The antibiotic resistance pattern of conjunctival bacteria: a key for designing a cataract surgery prophylaxis

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Abstract

Purpose To assess the prevalence of the antibiotics resistant conjunctival bacteria in order to adapt our cataract surgery prophylaxis to the new prophylaxis techniques.

Methods Observational prospective study of preoperative conjunctival cultures of consecutive patients undergoing cataract surgery during a year. Patients having eye surgical prophylaxis in the previous 6 months were excluded. The aerobiosis and microaerobiosis incubation lasted 2 and 7 days, respectively. Three profiles of identification and antibiotics sensibility tests were used. The data recorded on the Autoscan4 were exported to a Microsoft Access database. Statistical calculations were carried out with the Epidat program, 3.1 version.

Results Of 4391 microbes isolated, 94.2% bacteria were Gram-positive and 5.3% Gram-negative. In the 1940 selected patients, their prevalence was coagulase-negative Staphylococci (CNS) 88.3%, Diphtheroids 58.1%, Propionibacteria 31%, Streptococci 23.1%, *Staphylococcus aureus* 10.2%, *Haemophilus* plus Gram-negative diplococci 7.5%, other Gram-negative rods 4.5%, Enterococci 2%. The Enterococci–Staphylococci profile was the most resistant (erythromycin 47.4%, methicillin 42.8%, ciprofloxacin 23.1%, tetracycline 18.4%, gentamicin 15.7%, levofloxacin 15.1%, tobramycin 14.8%, ... , chloramphenicol 3.7%, rifampicin 1.6%, and fusidic-acid 0.6%). The typical respiratory bacteria remained sensitive to chloramphenicol and β -lactams. Other Gram-negative rods were sensitive to aminoglycosides, quinolones, and certain β -lactams.

Conclusions None of the antibiotics tested here, including cefuroxime and levofloxacin, was active against the whole isolated conjunctival bacteria of our patients. On the basis of our resistance patterns and other prophylaxes effects, two phases of local prophylaxis are suggested: first, eliminating Staphylococci and respiratory bacteria with rifampicin or chloramphenicol, preoperatively; second, giving levofloxacin from 1 h before surgery until 6 days afterwards.

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Introduction

Since 1991, it has been known that the conjunctival flora of patients undergoing cataract surgery are the main source of bacteria causing postoperative endophthalmitis (PE);¹ but, until the preliminary results of the European Society for Cataract and Refractive Surgeons (ESCRS) study were published, in 2006, the effect of the antibiotics for reducing the PE incidence after cataract surgery could not be shown,² thus bringing to an end the uncertainty involving the use of antibiotics for this surgery prophylaxis in recent years.³

In the 2000–2003 publications, a worldwide PE incidence increase was observed (0.265%) compared with previous decades.⁴ Contrary to this trend, during the period 2002–2004, a 0.05% PE incidence was obtained in a prospective study carried out on all the people in Sweden

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operated on for cataract.⁵ These patients were given 1 mg of intracameral cefuroxime at the end of each cataract surgery, as a prophylaxis. The cefuroxime efficacy in previous Swedish studies^{6,7} had motivated its use in the ESCRS study.² However, in the final results of the ESCRS study,⁸ the isolated bacterial spectrum of their PE cases was different from the last Swedish study spectrum,⁵ as Table 1 illustrates.

Given the magnitude of the Swedish study⁵ and its wide patient inclusion criteria, it can be assumed that the bacterial spectrum of their PE cases represents the conjunctival bacteria resistant to cefuroxime in the Swedish patients. However, there is no certainty that their results⁵ could be translated to our setting nor that the two antibiotics used in the ESCRS study⁸ were necessary. In fact, in the Swedish study,⁵ one *Enterococcus* was isolated for every 9019 cataract operations and one Gram-negative rod every 25052; but, whether these bacteria were part of the patients' conjunctival flora of the ESCRS study⁸ is unknown, because none of their four study groups contains more than 4056 operations. Moreover, some patients at risk of having resistant conjunctival bacteria⁹ were excluded from the ESCRS study, following their inclusion criteria.¹⁰

Therefore, the aim of this study is to assess the prevalence of our patients' conjunctival bacteria and their antibiotics resistance patterns in order to adapt our cataract surgery prophylaxis to the new prophylaxis techniques.^{5,8} Also, another aim of this study is to make possible the comparison of other setting antibiotics resistance patterns with ours.

Materials and methods

Study design

A prospective observational study of consecutive cases of patients registered from 1 April 2006 to 31 March 2007 to have a routine conjunctival culture was carried out before the cataract operation. A 1-year period was chosen in order to collect all those bacteria which appear on the conjunctiva in a seasonally and transitorily manner.¹¹ Patients who had undergone intraocular surgery in the 6 months before their first record during the study period and those having other cataract operations after this first record were excluded from the study, to avoid the effect of previous prophylaxis on the conjunctival flora. Patients having combined surgical procedures of phacoemulsification and pars plana vitrectomy were excluded too, due to the difficulty of collecting these patients samples in the same conditions as in the planned surgeries.^{11,12} In the Autoscan4 microbiologic system, the following were registered: the patients demographic data and their clinical record number; the identification, kind, origin, and collecting date of the samples. These samples were cultured and the isolated bacteria were identified. Antibiotics sensitivity tests were performed on every bacteria considered pathogen,^{11,12} but on the coagulase-negative Staphylococci (CNS) only when more than 5 colonies per microlitre were isolated (this is the inclusion criterion of our Ophthalmology Department assuming that a low density of non-pathogen bacteria implies a low risk of intraocular contamination).

Table 1 Incidence of PE cases due to different bacteria isolated, per 10 000 cataract operations, in recent studies^{5,8} using intracameral cefuroxime as surgical prophylaxis in three of them

PE series studies	Sweden ⁵		ESCRS ⁸ group A		ESCRS ⁸ group B		ESCRS ⁸ group C		ESCRS ⁸ group D	
Study period	2002–2004		2003–2006 ^a		2003–2006 ^a		2003–2006 ^a		2003–2006 ^a	
Number of cataract operations	225 471		4054		4056		4049		4052	
Number of PE cases/I ^b	109	4.83	14	34.53	3	7.40	10	24.7	2	4.94
CNS/I ^b	34	1.51	5	12.33	2	4.93	3	7.41	1	2.47
<i>Staphylococcus aureus</i> /I ^b	9	0.40	1	2.47	—	—	1	2.47	—	—
<i>Streptococci</i> /I ^b	7	0.31	5	12.33	—	—	3	7.41	—	—
<i>Enterococci</i> /I ^b	25	1.11	—	—	—	—	—	—	—	—
Gram-negative rods/I ^b	9	0.40	—	—	—	—	—	—	—	—
Other bacteria/I ^b	4	0.18	2	4.93	1	2.47	—	—	—	—
Non-proven PE cases/I ^b	21	0.93	4	9.87	1	2.47	3	7.41	1	2.47
Preoperative antisepsis	Chlorhexidine		Betadine		Betadine		Betadine		Betadine	
Preoperative drops	Nothing		Placebo		Placebo		Levofloxacin		Levofloxacin	
Intracameral antibiotic	Cefuroxime		Nothing		Cefuroxime		Nothing		Cefuroxime	
Postoperative drops	Nothing		Levofloxacin		Levofloxacin		Levofloxacin		Levofloxacin	

CNS = Coagulase-negative Staphylococci; ESCRS = European Society of Cataract and Refractive Surgeons.

^aPatients of each European country were not processed in the same period during these years.

^bIncidence of PE per 10 000 cataract operations.

Microbiological methods

The specimens collection and the culture technique were described elsewhere,^{11,12} except for two modifications: first, we used smooth sterile plastic loops for taking the samples instead of a platinum loop (both microliter size loops); second, after the reading of the culture media, incubated 48 h, the chocolate-agar plates were incubated in microaerobiosis for 5 more days. The antibiotic susceptibility tests were carried out in accordance with the National Committee for Clinical Laboratory Standard (NCCLS), using three antibiotics profiles adapted to the current general bacteria resistance, as follows: for rapid growing and non-exigent bacteria, combined Dade-Behring panels were used, which included the identification tests, (for Staphylococci and Enterococci, panel PC23; for Gram-negative rods, panel PC38, substituted by PUC37 in July, for including the cefuroxime test). These panels were automatically read and recorded in the AutoScan4.

For the more exigent bacteria sensibility tests, the Kirby-Bauer disc-diffusion technique was used; the results of these tests were recorded in the AutoScan4 database. The identification of Haemophilus, Neisseria, and Moraxella was carried out with the HNID Dade-Behring panel. Streptococci were identified by their growing characteristics and their macroscopic and microscopic morphology; *Streptococcus pneumoniae* was identified by the optochine differentiation disc.

Analysis of the results

In Autoscan4, a data text file was generated, which was exported to a Microsoft Access database (version 2003). By means of Access utilities patients were selected according to the inclusion criteria study. Doubts about the clinical indication were checked in our hospital computerised records system of surgical processes and in the patient clinical record when necessary. The frequencies of the isolated bacteria and those resistant to antibiotics were also obtained with the Access program utilities. The percentage of these bacteria and their confidence intervals (CI) were calculated with the Epidat program, 3.1 version.

Results

A total of 1940 consecutive patients were selected in the study period; their mean age was 73.8 years (range 22–98), and 46.3% were men. Among these patients, 1847 underwent cataract surgery, 68 cataract surgery combined with trabeculectomy, and 25 replacement of intraocular lens. From 1940 conjunctival cultures, 4391 microorganisms were isolated; 4138 (94.23%) of them

were Gram-positive bacteria and 233 (5.31%) Gram-negative. The conjunctival bacteria groups frequency is shown in Table 2, as well as their prevalence and their corresponding CI (with 95% security). The most prevalent conjunctival bacteria were CNS, harboured in 88.3% of the patients. A peculiar finding of this study was the isolation of 6.9% of Streptococci and 31% of Propionibacteria by prolonging the incubation period for 7 days, in microaerophilic conditions.

The bacteria resistance is described for the three antibiotics profiles used, which correspond to Tables 3–5. These profiles group the conjunctival bacteria according to their origin, in such a way that it could determine how to eradicate them. For this reason, the percentage of resistance to each antibiotic and its CI (with 95% security) are calculated for all the bacteria included in each profile.

In Table 3, Staphylococci, the common skin and conjunctiva colonisers (prevalent in nearly 100% of the patients), were sensitive to fusidic acid, rifampicin, amikacin, and chloramphenicol; Enterococci, which colonised the conjunctiva in 2% of the patients, were sensitive to fusidic acid, ampicillin, imipenem, and fosfomycin. In this table, the resistance to cefuroxime is indicated by oxacillin, as well as methicillin and other β -lactamic antibiotics; vancomycin/teicoplanin are not considered for prophylaxis purposes.

In Table 4, the resistance of the typical respiratory system bacteria is shown; it contains the Gram-positive bacteria prevalent in 23% of the patients and the Gram-negative prevalent in 7.5%; their permanence on the conjunctiva is normally short and seasonal.^{11,13} These bacteria are sensitive to chloramphenicol, tetracycline, and β -lactamic antibiotics. In theory, most of these bacteria are not sensitive to fusidic acid, as Staphylococci and Enterococci are, which reduces the sensitivity coincidences of Tables 3 and 4 to chloramphenicol. In this study, we did not test the bacteria in Table 4 for the rifampicin susceptibility because this antibiotic was not commercially available in Spain, as eye-drops, during the study period. However, rifampicin appeared in Table 3 because, in the commercial foreign panel used, this antibiotic was included, and the sensibility of the typical conjunctival bacteria colonisers tested on it was very high. In a previous study by our hospital,¹⁴ all seasonal bacteria tested in Table 4 were sensitive to rifampicin. For these reasons, after finishing this study we began to test rifampicin again obtaining the same low resistance during another whole year (unpublished data) for this seasonal bacteria group.

Table 5 groups the resistance of the Gram-negative rods, whose presence on the conjunctiva of 4.5% patients cannot yet be associated with any cause,¹¹ but some of them survive on it for long periods.¹³ These bacteria are rather sensitive to aminoglycosides, quinolones, and

Table 2 Annual prevalence of the preoperative conjunctival flora of our 1940 patients undergoing cataract extraction

Microorganisms groups	Number	% in 1940 patients	CI (95%) ^a	
<i>Gram-positive bacteria</i>	4138			
Coagulase-negative <i>Staphylococci</i>	1713	88.30	86.84	89.76
<i>Staphylococcus aureus</i>	197	10.15	8.79	11.52
<i>Corynebacterium xerosis</i>	899	46.34	44.1	48.59
<i>Propionibacterium</i> sp.	602	31.03	28.95	33.11
Other diphtheroid bacilli	229	11.80	10.34	13.27
<i>Streptococcus pneumoniae</i>	51	2.63	1.89	3.37
Other aerophilic <i>Streptococci</i>	263	13.56	12.01	15.11
Microaerophilic <i>Streptococci</i>	134	6.91	5.75	8.06
<i>Enterococci</i>	39	2.01	1.36	2.66
<i>Bacillus</i> sp.	11	0.57	0.21	0.93
<i>Gram-negative bacteria</i>	233			
<i>Haemophilus</i> sp.	70	3.61	2.75	4.46
<i>Neisseria</i> sp.	41	2.11	1.45	2.78
<i>Moraxella</i> sp.	35	1.80	1.19	2.42
<i>Acinetobacter lwoffii</i>	4	0.21 ^a	0.06	0.53
<i>Citrobacter kosei</i>	2	0.10 ^a	0.01	0.37
<i>Enterobacter</i> sp.	4	0.21 ^a	0.06	0.53
<i>Escherichia coli</i>	2	0.10 ^a	0.01	0.37
<i>Klebsiella</i> sp.	4	0.21 ^a	0.06	0.53
<i>Morganella morganii</i>	11	0.57	0.21	0.93
<i>Proteus mirabilis</i>	34	1.75	1.14	2.36
<i>Proteus vulgaris</i>	2	0.10 ^a	0.01	0.37
<i>Pseudomonas</i> sp.	8	0.41	0.08	0.72
<i>Serratia</i> sp.	5	0.26 ^a	0.08	0.60
NFGN rods	11	0.57	0.21	0.93
<i>Other microorganisms</i>	20			
<i>Candida</i> sp.	1	0.05 ^a	0.00	0.29
Saprophytic fungus ^b	19	0.98	0.51	1.44
Total of isolated germs	4391			
Cultures without germs	130	6.70	5.56	7.84

CI = confidence interval 95%; NFGN rods = Non-fermentative Gram-negative rods.

^aCalculated with the Exact method.^bIsolated at 48 h of incubation.

certain β -lactams. None of the two panels used for testing the antibiotic sensibility of these Gram-negative rods contained the chloramphenicol and rifampicin susceptibility tests, which reduced the possibility of finding out the current sensibility coincidences with bacteria tested in Tables 3 and 4. Nevertheless, in a previous study,¹⁴ we found that all these rods were resistant to rifampicin and half of them to chloramphenicol.

Discussion

Our study documents the current resistance of conjunctival bacteria of patients undergoing cataract surgery to the commonest available antibiotics, in a tertiary referral hospital of one of the warmest European countries. We found that no single antibiotic tested here had 'in vitro' activity for eradicating the whole

conjunctival bacteria of our patients. However, we found that *Staphylococci* (the most prevalent conjunctival bacteria) and the conjunctival seasonal bacteria (*Streptococci*, *Haemophilus*, *Neisseria*, and *Moraxella*) presented a very low 'in vitro' resistance to old antibiotics, such as chloramphenicol or rifampicin. If only one of these two antibiotics were given as cataract surgery prophylaxis, only about 5% of our patients harbouring on their conjunctiva Gram-negative rods, different from *Haemophilus*, and/or *Enterococci* would be unprotected from PE.

To our knowledge, this is the first study assessing the conjunctival bacteria antibiotic resistance during a whole year period. Although the conjunctival bacteria prevalence could vary as the climate¹¹ and the characteristics of patients^{13,15} vary, and the antibiotic resistance of ocular bacteria has been increasing over the years,^{16,17} to frame a year period study with this number

Table 3 Antibiotic resistance of Staphylococci and Enterococci from the conjunctiva of our patients undergoing cataract surgery

Bacteria	CNS			Staphylococcus aureus			Enterococci species			Total bacteria groups			
	Tested	Resistant	%	Tested	Resistant	%	Tested	Resistant	%	Tested	Resistant	%	CI (95%)
Amikacin	707	5	0.7	196	3	1.5	36	28	77.8	939	36	3.8	2.55 5.11
Amox./clavul. ^a	705	345	48.9	195	27	13.8	38	1	2.6	938	373	39.8	36.58 42.95
Ampicillin	707	621	87.8	196	178	90.8	38	1	2.6	941	800	85.0	82.68 87.35
Cefotaxime	707	345	48.8	195	112	57.4	38	30	78.9	940	487	51.8	48.56 55.06
Ciprofloxacin	707	182	25.7	196	29	14.8	38	6	15.8	941	217	23.1	20.32 25.80
Clindamicin	707	81	11.5	195	11	5.6	36	27	75.0	938	119	12.1	10.50 14.87
Chloramphenicol	707	23	3.3	196	3	1.5	38	9	23.7	941	35	3.7	2.46 4.98
Erythromycin	705	392	55.6	196	39	19.9	38	14	36.8	939	445	47.4	44.14 50.64
Fosfomycin	707	89	12.6	196	7	3.6	36	2	5.6	939	98	10.4	8.44 12.46
Fusidic acid	707	6	0.8	196	0	0.0	35	0	0.0	938	6	0.6	0.08 1.20
Gentamicin	707	108	15.3	196	10	5.1	36	29	80.6	939	147	15.7	13.29 18.03
Imipenem	707	343	48.5	195	27	13.8	38	1	2.6	940	371	39.5	36.29 42.65
Levofloxacin	706	115	16.3	196	23	11.7	36	4	11.1	938	142	15.1	12.79 17.49
Mupirocin	700	202	28.9	196	25	12.8	36	28	77.8	932	255	27.4	24.44 30.28
Oxacillin	704	343	48.7	195	27	13.8	36	30	83.3	935	400	42.8	39.56 46.01
Rifampicin	706	2	0.3	196	1	0.5	36	12	33.3	938	15	1.6	0.74 2.46
Teicoplanin	707	1	0.1	196	0	0.0	36	0	0.0	939	1	0.1 ^b	0.00 0.59
Tetracyclin	708	135	19.1	196	13	6.6	38	25	65.8	942	173	18.4	15.84 20.89
Tobramycin	706	91	12.9	196	19	9.7	36	29	80.6	938	139	14.8	12.49 17.15
Trimet./sulfam. ^c	708	76	10.7	196	3	1.5	38	9	23.7	942	88	9.3	7.43 11.25
Vancomycin	705	0	0.0	196	0	0.0	36	0	0.0	937	0	0.0 ^b	0.00 0.39

CI = confidence intervals; CNS = Coagulase-negative Staphylococci.

^aAmoxicillin/clavulanate.

^bCalculated with the Exact method.

^cTrimethoprim/sulfamethoxazole.

Table 4 Antibiotic resistance of the respiratory bacteria isolated from the conjunctiva of our patients undergoing cataract surgery

Bacteria groups	Streptococci			Haemophilus			Gram-negative cocci			Total respiratory bacteria			
	Tested	Resistant	%	Tested	Resistant	%	Tested	Resistant	%	Tested	Resistant	%	CI (95%)
Amox./clavul. ^a	377	8	2.1	65	10	15.4	68	3	4.4	510	21	4.12	2.29 5.94
Ampicillin	429	15	3.5	70	34	48.6	76	14	18.4	575	63	10.96	8.32 13.60
Cefotaxime	430	5	1.2	69	14	20.3	75	2	2.7	574	21	3.66	2.04 5.28
Cefuroxime	431	14	3.2	70	13	18.6	76	4	5.3	577	31	5.37	3.45 7.30
Chloramphenicol	431	7	1.6	70	1	1.4	75	1	1.3	576	9	1.56	0.46 2.66
Ciprofloxacin	428	62	14.5	70	2	2.9	75	3	4.0	573	67	11.69	8.97 14.41
Erythromycin	432	147	34.0	70	15	21.4	73	13	17.8	575	175	30.43	26.59 34.28
Fosfomycin	114	15	13.2	33	6	18.2	23	5	21.7	170	26	15.29	9.59 21.00
Gentamicin	432	289	66.9	68	3	4.4	76	1	1.3	576	293	50.87	46.70 55.04
Imipenem	431	1	0.2	70	12	17.1	76	1	1.3	577	14	2.43	1.08 3.77
Levofloxacin	265	77	29.1	44	1	2.3	49	3	6.1	358	81	22.63	18.15 27.1
Oxacillin	429	36	8.4	70	48	68.6	75	70	93.3	574	154	26.83	23.12 30.54
Tetracyclin	431	16	3.7	70	3	4.3	76	2	2.6	577	21	3.64	2.02 5.25
Trimethoprim	262	158	60.3	70	45	64.3	71	63	88.7	403	266	66.00	61.26 70.75
Vancomycin	431	0	0.0	70	66	94.3	76	55	72.4	577	121	20.97	17.56 24.38

CI = confidence intervals.

^aAmoxicillin/clavulanate.

of patients¹² is a reasonable approach for establishing the basis needed for updating ocular bacteria sensibility in the future. This approach would seem to be on line with the thinking of Dr O'Brien *et al.*¹⁸ After putting in perspective the current antibiotic cataract surgery prophylaxes, these authors¹⁸ stated that the potential changes in bacterial sensibility patterns, emergence of

new pathogens, advances in antimicrobial therapy, and modes of delivery highlight the need for continued investigation and periodic guideline reviews to optimise patient care.

As regards adapting our cataract surgery prophylaxis to the newest European protocols,^{5,8} the CNS methicillin resistance that we found (48.7%) was rather higher than

Table 5 Antibiotic resistance of Gram-negative rods isolated from the conjunctiva of our patients undergoing cataract surgery

Antibiotics	Tested	Resistant	%	CI (95%)	
Amikacin	83	0	0.0 ^a	0.00	4.35
Amoxocillin/ clavulanate	58	22	37.9	24.58	51.28
Ampicillin	83	58	69.9	59.41	80.35
Cefalotin	59	25	42.4	28.92	55.83
Cefazolin	59	26	44.1	30.55	57.58
Cefepime	83	4	4.8 ^a	1.33	11.88
Cefotaxime	84	5	6.0 ^a	1.96	13.35
Cefoxitin	59	13	22.0	10.61	33.46
Ceftazidime	84	7	8.3	1.83	14.84
Cefuroxime	59	24	40.7	27.30	54.06
Ciprofloxacin	84	3	3.6 ^a	0.74	10.08
Colistin	24	15	62.5	41.05	83.95
Fosfomycin	59	22	37.3	24.10	50.47
Gentamicin	83	7	8.4	1.85	15.01
Imipenem	84	1	1.2 ^a	0.03	6.45
Levofloxacin	83	2	2.4 ^a	0.29	8.43
Minocycline	25	10	40.0	18.80	61.20
Norfloxacin	59	10	16.9	6.53	27.37
Piperacillin	83	12	14.5	6.29	22.63
Piperacillin/ tazobactam	79	4	5.1 ^a	1.40	12.46
Ticarciline	83	17	20.5	11.20	29.77
Tobramycin	83	3	3.6 ^a	0.75	10.20
Trimethoprim/ sulfamethoxazole	82	28	34.1	22.27	45.02

CI = confidence interval.

^aCalculated with the Exact method.

this resistance that was in Sweden (6.8% in the conjunctival bacteria¹⁹ and 4.5% among the bacteria isolated in their PE cases after cataract operation;²⁰ this low methicillin resistance was one of the reasons for choosing cefuroxime in the Swedish cataract surgery prophylaxis²⁰). Our results are more consistent with the 37% of methicillin-resistant CNS found on the preoperative conjunctival flora of an American setting²¹ and that found for the bacteria isolated in the PE cases of the Endophthalmitis Vitrectomy Study.²² The Gram-positive bacteria isolated from the PE cases of the important Australian series²³ had reached 21.4% of methicillin resistance in the period 1995–2000. Our Gram-negative rods, except *Haemophilus*, turned out to be quite resistant to cefuroxime. Therefore, independently of the antibiotics form of administration used, cefuroxime seems to be a worse choice for our patients' cataract prophylaxis than for the Swedish patients.⁵ Levofloxacin would be the best choice for eradicating the whole Gram-negative bacteria and most Enterococci of our patients, but not for eradicating their CNS (Table 3) and Streptococci (Table 4).

In conclusion, based on our findings, a two-phase cataract surgery prophylaxis is suggested using two

different antibiotics. We propose the topical administration form in agreement with Dr Liesegang,²⁴ who recommends using topical antibiotics because of the concerns regarding intracameral antibiotics: preoperatively for limiting the number of bacteria at surgery, and postoperatively until the surgical wound is sealed.

In the first prophylaxis phase, the most prevalent conjunctival bacteria (Staphylococci and the seasonal bacteria group) could be eradicated with chloramphenicol or rifampicin, administering it preoperatively for 3 days until 1 h before the operation. Similar topical treatments have been found efficacious^{14,25,26} for eliminating these ocular bacteria. Also, it was shown in the Swedish study⁵ that these abundant bacteria were eradicated without using any antibiotic postoperatively; thus, these bacteria must have entered the eye only during the operation, which tends to confirm the idea of eradicating them preoperatively.

In the second prophylaxis phase, we suggest giving levofloxacin eye-drops from 1 h before the operation until 6 days afterwards, for eradicating the small quantity of Enterococci and Gram-negative rods, because the visual outcome of the PE cases caused by these bacteria is the most serious.^{27,28} These bacteria produced a relatively high PE incidence in the important Swedish series⁵ without using levofloxacin at any time nor any postoperative prophylaxis, but not in the ESCRS study⁸ using topical postoperative levofloxacin (although whether these bacteria colonised the conjunctiva of patients operated on in the ESCRS study⁸ is a question that remains unclear because of the study exclusion criteria¹⁰ of their patients). Also, in recent American PE series,²⁹ Enterococci and Gram-negative rods were not isolated among their PE cases, and they used topical new quinolones as prophylaxis.

On the other hand, taking into account our results and the need to use two different antibiotics, and according to other cataract surgery prophylaxis experiences outside Europe,^{18,29–32} it would be useful to investigate our conjunctival bacteria resistance to moxifloxacin in the near future. This antibiotic seems to have the best pharmacologic and pharmacodynamic properties¹⁸ and reduces the PE incidence to the levels as low as those achieved using intracameral cefuroxime, even when moxifloxacin was used topically.^{29–32} Nevertheless, moxifloxacin resistance has appeared in America, causing acute PE cases,^{24,30} which, besides the concerns regarding intracameral antibiotics, has addressed the need for a multipronged approach to limit the endophthalmitis risk, with antibiotics as only part of the strategy.²⁴ In this way and consistent with our results, it would be interesting to identify any clinical characteristic of the approximately 5% of patients harbouring

Enterococci and/or Gram-negative rods (except *Haemophilus*), which would allow the possibility of a specific prophylaxis for this small group of patients. This hypothetical treatment would enable the most prevalent bacteria to be eradicated at low cost, without creating resistance to new antibiotics in most patients.

A possible limitation of this study is not having tested the antibiotic sensibility of the huge quantity of *Corynebacteria* and other diphtheroids bacilli colonising the conjunctiva of our patients (Table 2), due to the traditional view of their low virulence when causing PE.²⁷ Usually, these bacteria were isolated in very few PE cases,^{5-8,22,23} compared with their high prevalence on the conjunctiva that we have found. Using the method of culturing for identifying the bacteria causing PE, the infectious origin of PE cases of relevant PE series^{6-8,22,23} remains unknown in about 30% of the patients. In our experience, most conjunctival *Corynebacteria* and other diphtheroids require especial conditions for growth when cultured. In fact, they do not grow on chocolate-agar plates and most broth culture media used; this difficulty for growing them is also shown in the study of the conjunctival bacteria carried out by Dr Miño de Kaspar *et al.*³³ Thus, these bacteria could easily be lost when handling aqueous humour or vitreous samples from tap or vitrectomy. In any case, the antibiotic resistance of these frequent conjunctival colonisers should be assessed, in order to eliminate the whole conjunctival bacteria flora of patients undergoing intraocular surgery.

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