

## Clinical Study

# Anterior Chamber Culture at the Conclusion of Cataract Surgery and Its Relation to Post-Cataract Surgery Endophthalmitis

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**Abstract.** *Purpose:* The purpose of this study is to reassess the pathogenesis of postoperative endophthalmitis (POE), aiming to determine the presence of bacteria in the anterior chamber at the conclusion of phacoemulsification cataract surgery, and the subsequent development of POE. *Methods:* A single surgeon performed all cataract procedures across the two nominated day surgical centres. Phacoemulsification surgery with intraocular lens implantation (IOL) was performed on 209 eyes. Patient demographics and POE risk factors were obtained, as well as an anterior chamber (AC) aspirate from each patient at the conclusion of the surgical procedure. The aspirate was cultured for 1 – 5 days. Fourteen eyes also underwent bacterial 16S polymerase chain reaction (PCR) analysis of the AC aspirate. Any subsequent development of POE was recorded. No intracameral antibiotics were used. *Results:* Of the 209 cultures, three cases (1.4%) were positive for growth (95% confidence interval). The three positive cases yielded different microorganisms. One case was positive for bacteria (*Corynebacterium* species) while the other two cases were positive for fungi (*Candida* species and a *Zygomycete*). Cases with positive culture growth had no statistically significant difference in the incidence of preoperative, operative and postoperative risk factors for POE, compared with patients with negative culture. No patient in this study developed POE. *Conclusion:* The bacterial contamination rate of the AC after phacoemulsification surgery with IOL implantation is extremely low. Strict aseptic technique and definitively closed incisions can potentially be attributed to the zero percentage incidence of POE. It is probable that POE is more likely due to postoperative factors.

**Keywords:** endophthalmitis, cataract surgery, culture, anterior chamber

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### Editor

Carsten H. Meyer

### Dates

Received 4 March 2017

Accepted 22 April 2018

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## 1. Introduction

Cataract surgery is the most commonly performed operation worldwide, and acute Post-operative cataract surgery Endophthalmitis (POE) complicates this procedure in approximately 0.1% of cases [1–7]. Despite POE being an uncommon occurrence, its establishment as a major cause of post-cataract surgery blindness has made it a devastating complication [8]. New South Wales, Australia holds the one of the highest documented POE rates in the world [9]. Data from the Australian Institute of Health and Welfare documented rates of endophthalmitis in New South Wales at 0.834% (from 1994 to 2003) [10]. Although these data did not specify the cause of endophthalmitis, almost all resulted from post-cataract surgery infection. This outcome could result from numerous factors, including the high prevalence of cataracts within the aging population, the large volume of cataract operations performed [11, 12], and the introduction of sutureless clear corneal cataract incisions during the 1990s [13].

Nearly all cases of endophthalmitis are caused by bacteria in the USA and Europe, whereas in tropical regions such as India, 10–20% of cases are due to fungi [14, 15]. The organisms recovered from POE generally originate from the oropharyngeal and mucosal flora of the affected individual [16]. It has been reported that 94% of cases are caused by Gram-positive pathogens, the majority of which were coagulase-negative *Staphylococci* (70%), followed by *Staphylococcus aureus* (9.9%), Viridans group *Streptococci* (9%), and *Enterococcus* species (2.2%) [17].

Cataract surgery requires an incision into the anterior chamber (AC), exposing it to the microorganisms that colonise the adjacent ocular surface and adnexa [18–20]. Bacteria enter the anterior chamber during cataract extraction; if they remain there at the end of surgery, POE may result [18, 19, 21, 22]. While ocular surface bacteria contaminate the aqueous humour in 7–43% of cataract operations, POE is rare [18, 21, 23]. This is likely to be due to the rapid turnover of the aqueous humour. Some studies suggest that there is a relationship between the patient's commensal flora and the infecting organism in patients with endophthalmitis [19, 24]. The ocular surface significantly contributes to the transmission of microbes into the anterior chamber during cataract surgery; however, natural defence mechanisms appear to fend off a minor inoculum with these microbes, which are generally of relatively low pathogenicity [23].

Prevention of POE can be achieved by routine sterile practices and prophylactic measures. Measures that are commonly employed include topical antibiotics, Povidone–iodine preoperative preparation of the ocular surface, intracameral antibiotics [25], and antibiotics administered in solutions used intracamerally during the phacoemulsification procedure. Ciulla et al. [26] concluded that only Povidone–iodine use was deemed “moderately important to clinical outcome”.

The purpose of this prospective study was to reassess the pathogenesis of POE within two Ophthalmic Day Surgery Centres in Sydney, Australia. Specifically, the study aimed to assess further the presence of bacteria in the AC at the conclusion of the surgical procedure, and its relationship to subsequent development of POE, with the addition of PCR conducted in a subset of patients.

## 2. Methods

This single-surgeon study was performed according to the World Medical Association Declaration of Helsinki. On this basis, all patients provided informed consent before they were included in the study after approval by the Ethics Committees of the two participating day surgical centres and the University of Notre Dame, Sydney.

The same surgeon (SI) performed all cataract surgical procedures across the two nominated day surgical centres. All patients underwent phacoemulsification cataract surgery at Manly Waters Private Hospital and The Ophthalmic Surgery Centre, located in Sydney, Australia, between January 2011 and September 17, 2014. During this period, 209 cataract operations were randomly selected for inclusion in the study. Demographics collected included patient age, gender, and preoperative, operative and postoperative risk factors.

### 2.1. Surgical technique

The preoperative preparation consisted of each patient receiving one drop of prophylactic chloramphenicol one hour preoperatively and a subsequent three-fold application of Povidone-iodine 5% (PI). The first application of PI occurred in the Anaesthetic bay before the administration of the Anaesthetic block. The second application used a 5% PI solution to clean the lids and periocular region prior to surgery. The third application used a 1%

PI solution to irrigate the conjunctiva and fornices before draping and setting of the speculum prior to the conjunctival incision.

The surgical technique consisted of a superior short scleral tunnel wound combined with the standard divide-and-conquer surgical technique of phacoemulsification. Preoperative and surgical aspects relevant to the study are detailed below.

If required, the temporal eyelashes were kept away from the surgical field by a sterile adhesive drape or with the addition of a sterile Steri-Strip™, as described by Fox et al. [27]. Following a superior conjunctival peritomy, a 2.2mm intrascleral incision 1mm posterior to the limbus was created for phacoemulsification. Phacoemulsification was performed in a routine manner using the divide-and-conquer technique [28]. All patients had an Acrylic IOL, either Hydrophobic or Hydrophilic, implanted into their capsular bag.

At the conclusion of the surgery, all superior scleral wounds were covered with conjunctiva, which was anatomically repositioned and sutured. All wounds were checked to ensure that a watertight seal was maintained. Patients were then given a subconjunctival injection of 0.25mL betamethasone and 25mg/0.25mL cefalothin. Within 60 seconds following wound closure, a 0.1 mL sample of AC aqueous was collected using a 29-gauge insulin syringe via the mainport incision. All patients were examined at 1 day, 1 week and 4 weeks postoperatively, with documentation of any clinical evidence of POE development.

### 2.2. Bacteriological evaluation

The anterior chamber aspirate was cultured on blood agar, chosen due to the nutritional support that it provides for growth of endophthalmitis causative organisms [10].

A more vigorous testing method was applied to 154 aspirations, where the anterior chamber aspirates were cultured on blood, chocolate and Sabouraud agar. The collection and analysis of these cultures were undertaken in conjunction with the Department of Microbiology of Douglass Hanly Moir Pathology, Sydney.

All aspirates were cultured for growth for a minimum of 48 hours, and colonies were identified using current bacteriological techniques [29].

Finally, the last 14 collected aspirates underwent broad range polymerase chain reaction (PCR) based on bacterial 16S rDNA in order to assess further the presence or absence of bacterial contamination at the conclusion of the surgery. The bacterial species were then identified by performing nucleotide sequencing of the PCR product followed by comparison of this sequence with known sequences in established databases [30].

### 2.3. Statistical methods

All data were collected and analysed using SPSS for Windows (version 19.0, IBM). A  $p \leq 0.05$  was considered statistically significant.

Fisher's exact test was used to analyse the association between gender, PCT (posterior capsular tear) incidence, and other risk factors with the presence of a positive AC culture.

Independent samples t-test was used to analyse the association between age and duration of surgery with the incidence of positive AC culture.

## 3. Results

The cohort comprised 209 subjects, 63% women, (mean age 74.79 years [SD  $\pm$  8.64]), with surgery of the left eyes representing 48.2% of the cases. The mean duration of the surgeries was  $17.28 \pm 2.79$  minutes (range 12-31 minutes), with one incident of PCT.

Of the 209 cultures, three cases (1.4%) were positive for growth. The three positive cases yielded different microorganisms. Only one case was positive for bacteria (*Corynebacterium* species) while the other two cases were positive for fungi: *Candida* species and *Zygomycete*. The three positive cases had their right eye operated on, had a mean age of 75 years (SD  $\pm$  5.3), and no definitive risk factors for the development of POE. Importantly, no patient in this study developed POE.

We found no association between age, gender, PCT, or other risk factors and the subsequent contamination of the AC (Table 1).

All PCR analyses were negative for bacterial contamination, as well as not developing POE.

## 4. Discussion

Recent studies report an incidence of POE of 0.07-0.32% in New South Wales, Australia [9, 31]. Advances in Ophthalmic surgical techniques appear to have stabilized the incidence of POE at 0.18% despite a three-fold increase in cataract surgery between 1980 and 2000 [32]. However, POE still represents a significant problem following cataract surgery, and controversy regarding the aetiology of POE still exists. The literature regarding the aetiology of POE

**Table 1:** Collated patient demographics and risk factors (RFs) associated with post-cataract surgery endophthalmitis.

Characteristic	Study characteristics <sup>a</sup>	Relative risk or mean difference (95% confidence interval) <sup>b</sup>	Significance (p-value)
Sample size	209	N/A	N/A
Age (mean $\pm$ standard deviation, range) (years)	74.91 $\pm$ 8.50 (45-92)	-0.087 (-12.599-12.424)	0.980
Sex		1.002 (0.969-1.036)	1.000
Female	133 (63.6%)		
Male	76 (36.4%)		
Preoperative RFs			
Diabetes	21 (10.0%)	0.984 (0.966-1.002)	1.000
Operative RFs			
Duration of surgery (min)	17.28 $\pm$ 2.79 (12-31)	-0.057 (-5.037-4.923)	0.967
Posterior capsule tear	1 (0.5%)	0.986 (0.970-1.002)	1.000
Eye operated	Left 101 (48.3%)	0.972 (0.942-1.004)	0.247
Clear corneal incision	0	N/A	N/A
Postoperative RFs			
Wound dehiscence	0	N/A	N/A
Vitreous incarceration	0	N/A	N/A
<sup>a</sup> Data shown as mean (SD) or n (%)			
<sup>b</sup> for negative AC culture. Relative risk is shown for categorical variables. Mean difference is shown for continuous variables.			

is divided between contamination from the operating field during surgery [33], and/or from microorganisms derived from the eyelid margin/preocular-tear-film [16], that contaminate the AC either directly or by adhering to the IOL [16]. In 65-74% of patients admitted for elective intraocular surgery, the conjunctiva was found to be colonised with pathogens capable of causing endophthalmitis [19, 20].

In this study, an incidence of bacterial AC contamination of 1.4% in a cohort of 209 patients has been documented. While none of the patients developed POE, we believe that this low incidence rate can be attributed to both strict aseptic and surgical wound closure techniques, strongly suggesting that POE is less likely to be due to intraoperative contamination and more likely due to postoperative factors.

PI solution has broad antibiotic activity and has been shown to significantly decrease conjunctival and perilimbal flora [34–36], and to decrease the incidence of culture-positive postoperative endophthalmitis [37]. Current literature debates the ideal concentration of PI to prevent POE, with 5% PI being more effective than 1% in decreasing the conjunctival bacterial load before surgery [38, 39].

High concentrations of PI are not generally required to prevent contamination, as concentrations as little as 0.25% have been shown to be effective in previously reported infection control protocols [40]. The results reported in this study further demonstrate that it is possible to utilize efficiently an aseptic protocol to achieve a very low rate of AC contamination in the

prevention of POE. Additionally, the range of AC contamination reported in other studies using phacoemulsification may stem from postoperative factors such as eye rubbing [41], vitreous incarceration, and wound leakage or dehiscence [12, 16, 42].

Evidence suggests that sutureless cataract surgery may provide a passage of microorganisms into the eye postoperatively. An Australian study on AC contamination after phacoemulsification surgery conducted in 98 patients with only 18% of cases sutured to ensure wound closure [19] showed that, while no patient had positive AC cultures, one patient who had a non-sutured superior corneal wound developed POE five days postoperatively [19]. Other laboratory studies demonstrated the movement of extraocular fluid into the AC at the completion of cataract surgery, including the migration of topical chloramphenicol ointment two months after an uncomplicated operation [10, 43–46]. A suture to seal the incision may be justified when there is any doubt about the self-sealing properties of the incision, although it is not clear how this is demonstrated. In particular, whether the wound leaks out or in, in relationship to the fluid in the AC, or the extraocular fluid, is not clear in the literature. Nevertheless, our study from NSW, Australia, demonstrated that the leakage in was the critical factor [10]. Similar studies have shown that clear corneal incisions managed by stromal hydration alone are not self-sealing [44, 47]. Cornut et al. [48]. found that all AC aspirates were sterile at the conclusion of phacoemulsification in 30 cases of cataract surgery. No case developed POE, and all eyes had their corneal wounds sutured. Comparably, all the patients enrolled in our study had their scleral wounds sutured with no cases of POE, which suggests that adequate infection prophylaxis (PI preparation, sterile draping, and chemoprophylaxis) and wound-suturing techniques should continue to be implemented [9, 10, 49, 50].

The patients enrolled in our study did not develop POE; however, we report an AC contamination rate of 1.4%. One of our patients developed culture-positive *Corynebacterium* sp, a commensal of lids and conjunctiva [51, 52] but did not develop POE. This patient had no preoperative, operative or postoperative risk factors for the development of POE; therefore the culture can be attributed to the physiological nature of the AC circulation. The rapid turnover time of the aqueous humour represents an intrinsic natural defence mechanism, appearing to fend off a minor inoculum with microbes of relatively low pathogenicity [23]. It is also possible that the growth of this organism was actually a contaminant introduced at the time of collection or during laboratory processing, as only a single colony was isolated after two days.

Two of our patients had fungi (*Candida* species and *Zygomycete* species) isolated. In a recent 15-year review on Australian microbiological isolates from POE cases, gram-positive organisms were isolated in 83.1% cases, gram-negative organisms in 15.6% and fungal organisms in 1.3% [53]. *Candida* POE is very rare, with reports indicating that 56% of patients with fungal endophthalmitis have an underlying medical condition such as those with diabetes, HIV-infection, immunocompromise, hepatitis C-infection, exposure to intravenous drug use, and malignancies [54–56]. The patients in our study who had fungi isolated did not have any of the risk factors associated with fungal POE, nor was the clinical setting in a tropical environment. Due to the rare occurrence for fungi to cause POE, the cases in which fungal growth was observed were thought to result from sample contamination and therefore considered to be false positive results. The fact that only a single colony of each fungus was isolated after several days further supports this conclusion.

The applicability of the findings in this study to the Ophthalmic surgeons in general, as there may be large variability in surgical technique, is limited due to the strict cataract surgical protocol applied. A single surgeon's technique was evaluated, thereby limiting the differences in technique and demonstrating that a very low AC contamination rate is possible when applying a strict aseptic technique and sutured wound closure. A negative culture does not necessarily imply AC sterility, and technical limitations (e.g. small volume of the AC fluid aspirated, the adherence of contaminating bacteria to the IOL, and imperfect culture growth and sensitivity) should be taken into account. In this study, PCR analysis was used to validate the results obtained in cultures and to rule out potential false negatives in a subset of samples. Our group considers that additional studies would be informative, but would be required to assess the differences related to operative technique, infection control protocol and wound closure.

The low incidence of POE in this study increases the challenge associated with studying and assessing the risk factors associated with POE. This has resulted in indirect inferences being readily made on the basis of understanding the aetiology of POE. Assuming the sterility of the AC prior to surgery, the current study indicates that a very low AC contamination rate is possible, and is rarely associated with subsequent development of POE. Our group supports the notion that there is a relationship between the patient's commensal flora and the infecting organism in patients with endophthalmitis [19, 24], with the possibility that bacteria enter the AC postoperatively through an unhealed or unsealed incision. This is further strengthened through current surgical technique and protocols addressing many surgical-orientated infection sources including surgical instruments, the operating microscope surface, surgeon skin/respiratory flora, and operating room air [26]. Hence, further consideration may need to be given to the various types of wound closure, and to other wound-related techniques that limit pathogens entering the eye after the completion of cataract surgery. Additionally, the evidence here presented does not support the use of intracameral antibiotics, and does not, therefore, allow our group to conclude that the current risks of these are justified at this time point. This study has shown that achieving minimal AC contamination during surgery is possible, inferring that the use of prophylactic intracameral antibiotics should not be employed as a panacea to inadequate aseptic and surgical technique.

If bacterial contamination routinely occurs with cataract surgery, then the use of antibiotic agents within the eye to counteract these microbes may be one logical approach. If the AC can remain sterile through to completion of surgery, then the risk associated with the use of intracameral antibiotics is not justified. With the emergence of significant antibiotic resistance in both hospital and community acquired infections, this question deserves to be addressed.

In conclusion, this study has shown that a very low microorganism contamination rate of the AC can be achieved after phacoemulsification cataract surgery. Strict aseptic technique and adequate wound closure may be, at least in part, responsible for the zero incidence of POE in the current study.

## Abbreviations

POE: Post-cataract surgical endophthalmitis

AC: Anterior chamber

IOL: Intraocular lens

PI: Povidone-iodine

PCR: Polymerase chain reaction

PCT: Posterior capsule tear

## Acknowledgements/Disclosure

- a. Funding/Support: No government and non-government support was provided for this study.
- b. Financial Disclosures: No financial disclosures.
- c. Other Acknowledgments: Nil.

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