


RESEARCH ARTICLE

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Bacteriology of the conjunctiva in pre-cataract surgery patients with occluded nasolacrimal ducts and the operation outcomes in Japanese patients

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Abstract

Background: Contamination of the conjunctiva in association with nasolacrimal duct obstruction is by all accounts a risk factor for infectious endophthalmitis post-cataract surgery.

Methods: All patients who underwent cataract day surgery routinely received nasolacrimal duct syringing with normal saline at the Wakayama Medical University Hospital, Japan, from 2011 to 2013. The microorganisms isolated from conjunctival swab samples of patients with occluded nasolacrimal ducts and their susceptibility to antibiotics, as well as the operation outcomes in all the patients were retrospectively investigated.

Results: Nasolacrimal duct obstruction was observed in 125 eyes of 90 patients (3.3%; 42 eyes of 30 male individuals, and 83 eyes of 60 female individuals) from a total of 3754 eyes of 2384 patients by using irrigation samples of nasolacrimal ducts. The mean age of the subjects with duct obstruction was 79 ± 8.5 years. In bacterial cultures of swabs from these 125 individuals, microbial growth was detected in 56 samples (i.e. 44.8%). Coagulase-negative *Staphylococcus* was detected in 28 eyes, and *Corynebacterium* species was detected in 17 eyes. *Staphylococcus aureus*, excluding methicillin-resistant *S. aureus* was detected in seven eyes with nasolacrimal duct obstruction. Methicillin-resistant *S. aureus* was isolated in two eyes with nasolacrimal duct obstruction. Each case was treated with topical antibiotics based on the results of antibiotic sensitivity tests. After culturing of cotton swab samples from the conjunctiva, and using direct micrography of bacteria every 2 or 3 days after starting treatment, and once the results were negative (consecutively tested three times), the patients received cataract surgery. In the current case series, bacteria were not detected in conjunctival swabs obtained consecutively three times for 3 weeks after starting topical antibiotics in 118 eyes from 125 eyes (94.4%), and later in the remaining patients. No patient required dacryocystorhinostomy to eliminate bacterial contamination in the conjunctiva following topical antibiotic therapy. No patient developed infectious endophthalmitis at least 1-year post-cataract surgery.

Conclusions: All the patients receiving cataract day surgery underwent the operation after the elimination of conjunctival microorganism contamination in association with nasolacrimal duct obstruction by using appropriate topical antibiotics.

Keywords: Nasolacrimal duct obstruction, Conjunctiva, Bacterium, Cataract surgery

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Background

Infectious endophthalmitis occurs in 0.04–0.075% of patients following cataract surgery [1–3]. Colonies of endogenous normal bacterial flora are the main source of bacterial contamination in the anterior chamber of the eye. *Staphylococci*, *Enterococci*, or Gram-negative bacilli could cause poor visual prognoses postinfection, although the incidence is reportedly low [4–7]. Gram negative bacteria reportedly constitute an increasing proportion of the bacteria found in chronic dacryocystitis and they may be a reservoir for postoperative intraocular infection [8]. It was suggested that these bacteria account for higher rates of nasolacrimal duct obstruction among patients who developed infectious endophthalmitis after cataract surgery [9–11]. Furthermore, these studies indicated that nasolacrimal duct obstruction might cause lacrimal sac and conjunctival bacterial contamination even in the absence of dacryocystitis. Such an occurrence could also be a intraocular infection risk factor subsequent to either trauma or surgery.

It is beneficial, therefore, to test for the presence of nasolacrimal duct obstruction prior to cataract surgery to prevent postoperative bacterial infection in the eye. We routinely perform syringing of the nasolacrimal duct in pre-cataract surgery patients. Furthermore, in all the patients having nasolacrimal duct obstruction regardless of the presence or absence of dacryocystitis we examine both their washings and conjunctival swab samples for bacteriological growth. The susceptibilities of the bacteria isolated from the conjunctival swab samples of patients with occluded nasolacrimal duct, to antibiotics, were determined to eliminate conjunctival bacterial contamination. In the current retrospective study, none of the patients received surgical treatment i.e. tubing or dacryocystorhinostomy, for nasolacrimal duct obstruction at our

institution to eliminate bacterial contamination in conjunctiva. The present study retrospectively summarizes our results and the outcomes of cataract surgery during 3 years (2011–2013) along with those abovementioned cases receiving pre-surgical antibiotic treatment. As a result of being given suitable topical antibiotics prior to nasolacrimal duct obstruction surgery, even though those individuals had positive bacterial cultures, there were no cases of postoperative endophthalmitis.

Methods

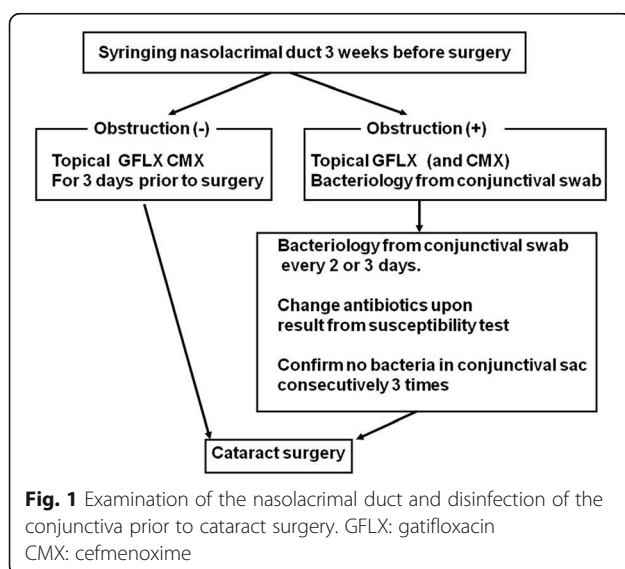
Patients

This retrospective study was approved by the institutional committee for clinical research. All the patients undergoing day surgery for cataract (3754 eyes of 2384 patients) received syringing (irrigation) of the nasolacrimal duct with normal saline at Wakayama Medical University Hospital, Wakayama, Japan, 3 weeks prior to the operation due date, for a 3-year period from 2011 to 2013. Bacteriological examinations and/or antibiotic susceptibility testing of samples isolated from conjunctival swabs were performed in patients with obstruction of the duct prior to surgery. Bacteria-positive patients received further examination of conjunctival swab samples at every 2 or 3 days, along with topical administration of antibiotics that were effective for the detected microorganism (Fig. 1). The patients underwent cataract surgery after obtaining negative results for bacterial infection consecutively for three times. Phacoemulsification and aspiration of the crystallin lens with implantation of an intraocular lens (IOL) was performed in 3707 eyes (98.7%) and planned extracapsular cataract extraction with IOL implantation was performed in 47 eyes (1.3%). No patient developed infectious endophthalmitis post-cataract surgery.

Bacteriological examinations

Conjunctival swab samples were obtained from patients with nasolacrimal duct obstruction by using cotton swabs under local anesthesia with topical lidocaine. On the same day, bacteriological culturing (blood agar medium, chocolate agar medium, MacConkey's medium, Colombian nutrient medium, and *Candida* medium) was conducted. Each culture was incubated in 35 °C for 16–20 h. Anaerobic culturing was not performed. The minimum inhibitory concentration was classified as "S" (susceptible) or "R" (resistant) by employing the criteria developed by the Clinical and Laboratory Institute.

All patients with nasolacrimal duct obstruction had received topical gatifloxacin 0.3%(GFLX) before receiving bacteriological examinations as described above. Patients with positive bacterial cultures received further administration of topical cefmenoxime hydrochloride 0.5% (CMX) when the detected bacteria were susceptible to these antibiotics. All patients with detected microorganisms by



culture examination after detecting nasolacrimal duct obstruction received further conjunctival swab examinations every 2 or 3 days along with topical antibiotics as necessary. Cataract surgery was performed after obtaining no bacterial positive results from the conjunctival swab cultures consecutively for three times.

Prior to the surgery, the eyelid skin and conjunctival sac were disinfected with povidone-iodine. The patients received intravenous sodium piperacillin during or immediately after the surgery. The affected eye received levofloxacin (LVFX) ointment after the operation. From the next day, the patients received topical GFLX for 1–3 months and oral cefcapene pivoxil hydrochloride for 4 days.

Results

The incidence of nasolacrimal duct obstruction

Nasolacrimal duct obstruction was observed in 125 eyes of 90 patients (3.3%; 42 eyes of 30 male individuals, and 83 eyes of 30 female individuals) in a total of 3754 eyes of 2384 patients. The mean age of the subjects with duct obstruction was 79 ± 8.5 years.

Bacteriological examinations of conjunctiva with nasolacrimal duct obstruction

Bacteriological cultures detected microbial growth from the swab samples of 56 of 125 subjects from 90 patients at the initial bacterial culturing (44.8%). Percentages for Gram-positive cocci, Gram-positive rods, Gram-negative bacilli, and fungi were 64, 24, 11, and 1%, respectively (Table 1). Among 125 eyes with positive results for bacteria or fungi, coagulase-negative *Staphylococcus* (CNS), *Corynebacterium* species, or *S. aureus* were detected in 28, 17, and seven eyes, respectively. Methicillin-resistant *S. aureus* (MRSA) was observed in two of seven eyes with *S. aureus*.

Table 1 Bacteria and fungus detected at the first conjunctival swab culture in patients with nasolacrimal duct obstruction

Gram-positive cocci	Coagulase-negative Staphylococci	28
	Staphylococcus aureus (including MRSA in 2 eyes)	7
	Enterococcus faecalis	3
	Streptococcus speices	6
Gram-positive bacilli	Corynebacterium species	17
Gram-negative bacilli	Enterobacter	3
	Moruganella	2
	Klebsiella	2
	Proteus	1
Fungus	Candida albicans	1

MRSA methicillin-resistant Staphylococcus aureus

Bacterial results following antibiotic treatment prior to surgery

As shown in Table 2, detected microorganisms exhibited resistance to antibiotics. The majority of the bacteria detected were found to be resistant to LVFX, cefazolin (CEZ), and/or gentamycin.

Table 3 includes all the cases in the current series that required additional topical administration of antibiotic eye drops besides the new quinolone drugs and cephem antibiotics. Conjunctival bacterial contamination was successfully eliminated by administration of topical dibekacin0.3%(DKB)or arbekacin0.5%(ABK)sulfate in case 1 or in cases 2 and 3, respectively. In three eyes of two patients, MRSA was detected at the second or later examination, but not at the first examination. MRSA detected in this case series exhibited resistance to LVFX and CEZ, but was sensitive to vancomycin(VCM). In case 7, *Corynebacterium* appeared after Gram-negative bacilli were eliminated with topical GFLX0.3%. Because this occurred during topical quinolone drug administration, the *Corynebacterium* was eliminated with topical tobramycin0.3%(TOB). In the current case series, no microorganisms were detected in conjunctival swabs consecutively for three times at 3 weeks after starting topical antibiotics in 118 eyes of 125 eyes (94.4%). Durations of more than 3 weeks were required before no bacteria were detected in swab cultures from conjunctiva taken consecutively for three times in cases 4–7 (Table 3).

Table 2 Sensitivity of detected microorganisms and their resistance to each antibiotic

Bacterium species	Antibiotic	Resistant	Sensitive
Coagulase-negative Staphylococci	LVFX	5	17
	CEZ	5	15
	GM	4	15
MSSA	LVFX	1	5
	CEZ	0	6
	GM	1	5
MRSA	LVFX	3	0
	CEZ	3	0
	GM	2	1
Streptococcus species	LVFX	1	2
	CEZ	1	1
Corynebacterium species	LVFX	3	2
	CEZ	0	4
Gram-negative bacilli	LVFX	1	7
	CEZ	3	5
	GM	1	7

MSSA methicillin-susceptible Staphylococcus aureus

MRSA methicillin-resistant Staphylococcus aureus

The majority of the bacteria were found to be resistant to levofloxacin (LVFX), cefazolin (CEZ), or gentamycin (GM)

Table 3 Cases that required administration of additional topical antibiotic eye drops in addition to quinolone and cephem drugs to achieve a negative result for bacterial infection

Case #	Bacterium species	Sensitivity	Additional antibiotic
1	CNS	LVFX (R) CEZ (R) GM (R) ABK (S)	DKB
2	CNS	LVFX (R) CEZ (R) GM (R) ABK (S)	ABK
3	CNS	LVFX (R) CEZ (R) GM (R) ABK (S)	ABK
4	MRSA	LVFX (R) CEZ (R) GM (R) VCM (S)	VCM
5	MRSA	LVFX (R) CEZ (R) GM (R) VCM (S)	VCM
6	MRSA Gram-negative bacilli	LVFX (R) CEZ (R) GM (R) VCM (S) LVFX (S) CEZ (S) GM (S)	VCM
7	Corynebacterium Spp. Gram-negative bacilli	LVFX (S) CEZ (S) GM (S)	TOB

CNS coagulase-negative Staphylococci

MSSA methicillin-susceptible Staphylococcus aureus

MRSA methicillin-resistant Staphylococcus aureus

DKB: dibekacin0.3%; ABK; arbekacin0.5%; VCM; vancomycin; TOB: tobramycin

Discussion

Obstruction of the nasolacrimal duct causes retention of tears in the lacrimal and conjunctival sac, leading to the acceleration of growth of the microorganisms in the accumulated tears. The likelihood of post-cataract surgery infectious endophthalmitis is much higher in patients whose nasolacrimal ducts are obstructed [9, 10]. This association suggests that this condition could be a risk factor for intraocular infection subsequent to either trauma or surgery. In addition, 82% of the bacteria detected from eyes with postoperative infectious endophthalmitis were reportedly genetically identical to those in the normal conjunctival flora [11]. There is no published guideline available in Japan describing a recommended strategy for treating patients with nasolacrimal duct obstruction and have contaminated conjunctivae prior to intraocular surgery. Therefore, examination of the nasolacrimal duct by syringing and bacteriological examinations in eyes with obstruction of the duct should be performed prior to intraocular surgeries according to our protocol.

A previous study found the incidence of adult nasolacrimal duct obstruction to be 3.1%. Anatomical differences may account for the difference in the incidence of obstruction between male and female individuals [12]. Microorganisms were detected in 44.8% of the eyes with nasolacrimal duct obstruction. We did not perform anaerobic culturing, and this could account for the difference in the detection rate (30–80%) between our study and the previous studies [13–16].

CNS was the most prevalent finding, and therefore in the current case series, *Corynebacterium* and *S. aureus*

were detected. This result is similar to that of a previous study, although we did not perform anaerobic culturing and could not detect *Propionibacterium acnes* [8]. CNS is the bacterial type most frequently observed in post-cataract surgery infectious endophthalmitis [4]. Obstruction of the nasolacrimal duct reportedly increases the percentage of Gram-negative bacilli in the conjunctiva in non-Japanese subjects [8, 16]. Bacteriology of conjunctiva in healthy Japanese subjects without nasolacrimal duct obstruction was also reported [17, 18]. Suto et al. described bacterial presence without screening for nasolacrimal duct obstruction in pre-cataract surgery patients [14]. Thus this data is not applicable to this study. Hoshi et al. reported an increased incidence of Gram-negative bacilli in Japanese subjects as compared with healthy subjects [17]. Moreover, Omatsu et al. reported that the incidence of Gram-negative bacilli was 3.2% [18]. In the current study, 6.4% of the bacilli were Gram-negative in the conjunctiva among all subjects, which is indicative of a higher incidence than previously reported. As Gram-negative bacilli are one of the notable bacterial groups that are post-cataract surgery pathogens causing endophthalmitis, these findings support the notion that nasolacrimal duct obstruction could be a risk factor of this infection.

Although *Corynebacterium* species is one of the most frequently detected bacterial species in normal bacterial flora in human conjunctiva, it was reported that it causes infection in corneas treated with topical corticosteroid therapy after penetrating keratoplasty [19]. Postoperative infectious endophthalmitis is quite rare, presumably because the aqueous humor contains low levels of lipid components that are required for *Corynebacterium* species to grow. *Corynebacterium* in the conjunctiva is sensitive to cephem antibiotics and aminoglycosides, while the bacterium is frequently resistant to new quinolones [6]. We successfully eliminated *Corynebacterium* that newly appeared after the elimination of Gram-negative bacilli by adding the aminoglycoside in case 7. The phenomenon observed in case 7 was considered to be a form of microbial substitution.

Conclusions

In summary, nasolacrimal duct obstruction was observed in 125 eyes of 90 patients (3.3%; 42 eyes of 30 male individuals, and 83 eyes of 60 female individuals) from a total of 3754 eyes of 2384 patients by using samples from syringing of the nasolacrimal duct with normal saline. Each case with positive microorganisms cultured from conjunctival swabs was treated with topical antibiotics based on the results of susceptibility tests. After results from culturing of cotton swab samples from the conjunctiva, and by direct micrography for bacteria every 2 or 3 days (consecutively for three times) were negative, the patients

received cataract surgery. Normalization of bacterial flora in the conjunctiva with nasolacrimal duct obstruction reportedly requires 4–5 weeks after dacryocystorhinostomy [20]. Another report showed that dacryocystorhinostomy decreased the percentage of conjunctival sac Gram positive cases from 82% to 36% [21]. We successfully eliminated bacterial contamination of the conjunctiva in 94.4% of the patients with nasolacrimal duct obstruction at 3 weeks before cataract surgery, and eventually also eliminated bacterial contamination in all the other cases. In our series, no patient required tubing or dacryocystorhinostomy to eliminate bacterial contamination in the conjunctiva following topical antibiotic therapy. No patient developed infectious endophthalmitis for at least 1-year post-cataract surgery who received topical antibiotic treatment, although previous reports already suggested that nasolacrimal duct obstruction is a potential risk factor of post-cataract surgery infectious endophthalmitis.

Abbreviations

ABK: Arbekacin; CEZ: Cefazolin; CMX: Cefmenoxime; CNS: Coagulase-negative *Staphylococcus*; DKB: Dibekacin; GLFX: Gatifloxacin; IOL: Intraocular lens; LVFX: Levofloxacin; MRSA: methicillin-resistant *Staphylococcus aureus*; MSSA: Methicillin-susceptible *Staphylococcus aureus*; TOB: Tobramycin; VCM: Vancomycin

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Availability of data and materials

The datasets produced during and/or analyzed during the current study available from the corresponding author on reasonable request.

Authors' contributions

All authors participated in obtaining the results as well as in writing and revising the manuscript. Specific additional contributions include: YH, SF, KT, NI, MK, and TS participated in the examination of the syringed nasolacrimal duct samples and in taking the conjunctival swab samples from the patients. TM, YO, and SS participated in the interpretation of the results. All authors read and approved the final manuscript.

Competing interest

The authors declare that they have no competing interests and no financial competing interests.

Consent for publication

Not applicable (no identifying patient data).

Ethics approval and consent to participate

All study participants gave oral informed consent for bacterial examination prior to their cataract surgeries. This project adhered to tenets of the Declaration of Helsinki. The protocol of the study was approved by IRB of Wakayama Medical University (#1707). The title of the project approved is "A retrospective study on commensal bacteria in the conjunctiva of pre-cataract surgery patients with nasolacrimal duct obstruction". Each patient with nasolacrimal duct obstruction received explanation about the necessity and usefulness of conjunctival swab sampling. Consent by each of them was indicated on his (her) medical record. We posted a poster which listed study contents on the clinic to get the common knowledge about the purpose of the study according to the instructions of the university authorities.

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References

- Wong TY, Chee SP. The epidemiology of acute endophthalmitis after cataract surgery in an Asian population. *Ophthalmology*. 2004;111:699–705.
- Lalitha P, Rajagopalan J, Prakash K, Ramasamy K, Prjana NV, Srinivasan M. Post-cataract endophthalmitis in South India: incidence and outcome. *Ophthalmology*. 2005;112:1884–9.
- Miller JJ, Scot IU, Flynn Jr HW, Smiddy WE, Newton J, Miller D. Acute onset endophthalmitis after cataract surgery (2000–04) incidence, clinical settings and visual acuity outcomes, after treatment. *Am J Ophthalmol*. 2005;139:983–7.
- Peyman GA. Endophthalmitis diagnosis and management 102–107. London and New York: Taylor & Francis; 2004.
- Major Jr JC, Engelbert M, Flynn Jr HW, Miller D, Smiddy WE, Davis JL. *Staphylococcus aureus* endophthalmitis: antibiotic susceptibilities, methicillin resistance, and clinical outcomes. *Am J Ophthalmol*. 2010;149:278–83.
- Scott IU, Loo RH, Flynn Jr HW, Miller D. Endophthalmitis caused by enterococcus faecalis: antibiotic selection and treatment outcomes. *Ophthalmology*. 2003;110:1573–7.
- Schmidt ME, Smith MA, Levy CS. Endophthalmitis caused by unusual Gram-negative bacilli: three case reports and review. *Clin Infect Dis*. 1993;17:686–90.
- Hartikainen J, Lehtonen OP, Saari KM. Bacteriology of lacrimal duct obstruction in adults. *Br J Ophthalmol*. 1997;81(1):37–40.
- Kam JK, Cheng NM, Allen PJ, Brooks AM. Nasolacrimal duct screening to minimize post-cataract surgery endophthalmitis. *Clin Experiment Ophthalmol*. 2014;42:447–51.
- Lopez PF, Beldavs RA, al-Ghamdi S, Wilson LA, Wojno TH, Sternberg Jr P, Aaberg TM, Lambert HM. Pneumococcal endophthalmitis associated with nasolacrimal obstruction. *Am J Ophthalmol*. 1993;116:56–62.
- Speaker MG, Milch FA, Shah MK, Eisner W, Kreiswirth BN. Role of external bacterial flora in the pathogenesis of acute postoperative endophthalmitis. *Ophthalmology*. 1991;98:639–49.
- Shigeta K, Takegoshi H, Kikuchi S. Sex and age differences in the bony nasolacrimal canal. *Arch Ophthalmol*. 2007;125:1667–81.
- Hara J, Yasuda F, Higashitsutsumi M. Preoperative disinfection of the conjunctival sac in cataract surgery. *Ophthalmologica*. 1997;211 suppl 1:62–7.
- Suto C, Morinaga M, Yagi M, Tsuji C, Toshih H. Conjunctival sac bacterial flora isolated prior to cataract surgery. *Infect Drug Resist*. 2012;5:37–41.
- Keshav BR, Basu S. Normal conjunctival flora and their antibiotic sensitivity in Omanis undergoing cataract surgery. *Oman Ophthalmol*. 2012;5:16–8.
- Arantes TE, Cavalcanti RF, Diniz Mde F, Severo MS, Lins N, Castro CM J. Conjunctival bacterial flora and antibiotic resistance pattern in patients undergoing cataract surgery. *Arq Bras Ophthalmol*. 2006;69:33–6.
- Hoshi S, Urabe K. Risk factors for conjunctival bacterial colonization in preoperative cataract patients. *Atarashii Ganka (J Eye)*. 2011;28:1313–9 (in Japanese).
- Omatsu Y, Miyazaki D, Tominaga T, Matsuura K, Inoue Y. Bacterial flora in the conjunctival sac in eyes before cataract surgery cultured as routine procedure. *Rinsho Ganka (Jpn J Clin Ophthalmol)*. 2014;68:637–43. in Japanese.
- Eguchi H, Kuwahara T, Miyamoto T, Nakayama-Imaohji H, Ichimura M, Hayashi T, et al. High level fluoroquinolone resistance in ophthalmic clinic isolates belonging to the species *Corynebacterium macginleyi*. *J Clin Microbiol*. 2008;46:527–32.
- Owji N, Khalili MR. Normalization of conjunctival flora after dacryocystorhinostomy. *Ophthalm Plast Reconstr Surg*. 2009;25:136–8.
- Hamatsu Y, Gotoh Y, Tazawa Y. Changes in bacterial flora in the conjunctival sac following lacrimal drainage surgery. *Rinsho Ganka (Jpn J Clin Ophthalmol)*. 2003;57:249–52 (in Japanese).