Days until diagnosis | Culture result | AC/Vittap (times) | Vision in initial vit. tap | PPV (times) | Vision in PPV | Intravitreous drug(mg) | Final acuity | Follow-up (months) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 74/man | Trabculectomy | – | 9 | No growth | 0/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | NLP | 41 |
| 39 | 70/man | PHACO | Lung | 2 | Strept. pneumo | 0/3 | 0.03 | | | VM (1), AM (0.4), Dexa (0.4) | HM | 0.2 |
| 40 | 78/man | PHACO | DM | 2 | Enterococcus | 0/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.05 | 3 |
| 41 | 64/man | PHACO | – | 21 | Staph. epi | 0/1 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.1 | 5 |
| 42 | 65/woman | PHACO | – | 1 | No growth | 0/1 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 0.5 | 2 |
| 43 | 71/woman | PHACO | – | 6 | Staph. aureus | 0/1 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 0.05 | 33 |
| 44 | 70/man | PHACO | – | 1 | No growth | 1/1 | HM | | | VM (1), AM (0.4), Dexa (0.4) | CF | 9 |
| 45 | 60/man | PHACO | – | 9 | Staph. coagulase(–) | 0/2 | LP | | | VM (1), AM (0.4), Dexa (0.4) | 1.0 | 18 |
| 46 | 67/man | PHACO | – | 7 | Staph. epi | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.2 | 46 |
| 47 | 66/woman | PHACO | DM, LC | 22 | No growth | 1/1 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 1.0 | 26 |
| 48 | 69/man | PHACO | DM | 2 | Enterococcus | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | CF | 19 |
| 49 | 58/man | ECCE | DM | 3 | No growth | 0/1 | 0.025 | | | VM (1), AM (0.4), Dexa (0.4) | 0.3 | 1 |
| 50 | 65/man | PHACO | – | 2 | Enterococcus | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | HM | 2 |
| 51 | 80/woman | ECCE | – | 5 | Corynebacterium | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.03 | 5 |
| 52 | 22/man | 2nd implant | – | 3 | Staph. epi | 0/2 | HM | | | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 7 |
| 53 | 62/man | PHACO | DM, HT | 8 | No growth | 0/2 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.2 | 1 |
| 54 | 74/man | PHACO | – | 13 | No growth | 0/1 | CF | | | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 21 |
| 55 | 71/man | PHACO | Heart | 37 | Micrococcus, Corynebacterium | 0/1 | 0.2 | | | VM (1), AM (0.4), Dexa (0.4) | 0.4 | 9 |
| 56 | 81/man | PHACO | – | 88 | No growth | 0/5 | 0.08 | 1 | CF | VM (1), AM (0.4), Dexa (0.4) | 0.1 | 9 |

*Donor cornea culture positive for the same bacteria

**Table 3** Differences in the rates of endophthalmitis over time for cataract operations using ECCE and phacoemulsification

| | Infection cases/ total cases (%) | | |
|---|---|---|---|
| | First 5-year period | Second 5-year period | Most recent 4-year period |
| ECCE | 11/8,578 | 4/4,157 | 2/660 |
| | 0.13% | 0.10% | 0.30% |
| PHACO | 2/45 | 15/3,727 | 12/4,380 |
| | 4.44% | 0.40% | 0.27% |
| *p* value | 0.002* | 0.006* | 0.704 |

*p* value by Fisher's exact test or Chi-squared test. *means statistically significant difference ($p < 0.05$)

(coagulase-negative *Staphylococcus*) was significantly associated with a favorable visual outcome compared with more virulent organisms (*Staphylococcus aureus*, *Streptococci* species and gram-negative bacilli; $p<0.001$, *t* test). Development of endophthalmitis after cataract surgery was associated with a better visual outcome than after other surgeries ($p<0.001$, *t* test). There were no significant differences in visual outcome between the acute, subacute, and delayed-onset endophthalmitis groups ($p=0.795$, analysis of variance). Diabetes mellitus, positive culture result, vitrectomy, or type of cataract surgery did not significantly influence the visual outcome.

**Table 4** Bacteria cultured in each postoperative endophthalmitis group

| Surgery | Bacteria | Number of positive cultures |
|---|---|---|
| Cataract | Coagulase-negative *Staphylococcus* | 13 |
| | *Enterococcus faecalis* | 6 |
| | *Corynebacterium sp.* | 2 |
| | *Staphylococcus aureus* | 1 |
| | *Streptococcus pneumoniae* | 1 |
| | *Micrococcus sp.* | 1 |
| PK | | |
| | *Pseudomonas aeruginosa* | 2 |
| | *Candida tropicalis* | 2 |
| | *Staphylococcus aureus* | 1 |
| | *Streptococcus pneumoniae* | 1 |
| | *Enterococcus faecalis* | |
| Trabculectomy | *Enterococcus faecalis* | 1 |
| PPV | *Enterococcus faecalis* | 1 |
| 2nd IOL implant | Coagulase-negative *Staphylococcus* | 1 |

## Discussion

Postoperative endophthalmitis is a devastating complication. Modern advances in surgical technique and infection prophylaxis may have reduced the incidence of complications. Current reports indicate incidence ranges from 0.3 to 0.07% [1, 9, 10, 13, 23, 25, 29, 32]. The incidence rate of postoperative endophthalmitis in this series was 0.19%.

The incidence of postoperative endophthalmitis seems to depend on the type of surgery. The highest incidence of postoperative endophthalmitis in this study was found in patients who underwent penetrating keratoplasty (0.61%). The reason for the higher incidence in these patients may be due to storage medium contamination with microorganisms and special surgical conditions. In the six cases of PKP with endophthalmitis, the donor corneal tissues were all harvested from excised donor corneoscleral rim and preserved for the results of serologic testing of the donor. The corneal buttons were preserved with Optisol-GS (Bausch & Lomb Surgical, Rochester, NY, USA) at 4°C in 5 cases and organ-cultured corneas at 34°C in 1 case. There were 4 positive donor rim cultures and the culture results of 3 cases were compatible with the finding of recipient vitreous needle aspiration culture, with 2 yielding *Pseudomonas aeruginosa*, 1 yielding *Candida* tropicalis. There were no donors with a previous history of bacterial or fungal sepsis. Positive donor rim culture is a risk factor for post-PK endophthalmitis [2]. In addition, the large wound size and complexity of PK or its use in combination with other surgical procedures may be other risk factors.

Because cataract surgery is the most common intraocular surgery, most cases of postoperative endophthalmitis follow cataract extraction [30]. It has been hypothesized that ECCE, with its larger incision, would provide an important retrograde current of the irrigation fluid from the ocular surface into the eye compared with phacoemulsification, which has a smaller incision and outward intraocular pressure gradient. However, Mistlberger and colleagues studied the anterior chamber aspirate in 511 phacoemulsification and 189 ECCE procedures, and found no significant difference in culture rates between phacoemulsification and ECCE eyes [16]. Few studies have directly compared the risk of endophthalmitis between ECCE and phacoemulsification. In two previous studies, endophthalmitis rates did not significantly differ between ECCE and phacoemulsification (0.22% vs. 0.30% in one study [17], and 0.26% versus 0.27% in another [12]. These results are similar to the most recent 4-year period in this study. In a recent study, phacoemulsification was associated with a higher risk of acute endophthalmitis relative to ECCE, independent of posterior capsule rupture [32]. During the period of this study, the surgical technique for cataracts transitioned from ECCE to phacoemulsification at this institution. Accordingly, there was a learning curve for the

**Table 5** Final visual outcome by characteristics. *IVI* intravitreous antibiotics injection, *LogMAR* logarithm of the minimum angle of resolution

| Characteristics | Number of cases | Landolt C acuity | | LogMAR | | *p* value |
|---|---|---|---|---|---|---|
| | | Median | Range | Mean | SD | |
| Diabetic mellitus | | | | | | |
| Yes | 16 | 0.1 | NLP~1.0 | 1.43 | 1.52 | 0.950 |
| No | 40 | 0.14 | NLP~1.0 | 1.45 | 1.30 | |
| Initial vision of infection | | | | | | |
| CF or better | 30 | 0.3 | NLP~1.0 | 0.93 | 1.09 | 0.006* |
| HM or worse | 22 | 0.01 | NLP~1.0 | 1.91 | 1.38 | |
| Treatment | | | | | | |
| IVI | 46 | 0.14 | NLP~1.0 | 1.39 | 1.30 | 0.482 |
| PPV | 10 | 0.14 | NLP~0.5 | 1.72 | 1.65 | |
| Culture result | | | | | | |
| Postive | 31 | 0.05 | NLP~1.0 | 1.59 | 1.41 | 0.360 |
| Negative | 25 | 0.2 | NLP~1.0 | 1.26 | 1.29 | |
| Virulent of organism | | | | | | |
| Low virulence | 14 | 0.35 | 0.01~1.0 | 0.54 | 0.57 | <0.001* |
| High virulence | 6 | LP | NLP~0.2 | 2.60 | 1.37 | |
| Type of onset | | | | | | |
| Acute | 29 | 0.05 | NLP~1.0 | 1.52 | 1.26 | 0.795 |
| Subacute | 23 | 0.3 | NLP~1.0 | 1.43 | 1.58 | |
| Delay-onset | 4 | 0.14 | NLP~0.4 | 1.02 | 0.70 | |
| Type of cataract surgery | | | | | | |
| ECCE | 17 | 0.3 | NLP~0.9 | 1.27 | 1.43 | 0.510 |
| PHACO | 29 | 0.2 | HM~1.0 | 1.04 | 0.91 | |
| Surgical procedure | | | | | | |
| Cataract | 46 | 0.25 | NLP~1.0 | 1.12 | 1.12 | <0.001* |
| Other | 10 | NLP | NLP~0.2 | 2.94 | 1.40 | |

*p* value by Student's *t* test or analysis of variance (ANOVA)
*means statistically significant difference ($p<0.05$)

newer, more complex technique of phacoemulsification in the first and second 5-year periods. This may explain the higher incidence of endophthalmitis in patients receiving phacoemulsification compared with ECCE. Additional factors that may facilitate the entering of pathogen into the anterior chamber and sutureless wound include a high number of instruments passing in and out of the eye [14, 28], the lack of routine disinfection of the vacuum control manifold in phacoemulsification equipment [15], and the potential abscess cavity created by scleral tunnel incisions [3, 7, 19]. In this study, most cases of postoperative endophthalmitis in the phacoemulsification group received sutureless procedures. An infective inoculum may be introduced into the anterior chamber by the ingress of intraoperative or early postoperative fluids through the external opening of the sutureless wound as a result of externally applied pressure. Eye rubbing, particularly with the eye in extreme infraduction, can promote such a mechanism [10].

The underlying disease of diabetes mellitus was present in nearly a third (29%) of patients with postoperative endophthalmitis. Patients with diabetes mellitus have a higher susceptibility for developing bacterial and fungal infections [21]. Patients with systemic conditions should be treated with caution, especially those with diabetes mellitus or immunocompromised status [31].

Endophthalmitis was culture-proven in 55% of all cases. This positive culture rate was slightly lower than in previous reports, which ranged between 60 and 70%[5, 26]. This discrepancy may have been due to the method of sample collection, which was by vitreous needle aspiration in most cases. A vitreous specimen may be obtained by needle aspiration using either a vitrectomy biopsy procedure or as part of a full therapeutic vitrectomy. The vitreous in patients with endophthalmitis can be dense and contain inflammatory membranes, so needle aspiration may not provide sufficient volume for analysis.

In this study, coagulase-negative *Staphylococcus* was the most common pathogen responsible for postoperative endophthalmitis and accounted for 45% of the culture-proven cases, which is consistent with previous reports [2, 8, 20]. The high frequency of infection by this organism may be related to its high prevalence on external ocular surfaces, and especially its origination from the normal flora on the patient's lid [8, 22, 27].

In this study, isolation of pathogens with low virulence was associated with better visual outcome than isolation of pathogens with high virulence. The ability of highly

virulent organisms such as *Staphylococcus aureus*, streptococcal species or gram-negative organisms to provoke a tremendous inflammatory reaction may explain this finding. Several studies have reported that virulent organisms were a risk factor for poor visual outcome [1, 5, 26].

The endophthalmitis vitrectomy study recommended that immediate vitrectomy be reserved for eyes that have a visual acuity of light perception or worse [5]. In this study, vitrectomy was performed in 9 cases and 8 of them had a visual acuity of HM or CF before vitrectomy. Vitrectomy provided no significant advantage in the visual outcome of these patients. This finding is similar to results reported by Aaberg et al. [1], and supports that vitrectomy should be reserved for eyes with poor visual acuity of light perception or worse [5].

Previous studies showed that positive culture, more virulent pathogens, and poor initial visual acuity are risk factors for worse visual outcome [1, 26]. This study revealed that pathogens with low virulence, initial visual acuity of CF or better, and cataract surgery compared with other intraocular surgery were significantly associated with better visual outcome.

Positive culture result was a risk factor for worse visual outcome in previous studies [23, 26]. It is possible that the presence of a larger number of intraocular bacterial colonies at sampled sites led to positive culture results, while more silent organisms or those of low virulence, such as *Propionibacterium acnes*, would have led to negative culture results. However, in this study there was no significant difference in the visual outcomes of our patients, even though the median visual acuity and mean logMAR vision of patients with a negative culture result were better than those with a positive culture result. Another study of nosocomial acute-onset postoperative endophthalmitis also found no significant difference in mean logMAR visual outcome between patients with positive and negative culture results ($t$ test, $p$=0.74, our data recalculation from the original data found in Table 3 of that study) [1]. The importance of positive culture results to visual outcome deserves further prospective study.

This study had several limitations. In addition to the use of a retrospective study design, potential preoperative risk factors for postoperative infection were not collected systematically.

In summary, the rate of nosocomial postoperative endophthalmitis after intraocular surgery over the 14-year period of this study was 0.19%. Coagulase-negative *Staphylococcus* was the most common infectious organism. Factors associated with better visual outcomes included initial visual acuity of CF or better, infection by a low virulence pathogen, and a history of cataract surgery.

## References


1. Aaberg TM Jr, Flynn HW Jr, Schiffman J, Newton J (1998) Nosocomial acute-onset postoperative endophthalmitis survey. A 10-year review of incidence and outcomes. Ophthalmology 105:1004–1010
2. Antonios SR, Cameron JA, Badr IA et al (1991) Contamination of donor cornea: postpenetrating keratoplasty en dophthalmitis. Cornea 10:217–220
3. Cosar CB, Cohen EJ, Rapuano CJ, Laibson PR (2001) Clear corneal wound infection after phacoemulsification. Arch Ophthalmol 119:1755–1759
4. Eifrig CW, Flynn HW Jr, Scott IU, Newton J (2002) Acute-onset postoperative endophthalmitis: review of incidence and visual outcomes (1995–2001). Ophthalmic Surg Lasers 33:373–378
5. Endophthalmitis Vitrectomy Study Group (1995) Results of the Endophthalmitis Vitrectomy Study. A randomized trial of immediate vitrectomy and of intravenous antibiotics for the treatment of postoperative bacterial endophthalmitis. Arch Ophthalmol 113:1479–1496
6. Fox GM, Joondeph BC, Flynn HW Jr et al (1991) Delayed-onset pseudophakic endophthalmitis. Am J Ophthalmol 111:163–173
7. Garg P, Mahesh S, Bansal AK et al (2003) Fungal infection of sutureless self-sealing incision for cataract surgery. Ophthalmology 110:2173–2177
8. Hughes DS, Hill RJ (1994) Infectious endophthalmitis after cataract surgery. Br J Ophthalmol 78:227–232
9. Javitt JC, Vitale S, Canner JK et al (1991). National outcomes of cataract extraction. Endophthalmitis following inpatient surgery. Arch Ophthalmol 109:1085–1089
10. Kanellopoulos AJ, Dreyer EB (1996) Postoperative infection following current cataract extraction surgery. Int Ophthalmol Clin 36:97–107
11. Kattan HM, Flynn HW Jr, Pflugfelder SC et al (1991) Nosocomial endophthalmitis survey. Current incidence of infection after intraocular surgery. Ophthalmology 98:227–238
12. Koc F, Sen E, Demirbay P et al (2002) Factors influencing treatment results in pseudophakic endophthalmitis. Eur J Ophthalmol 12:34–39
13. Li J, Morlet N, Ng JQ et al (2004) Significant nonsurgical risk factors for endophthalmitis after cataract surgery: EPSWA Fourth Report. Invest Ophthalmol Vis Sci 45:1321–1328
14. Miller KM, Glasgow BJ (1993) Bacterial endophthalmitis following sutureless cataract surgery. Arch Ophthalmol 111:377–379
15. Mino de Kaspar H, Grasbon T, Kampik A (2000) Automated surgical equipment requires routine disinfection of vacuum control manifold to prevent postoperative endophthalmitis. Ophthalmology 107:685–690

16. Mistlberger A, Ruckhofer J, Raithel E et al (1997) Anterior chamber contamination during cataract surgery with intraocular lens implantation. J Cataract Refract Surg 23:1064–1069
17. Montan P, Lundstrom M, Stenevi U, Thorburn W (2002) Endophthalmitis following cataract surgery in Sweden. The 1998 national prospective survey. Acta Ophthalmol Scand 80:258–261
18. Olson RJ (2004) Reducing the risk of postoperative endophthalmitis. Surv Ophthalmol 49 [Suppl 2]:S55–S61
19. Ormerod LD, Puklin JE, McHenry JG, McDermott ML (1993) Scleral flap necrosis and infectious endophthalmitis after cataract surgery with a scleral tunnel incision. Ophthalmology 100:159–163
20. Ormerod LD, Becker LE, Cruise RJ et al (1993) Endophthalmitis caused by the coagulase-negative staphylococci. II. Factors influencing presentation after cataract surgery. Ophthalmology 100:724–729
21. Phillips WB Jr, Tasman WS (1994) Postoperative endophthalmitis in association with diabetes mellitus. Ophthalmology 101:508–518
22. Samad A, Solomon LD, Miller MA, Mendelson J (1995) Anterior chamber contamination after uncomplicated phacoemulsification and intraocular lens implantation. Am J Ophthalmol 120:143–150
23. Sandvig KU, Dannevig L (2003) Postoperative endophthalmitis: establishment and results of a national registry. J Cataract Refract Surg 29:1273–1280
24. Scott IU, Schein OD, West S et al (1994) Functional status and quality of life measurement among ophthalmic patients. Arch Ophthalmol 112:329–335
25. Shrader SK, Band JD, Lauter CB, Murphy P (1990) The clinical spectrum of endophthalmitis: incidence, predisposing factors, and features influencing outcome. J Infect Dis 162:115–120
26. Somani S, Grinbaum A, Slomovic AR (1997) Postoperative endophthalmitis: incidence, predisposing surgery, clinical course and outcome. Can J Ophthalmol 32:303–310
27. Speaker MG, Milch FA, Shah MK et al (1991) Role of external bacterial flora in the pathogenesis of acute postoperative endophthalmitis. Ophthalmology 98:639–649; discussion 50
28. Stonecipher KG, Parmley VC, Jensen H, Rowsey JJ (1991) Infectious endophthalmitis following sutureless cataract surgery. Arch Ophthalmol 109:1562–1563
29. Sunaric-Megevand G, Pournaras CJ (1997) Current approach to postoperative endophthalmitis. Br J Ophthalmol 81:1006–1015
30. Verbraeken HE (1994) Endophthalmitis after lens extraction. Doc Ophthalmol 87:153–158
31. Wilson FM Jr (1987) Causes and prevention of endophthalmitis. Int Ophthalmol Clin 27:67–73
32. Wong TY, Chee SP (2004) The epidemiology of acute endophthalmitis after cataract surgery in an Asian population. Ophthalmology 111:699–705