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Original article

# Acute postoperative endophthalmitis after phacoemulsification in a private ophthalmic surgical group

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ABSTRACT

*Purpose:* To analyze the incidence, causes, risk factors and treatment of acute postoperative endophthalmitis (POE) after phacoemulsification in a private ophthalmological group.
*Design:* Uncontrolled retrospective observational study of all cases of POE over 22 years.
*Material and methods:* 369,476 eyes were included after phacoemulsification in 41 surgical centers of the Clínica Baviera-AIER EYE Group from 2002 to 2023. POE cases were reviewed.
*Results:* The general group was divided into two: group A (2002–2007), with vancomycin in the intracameral irrigation flow (27,705 eyes); Group B (2008–2023), with intracameral cefuroxime (341,771 eyes). 31 cases of POE were found (incidence, 0.0084%); 5 in group A (0.018%) and 26 in group B (0.0076%) ($P = .314$), with a mean age of 67.3 years (14 men and 17 women). Cultures were positive in 14 cases in Groups A and B. Treatment was based on intravitreal antibiotics and vitrectomy. The mean time to symptom onset was 6.76 days and the mean time to resolution was 120.7 days. 12 eyes achieved corrected distance visual acuity $\geq$ 20/40.
*Conclusions:* The incidence of POEwas 0.0084% (0.0181% in group A and 0.0076% in group B). The probability of having POE in group A was 2.37 times greater than in group B (OR: 2.37; 95% CI: 0.71–6.2; $P = .079$). The only significant risk factor for POE was posterior capsular rupture.



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## Endoftalmitis aguda tras facoemulsificación en un grupo oftalmológico privado

*Palabras clave:*
Endoftalmitis postoperatoria aguda
Facoemulsificación
Antibiótico intracameral

RESUMEN

*Objetivo:* Analizar incidencia, causas, factores de riesgo y tratamiento de la endoftalmitis aguda postoperatoria (EAP) tras facoemulsificación en un grupo oftalmológico privado.
*Diseño:* Estudio observacional retrospectivo no controlado de todos los casos de EAP durante 22 años.
*Material y método:* Se incluyeron 369.476 ojos tras facoemulsificación en 41 centros quirúrgicos de Clínica Baviera-AIER EYE Group de 2002 a 2023. Se revisaron los casos de EAP.
*Resultados:* El grupo general se dividió en dos: grupo A (2002 a 2007), con vancomicina en el flujo de irrigación intracameral (27.705 ojos); Grupo B (2008 a 2023), con cefuroxima intracameral (341.771 ojos). Se encontraron 31 casos de EAP (incidencia de 0,0084%); 5 en el grupo A (0,018%) y 26 en el grupo B (0,0076%) ($P = ,314$), con edad media de 67,3 años (14 varones y 17 mujeres). Los cultivos fueron positivos en 14 casos en los Grupos A y B. El tratamiento se basó antibióticos intravítreos y vitrectomía. El tiempo medio de aparición de los síntomas fue de 6,76 días y el de resolución fue de 120,7 días. 12 ojos alcanzaron una agudeza visual lejana corregida $\geq$ 20/40.
*Conclusiones:* La incidencia de EAP fue de 0,0084% (0,0181% en el grupo A y 0,0076% en el B). La probabilidad de tener EAP en el grupo A fue 2,37 veces mayor que en el grupo B (OR: 2,37; IC 95%: 0,71–6,2; $P = ,079$). El único factor de riesgo significativo de EAP fue la rotura capsular posterior.



## Introduction

Endophthalmitis is an ocular inflammation that threatens vision. For both patients and surgeons, one of the most feared complications of lens surgery is acute postoperative endophthalmitis (APE), with a reported incidence ranging from 0.01% up to 0.41%.[1–4]

Cataract surgery and refractive lensectomy are among the most common and successful ocular surgical procedures worldwide, requiring effective prophylaxis vs APE.[5]

APE is often associated with severe morbidity. Visual outcomes after endophthalmitis are typically poor. Some eyes fail to achieve a best-corrected distance visual acuity (CDVA) greater than finger counting, and 50% do not recover a CDVA > 20/40. In some cases, anatomical disruption of the eyeball may even occur.[6]

Progressive improvements in phacoemulsification techniques—specifically the use of increasingly smaller sutureless incisions, topical anesthesia, and injectable intraocular lenses (IOLs)—may contribute to reduced APE rates.[2,3] Povidone-iodine (PVI) is a disinfectant and antiseptic agent used for preoperative preparation of ocular adnexa (eyelashes and eyelids) and conjunctiva before intraocular surgery. It has been shown to reduce ocular surface flora and the incidence of positive cultures causing APE without any adverse reactions.[7,8] Additionally, there is evidence that the intracameral administration of antibiotics, such as cefuroxime or vancomycin, can reduce the risk of APE.[9,10]

The primary endpoint of this study is to study the incidence of APE after the use of intracameral vancomycin or cefuroxime in a 22-year retrospective study of eyes undergoing phacoemulsification lens surgery (cataract or refractive lensectomy) at a private center.

Secondary endpoint sinclude: a) analyzing the influence of risk factors on APE fter phacoemulsification with intracameral antibiotics; b) investigating the timing of symptom onset, duration of the condition, and anatomical and visual outcomes in patients diagnosed with postoperative endophthalmitis.

## Methods

The presence of APE was retrospectively reviewed in the health records of 369,476 eyes that underwent phacoemulsification (cataract or refractive lensectomy) consecutively in 41 surgical centers of Clínica Baviera-AIER EYE Group from December 2nd, 2002, through December 30th, 2023. The study fully complied with the principles set forth in the Declaration of Helsinki and was approved by the Medical-Legal Committee of Clínica Baviera. All patients received and signed an Informed Consent form.

Medical data were recorded from the centralized electronic health records system. Most data were automatically extracted from the Clínica Baviera database: automatic entry of patient charts for laterality, treated eye, and sex; automatic and manual (FL) verification of age, surgery day, anesthesia type, suture, incision type, incision size in millimeters, and intracameral antibiotic use. Data on diabetes, wound leakage, and posterior capsular rupture (PCR) were searched across the database, and an experienced ophthalmologist (FL) man-

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**Table 1 – Demographic data.**

| | Non-APE group | APE group | *P* |
|---|---|---|---|
| *Surgical procedures* | 369,445 | 31 | |
| *Laterality (eye)* | | | |
| Right | 50.1% | 55% | .03* |
| Left | 49.9% | 45% | |
| *Gender* | | | |
| Female | 57.9% | 55% | .86* |
| Male | 42.1% | 45% | |
| *Mean age (years)* | 60.6 | 67.3 | .017‡ |
| *Type of anesthesia* | | | |
| Peribulbar | 2% | 0% | 1.000* |
| Sub-Tenon | 0.4% | 0% | |
| Topical | 97.6% | 100% | |
| *Incision suture* | | | |
| No | 98.4% | 100% | 1.000* |
| Yes | 1.7% | 0% | |
| *Incision location* | | | |
| Clear cornea | 94.8% | 90.4% | .88* |
| Limbal | 2.5% | 6.4% | |
| Scleral | 2.7% | 3.2% | |
| *Incision size (mm)* | 2.9 | 3.4 | .002‡ |
| *Intracameral antibiotic* | | | |
| Vancomycin | 7.5% | 16% | .22* |
| Cefuroxime | 92.5% | 84% | |
| *Diabetes* | 5% | 3.2% | .04* |
| *Seidel test* | 0.04% | 0% | 1.000 |
| *Posterior capsule rupture* | 0.66% | 16% | <.001* |

APE: acute postoperative endophthalmitis.
* Chi-squared test.
‡ Independent *t*-test.

ually validated identified cases (based on clinical data, culture results, and differential diagnosis, particularly with TASS) (Table 1).

Phacoemulsification surgical procedures were performed by experienced surgeons using the same protocol, instruments, and devices in all cases. The preoperative protocol included topical antibiotics and nonsteroidal anti-inflammatory drugs (NSAIDs), ocular antisepsis and disinfection (10% PVI on periocular skin and 5% PVI on the cornea and conjunctiva), and isolation of the ocular area. In all cases in this series, intracameral antibiotics were used: vancomycin or cefuroxime. Cases where no intracameral antibiotic was used or where an antibiotic other than vancomycin or cefuroxime was employed were excluded from the study. The postoperative treatment protocol included topical antibiotics, steroids, and NSAIDs.

The overall group (369,476 eyes) was categorizedin into 2 groups based on the intracameral antibiotic used: group A (27,705 eyes): vancomycin administered via intracameral irrigation flow, and group B (341,771 eyes): cefuroxime injected into the anterior chamber at the end of the procedure. APE-diagnosed cases were further categorized into 2 subgroups: group A (5 eyes) and group B (26 eyes), using identical criteria. The diagnosis of APE was manually validated by an experienced ophthalmologist (FL).

The diagnosis of APE was based on symptomatology and clinical examination, demonstrating a disproportionate inflammatory reaction during the normal postoperative course within the first 6 weeks after surgery.[11] Suspected APE prompted aqueous humor and/or vitreous humor sampling for microbiological smear analysis, culture, and antibiogram. Since 2013, APE has been managed based on the clinical practice guidelines of the European Society of Cataract and Refractive Surgeons (ESCRS) and the Spanish Vitreo-Retinal Society (SERV) for the prevention and treatment of endophthalmitis after cataract surgery.[11,12]

The potential risk factors for APE were analyzed, including age, sex, laterality, incision type, suture, intracameral antibiotic use, diabetes, wound leakage, and PCR (Table 2). Patients diagnosed with endophthalmitis were re-examined to assess incidence, prophylaxis, causative pathogens, risk factors, and final anatomical and visual outcomes.

### *Statistical analysis*

Data were extracted from the SQL database and processed and analyzed using R Core Team (2019). A bivariate analysis was performed to study the association of risk factors with APE occurrence. Differences in APE incidence with respect to categorical factors were tested using the chi-square test. Differences for continuous variables were tested using the independent *t*-test. *P*-values <.05 were considered statistically significant.

## Results

A total of 31 cases of APE were identified within the first 6 weeks after surgery out of 369,476 phacoemulsification pro-

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**Table 2 – Incidence of postoperative APE by year and ICA.**

| Year | No. of surgical procedures | No. APE cases | Incidence (%) | ICA | P |
|---|---|---|---|---|---|
| 2002 | 2756 | 1 | 0.03628 | Vancomycin (Group A; incidence rate: 0.0181%) | .223 |
| 2003 | 3590 | 2 | 0.05571 | | |
| 2004 | 4034 | 1 | 0.02479 | | |
| 2005 | 4626 | 0 | 0.00000 | | |
| 2006 | 5496 | 1 | 0.01820 | | |
| 2007 | 7203 | 0 | 0.00000 | | |
| 2008 | 8242 | 5 | 0.06066 | Cefuroxime (Group B; incidence rate: 0.0076%) | |
| 2009 | 8744 | 2 | 0.02287 | | |
| 2010 | 10,744 | 1 | 0.00931 | | |
| 2011 | 13,125 | 3 | 0.02286 | | |
| 2012 | 14,640 | 3 | 0.02049 | | |
| 2013 | 15,373 | 1 | 0.00650 | | |
| 2014 | 17,181 | 0 | 0.00000 | | |
| 2015 | 17,396 | 1 | 0.00575 | | |
| 2016 | 17,399 | 1 | 0.00575 | | |
| 2017 | 19,626 | 1 | 0.00510 | | |
| 2018 | 21,781 | 1 | 0.00459 | | |
| 2019 | 23,583 | 1 | 0.00424 | | |
| 2020 | 22,914 | 1 | 0.00436 | | |
| 2021 | 35,828 | 1 | 0.00279 | | |
| 2022 | 44,683 | 2 | 0.00447 | | |
| 2023 | 50,512 | 2 | 0.00395 | | |
| **Total** | **369,476** | **31** | **0.00811** | | |

APE: acute postoperative endophthalmitis; ICA: intracameral antibiotic.
The incidence of APE in group A was 0.0181% (5:27,705) (0.0076% [26:341,771] in group B). The probability of developing APE in group A was 2.37 times higher vs that of group B (OR, 2.37; 95%CI, 0.71–6.2). However, this difference was not statistically significant (Fisher's exact test; $P = .079$).

cedures (incidence: 0.0084%). The incidence of APE in group A was 0.0181% (5:27,705) ([26:341,771] in group B). Therefore, the likelihood of developing endophthalmitis was 2.37 times higher in group A vs group B (OR, 2.37, 95%CI, 0.71–6.2). However, this difference was not statistically significant (Fisher's exact test; $P = .079$) (Table 1). Twenty-six out of the 31 cases involved cataract surgery and 5, refractive lensectomies. All patients received an acrylic IOL implant (Table 2).

The mean age of the overall group (202,572 patients) was $60.6 \pm 7$ years. However, the mean age of patients with APE was $67.3 \pm 10$ years. Regarding sex distribution, in the APE group, 17 cases (55%) were women, and 14 were men (45%) (Table 1).

Regarding laterality, the incidence of APE was higher in the left eye (17 cases) vs the right one (14 cases), with no bilateral cases. Topical anesthesia was used in 97.2% of procedures, peribulbar anesthesia in 2.4%, and sub-Tenon anesthesia in 0.4%. No surgical procedures were performed under general anesthesia. All APE cases occurred in patients who received topical anesthesia (Table 1).

The main incision was clear corneal in 94.83% of patients, limbal in 2.34%, and scleral in 2.82%. The mean incision size was $2.96 \pm 0.2$ mm. In the APE group, 28 procedures were performed through clear corneal incisions (2.2 mm up to 4 mm), 2 through limbal incisions, and 1 through a scleral incision. No statistically significant differences were found regarding the type of incision ($P = .834$). Wound leakage was not described in any APE cases. The incidence of diabetes was 5.01% in the overall group (15.38% in the APE group [$P = .048$]). PCR occurred in 0.6% of all procedures but in 16% of cases APE developed (Table 1).

Positive cultures were obtained in 14 cases: *Corynebacterium* and *Streptococcus* spp., and *Enterococcus* in group A; and *Staphylococcus waneri*, *Bacillus* spp., *Enterococcus faecalis*, 4 *Staphylococcus epidermidis*, 2 *Propionibacterium* acnes, 1 *Stachybotrys chartrum*, 1 *Pseudomonas aeruginosa*, and 2 *Candida parapsilosis* in group B (Table 3). Treatments included vitrectomy and intravitreal antibiotic injection, vitreous tap with intravitreal antibiotics, and fortified topical antibiotics. The mean symptom onset was 9 days, and resolution occurred after a mean of 121 days. Sixteen eyes achieved a CDVA $\geq$ 20/40. Anatomical sequelae occurred in 13 cases, including retinal ischemia (1 case; group A), phthisis bulbi (1 case), corneal edema (1 case), epiretinal membrane (8 cases), and acute glaucoma (2 cases) (Table 3).

We conducted a multivariate analysis for 4 factors associated with APE (age, incision size, diabetes, and PCR). A logistic regression model adjusted for all variables significantly associated with APE in the bivariate analysis revealed that only PCR retained statistical significance, indicating that eyes with PCR are at higher risk for APE vs eyes without PCR.

## Discussion

In our study, a low incidence of APE was found (0.008%). A systematic review of publications in the literature from 1964 through 2003, including 3,140,650 cataract extractions, estimated a, APE rate of 0.128%.[13] In other studies, the incidence ranges from 0.029% to 0.048% in Sweden,[14,15] 0.026% in China,[16,17] 0.15% in Quebec, Canada,[18] and 0.28% in a public hospital in Madrid, Spain.[19] In an analysis of more than 5 million patients in the Intelligent Research in Sight (IRIS®) registry, Pershing et al.[2] reported an incidence of APE of 0.04% after cataract surgery in the United States, which is similar

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**Table 3 – Clinical data of postoperative cases of APE.**

| Sex | Age (yrs) | Surgery | Eye | Anesthesia | Year | Incision | | | ICA | Beginnig (days) | Risk factor | | Culture | Initial treatment | Time to resolution (days) | Final CDVA | Sequelae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Location | Size | Suture | | | | | | | | | |
| M | 76 | Cat | OD | T | 2002 | CC | 4 | No | V | 7 | PCR | v | Cb | V + A | 18 | 0.05 | RI |
| F | 76 | Cat | OI | T | 2003 | CC | 3.2 | No | V | 3 | None | a | Sc-Ec | A | 60 | Amaurosis | Phthisis bulbi |
| F | 71 | Cat | OD | T | 2003 | CC | 3.5 | No | V | 21 | PCR | v | – | V + A | 180 | HM | Gla |
| F | 70 | Cat | OD | T | 2004 | CC | 3.5 | No | V | 6 | None | v | – | V + A | 52 | 0.6 | ERM |
| F | 67 | Cat | OD | T | 2006 | CC | 3.5 | No | V | 9 | None | v | – | V + A | 30 | 0.16 | CE |
| M | 66 | Cat | OI | T | 2008 | CC | 4 | No | C | 7 | None | v | – | V + A | 50 | 0.05 | ERM |
| M | 67 | Cat | OD | T | 2008 | CC | 12 | No | C | 12 | None | a | Sw + B | A | 210 | 0.1 | Aphakia |
| M | 70 | Cat | OD | T | 2008 | S | 3.2 | No | C | 2 | None | a | Ecf | A | 11 | 0.6 | |
| F | 64 | Cat | OD | T | 2008 | CC | 3 | No | C | 7 | None | v | – | A | 90 | 1.0 | |
| F | 75 | Cat | OD | T | 2008 | CC | 3.2 | No | C | 15 | None | v | Sce | A | 41 | 0.7 | |
| M | 56 | RL | OD | T | 2009 | CC | 3.2 | No | C | 5 | PCR | v | – | A | 116 | 0.45 | |
| M | 65 | Cat | OD | T | 2009 | CC | 4.1 | Yes | C | 8 | None | v | – | V + A | 58 | 0.2 | ERM |
| F | 50 | Cat | OD | T | 2010 | CC | 3.5 | No | C | 1 | None | v | – | V + A | 117 | 0.8 | |
| F | 74 | Cat | OI | T | 2011 | CC | 3.2 | No | C | 20 | None | a | Pa | A | 27 | 1.0 | |
| M | 74 | Cat | OI | T | 2011 | CC | 2.7 | No | C | 8 | None | v | – | V + A | 33 | 0.35 | |
| F | 73 | Cat | OD | T | 2011 | CC | 4 | No | C | 10 | None | v | – | V + A | 330 | 0.2 | |
| F | 69 | Cat | OD | T | 2012 | CC | 4 | No | C | 4 | None | a | Pa | A | 140 | 0.94 | |
| F | 67 | Cat | OI | T | 2012 | CC | 3 | No | C | 11 | PCR | v | Se | V + A | 260 | 0.62 | ERM |
| M | 49 | Cat | OI | T | 2012 | L | 3,2 | No | C | 8 | None | a | – | V + A | 138 | 0.9 | VHF |
| M | 54 | Cat | OD | T | 2013 | CC | 2,8 | No | C | 4 | None | v | Sch | A | 540 | 0.4 | |
| M | 55 | RL | OI | T | 2015 | CC | 3,2 | No | C | 5 | None | v | – | V + A | 120 | 0.5 | ERM |
| F | 54 | RL | OI | T | 2016 | CC | 3,5 | No | C | 3 | PCR | v | Se | A | 47 | 0.6 | ERM |
| F | 55 | RL | OI | T | 2017 | CC | 2,8 | No | C | 1 | None | v | – | V + A | 115 | 0.96 | |
| F | 52 | Cat | OI | T | 2018 | CC | 2,4 | No | C | 4 | None | v | – | V + A | 394 | 0.7 | |
| M | 82 | Cat | OI | T | 2019 | CC | 3,2 | Yes | C | 11 | None | v | – | A | 15 | 0.1 | VO |
| F | 83 | Cat | OI | T | 2020 | CC | 3,2 | No | C | 1 | None | v | – | V + A | 10 | 0.3 | Gla |
| M | 81 | Cat | OI | T | 2021 | CC | 2,4 | No | C | 32 | None | v | Cp | V + A | 120 | 0.7 | ERM |
| F | 81 | Cat | OI | T | 2022 | CC | 2,8 | No | C | 29 | None | v | Cp | V + A | 260 | 0.15 | |
| M | 79 | Cat | OI | T | 2022 | CC | 2,8 | No | C | 15 | None | v | Se | V + A | 80 | 0.9 | ERM |
| F | 56 | RL | OI | T | 2023 | L | 2,8 | No | C | 14 | None | v | Psa | V + A | 40 | 0.16 | |
| M | 76 | Cat | | T | 2023 | CC | 2,8 | No | C | 3 | None | a | – | V + A | 180 | 0.65 | |

M: male; F: female; surgery: type of procedure; Cat: cataract; RL: refractive lensectomy; T: topical; CC: clear cornea; L: limbal; ICA: intracameral antibiotic; V: vancomycin; C: cefuroxime; PCR: posterior capsular rupture; v: vitreous; a: aqueous; Cb: *Corynebacterium*; Sc + Ec: *Streptococcus* spp. and *Enterococcus*; Sw + B: *Staphylococcus warneri* + *Bacillus* spp.; Ecf: *Enterococcus faecalis*; Se: *Staphylococcus epidermidis*; Pa: *Propionibacterium acnes*; Sch: *Stachybotrys chartarum*; Cp: *Candida parapsilosis*; Psa: *Pseudomonas aeruginosa*; V: pars plana posterior vitrectomy; A: intravitreal antibiotic; Final CDVA: final corrected distance visual acuity (Snellen decimal); HM: hand motion vision; RI: retinal ischemia; Gla: glaucoma; ERM: epiretinal membrane; ce: corneal edema; VHF: vitreal hyperreflective foci; VO: vitreous opacity.

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to the rates reported in other large studies worldwide.[14,20–22] A study including 315,246 phacoemulsification procedures performed in 38 surgical centers in California over 8 years reported an incidence of APE of 0.068% in the overall group (0.044% with intracameral prophylaxis using cefuroxime and 0.070% in the topical-only group).[23]

Moreover, there is a significant association between extracapsular or intracapsular cataract extraction and APE vs phacoemulsification,[22–26] which could explain the low incidence observed in our study. Additionally, our APE-affected patients are younger (67.3 ± 10 years) vs those in other series, and most underwent surgery under topical anesthesia.[2,20]

Topical PVI has been shown to reduce APE incidence without adverse reactions.[7] In a review of APE prophylaxis, it was the only measure to receive a category B recommendation (moderately important for clinical outcomes).[27,28] All other reviewed measures were categorized as C (possibly relevant but not definitively related to clinical outcomes).[8] In our series, topical PVI was used according to the standard preoperative protocol.

The role of antibiotics in APE prophylaxis remains controversial.[29] However, intracameral antibiotics are known to reduce the incidence of endophthalmitis after cataract surgery. Cefuroxime, vancomycin, and moxifloxacin are the most widely used intracameral antibiotics, along with cefazolin.[30] In Europe, cefuroxime is commonly employed, whereas moxifloxacin is preferred in countries such as the United States.[31]

Intracameral cefuroxime can be significantly more effective than traditional topical or subconjunctival approaches.[32] Vancomycin, a broad-spectrum antibiotic, covers nearly all species of staphylococci and streptococci associated with cataract-surgery-related APE.[33] Witkin et al. reported a series of cases of hemorrhagic occlusive retinal vasculitis (HORV) associated with the use of intracameral vancomycin within 2 weeks of uncomplicated cataract surgery.[34] No HORV cases were described in our series. The APE incidence was 0.018% with intracameral vancomycin prophylaxis and 0.0076% with cefuroxime, with no statistically significant differences across the 2 groups. We started using intracameral cefuroxime in 2008 due to evidence of its effectiveness in APE prophylaxis and reported toxic effects of vancomycin. Intracameral antibiotics are routinely used in our protocols, with cefuroxime being the standard of care. Occasionally, moxifloxacin is used in penicillin-allergic patients; however, these cases were excluded from the study due to their low frequency and limited statistical weight.

We reviewed some risk factors mentioned in the literature and their concordance with APE cases in our series.[35,36] Various studies mention an increased risk with advanced age, possibly due to reduced natural immunity in this age group.[37] The mean age of our patients in the general group was 60 years (67 years for those diagnosed with APE), which may explain the lower general infection incidence. However, no statistically significant differences were found when adjusted for other risk factors.

Several studies have reported that men are more prone to experiencing APE.[38–40] In our series, 55% of APE cases occurred in women, with no statistically significant differences between sexes.

Surgical incision is cited as a risk factor for APE development.[41] Some studies have demonstrated that clear corneal incision is a significant APE risk factor.[41–43] However, other authors argue that the location of the incision (corneal or scleral) is less important than its structure, stability, and self-sealing ability.[44–48] In our series, most incisions were clear corneal (94.83%); 27 out of the 31 APE cases occurred through corneal incisions ($P = .834$). Wound leakage was observed in only 0.038% of procedures in the entire group, with no cases of Seidel positive wounds among APE cases.

In their meta-analysis, Cao et al. confirmed the association between silicone IOLs and an increased APE risk.[35] The ESCRS series also observed a higher IOL-related APE incidence.[45] Experimental studies and some clinical data corroborate increased bacterial adherence to silicone lenses vs polymethyl methacrylate and acrylic lenses.[49,50] In our series, all IOLs were acrylic.

Our surgical procedures were outpatient, performed by experienced surgeons using similar protocols, instruments, and devices. Our PCR incidence was 0.66%, which is similar to the rates in surgical procedures performed by experienced surgeons.[45] PCR is a significant APE risk factor, as demonstrated by in vitro and animal models.[51] The overall PCR incidence reported in the literature ranges from 0.2% up to 14%, though recent studies report lower rates (0.45%–5.2%, even 0.45%–3.6%) when performed by expert surgeons.[52,53] An acceptable incidence rate is <2%.[54] Cao et al. estimate that PCR increases the APE risk sixfold,[35] potentially up to 14–17 times.[55–57] In our series, 16% of APE cases had PCR, which increased the APE risk 25-fold compared to cases without PCR after adjusting for other risk factors. We agree with Sun et al.[58] that intraoperative PCR was the primary APE risk factor.

Diabetes has been mentioned as a APE risk factor by several authors, though this remains controversial to this date.[17,39,59–61] In our series, 5% of eyes belonged to diabetic patients, with 12% of APE cases involving these eyes ($P = .048$). Diabetes was not significant after adjusting for other risk factors.

Former studies reported gram-positive bacteria as the most common organisms isolated in APE cases. Recent studies showed that *Staphylococcus* was the most prevalent bacterium in positive vitreous cultures, followed by other gram-positive organisms (*Staphylococcus aureus*, *Streptococcus* spp.) and other gram-negative bacteria.[49] Cefuroxime and vancomycin are generally effective vs the broad spectrum of bacteria causing APE.[29,33,62] In our study, cultures were positive in 14 cases, with *Staphylococcus* isolated in 5.

The low APE incidence in our series, similar to recent studies, supports the safety of lens surgery and, for various reasons, immediate sequential bilateral surgery.[63,64]

Regarding APE treatment, it should ideally begin immediately, with antibiotics tailored to the specific sensitivity of the implicated organism. However, identifying the causative organism is not always possible. A negative culture does not necessarily indicate the absence of an infecting organism, and new methods should be adopted to identify the causative agent. Broad-spectrum antibiotics are recommended until culture results are available.[65–68]

Our study has limitations due to its retrospective nature and potential variations in practice among participant

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surgeons. However, we hope our findings contribute to establishing concise criteria for APE prophylaxis after phacoemulsification.

In conclusion, phacoemulsification-related APE can have devastating effects on final visual outcomes. The APE incidence after phacoemulsification with intracameral antibiotic administration in our private ophthalmological surgical center was comparable to that reported in previous international studies. Proper ocular antisepsis and disinfection—especially with PVI—before surgery, along with a well-defined intraoperative protocol and intracameral antibiotic use, are the most effective prophylactic measures. Despite the lack of differences between prophylactic cefuroxime or vancomycin use, the risk of HORV associated with prophylactic intracameral vancomycin led to its discontinuation. Additionally, no significant adverse effects were found with cefuroxime. Early APE diagnosis and treatment can promote anatomical and visual recovery. Age, incision size, diabetes, and PCR significantly correlated with APE incidence, though only PCR retained statistical significance.

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## Declaration of competing interest

None declared.

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