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Effects of levofloxacin eye drops on ocular surface bacterial colonization and postoperative infection rate in patients undergoing blepharoplast

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Abstract: **Background**: Ocular surface bacterial colonization is a key risk factor for postoperative infection after blepharoplasty, yet clinical evidence on the impact of levofloxacin eye drops remains limited. **Objectives**: This study aims to evaluate the actual impact of perioperative levofloxacin eye drops on bacterial colonization density, changes in bacterial spectrum and postoperative infection rates in patients undergoing blepharoplasty. **Methods**: This single-center retrospective cohort study reviewed the electronic medical records of 215 patients who underwent blepharoplasty between January 2023 and January 2025. Based on the treatment they actually received, patients were categorized into two groups: the combination group (n=108), who received levofloxacin eye drops (4 times daily for 1 week) in addition to basic treatment and the control group (n=107), who received basic treatment only. The primary outcome was the incidence of postoperative infection. Secondary outcomes included the bacterial colonization positivity rate and density (days 3 and 7), changes in the bacterial spectrum, ocular surface irritation scores, wound-healing time, and adverse reactions. **Results**: The postoperative infection rate in the combination group was 2.78% (3/108), which was significantly lower than that in the control group (11.21% (12/107), p = 0.013). Multivariate regression analysis showed that levofloxacin use was a protective factor for postoperative infection (OR = 0.23, 95% CI: 0.07-0.81), while a history of diabetes was an independent risk factor (OR = 3.47, 95% CI: 1.14-10.55). There was no significant difference in the time to wound healing between the two groups (7.5 ± 1.2 days vs 7.7 ± 1.4 days, p = 0.258). **Conclusion**: Perioperative levofloxacin eye drops may reduce ocular surface bacterial colonization and the risk of postoperative infection in blepharoplasty patients without delaying wound healing.

Keywords: Blepharoplasty; Bacterial colonization; Levofloxacin eye drops; Ocular surface; Postoperative infection; Retrospective study

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INTRODUCTION

Eyelid plastic surgery is a common procedure in ophthalmology and plastic surgery. It is mainly used to correct anatomical abnormalities such as loose eyelid skin and prominent eye bags, aiming to achieve both functional improvement and cosmetic results. (Yadav *et al.,* 2026) With the acceleration of societal aging and increasing demands for a higher quality of life, the number of patients undergoing this surgery has shown steady growth. (Hsieh *et al.,* 2026) Although this surgical technique is well established, postoperative infection remains a notable complication. Although the incidence of infection is relatively low under strict aseptic conditions, once it occurs, it may progress to severe conditions such as eyelid cellulitis or orbital septal inflammation, which not only affects the surgical outcome but also prolongs the recovery time and poses a potential threat to the patient's visual health (Niec *et al.,* 2024).

The ocular surface and eyelid regions have a complex microbial community, including *Staphylococcus epidermidis*, *Staphylococcus aureus* and certain Gram-negative bacteria, which maintain a dynamic balance under normal conditions. (Konduri, Saiabhilash and Shivaji 2021) Surgical trauma disrupts the anatomical barriers and microenvironment of local tissues, potentially leading to excessive proliferation of opportunistic pathogens and increasing the risk of infection. (Long, Alverdy and Vavilala 2022) Therefore, the preventive use of antibiotics during the perioperative period has become a routine practice in many medical institutions. (Klifto *et al.,* 2023) In the field of eye surgery, topical eye drops have become the preferred mode of administration due to their advantages, such as ease of use, high local drug concentration and minimal systemic side effects. (Castro-Balado *et al.,* 2020) Levofloxacin, as a third-generation fluoroquinolone antibacterial drug, exerts its effect by inhibiting bacterial DNA gyrase (Elsevier 2008; Koh *et al.,* 2025). It shows excellent antibacterial activity against the most common ocular surface pathogenic bacteria and

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has become a commonly used preventive medication during ophthalmic surgeries. (Elsevier 2008; Koh *et al.,* 2025).

However, several issues remain regarding the preventive use of levofloxacin eye drops in eyelid plastic surgery that warrant further exploration. Most existing studies focus on intraocular surgeries, such as cataract extraction, while relatively few specialized studies address external eye surgeries, such as eyelid plastic surgery. (Mackenbrock *et al.,* 2025) The blood supply, anatomical structure and microbial environment of the eyelid tissues differ from those of the interior of the eyeball. Directly applying the research conclusions from internal eye surgeries may not be accurate enough. (Lai *et al.,* 2024) Furthermore, previous studies evaluating the efficacy of antibiotic prophylaxis have mostly regarded "postoperative infection rate" as the primary endpoint. Although this indicator has clear clinical significance, its low incidence requires a large sample size to demonstrate statistical differences and its occurrence is influenced by multiple factors. (Bwire *et al.,* 2025; Toman *et al.,* 2024).

It is worth noting that bacterial colonization, a prerequisite for infection, can serve as a sensitive indicator of antibiotic efficacy. By monitoring changes in the types and numbers of bacteria on the ocular surface before and after surgery, the microbiological effects of prophylactic antibiotics can be more directly and sensitively assessed. (Hotta *et al.,* 2023; Zhao *et al.,* 2025) However, at present, there is a lack of systematic clinical research evidence regarding the impact of levofloxacin eye drops on the colonization density and bacterial spectrum composition of the ocular surface in patients undergoing eyelid plastic surgery. (Tariq, Hehar and Chigbu 2025; Zhao *et al.,* 2025) The absence of such evidence leaves insufficient evidence-based medical basis for clinical medication decisions, which may result in either excessive or insufficient antibiotic use. The former may exacerbate the emergence of bacterial resistance, while the latter may expose patients to infection risks that could have been avoided. (Bebell and Muiru 2014).

Based on the above background, this study aims to evaluate the impact of levofloxacin eye drops on ocular bacterial colonization and the incidence of postoperative infection in patients undergoing eyelid surgery, using a retrospective cohort design. The specific research objectives include: at the clinical effect level, clarifying the actual impact of this drug on the incidence of postoperative infection; at the microbiological effect level, quantitatively analyzing its influence on the positive rate of bacterial colonization on the ocular surface, colonization density and bacterial species distribution; at the safety level, observing the effects of this medication regimen on the healing process of the incision and the ocular surface tissues and comprehensively assessing its safety characteristics in clinical application.

MATERIALS AND METHODS

Research subjects

A retrospective cohort study design was adopted. A total of 215 patients who underwent bilateral blepharoplasty in the department of plastic surgery from January 2023 to January 2025 were selected as the research subjects. Clinical data for all eligible patients were retrieved from the hospital's electronic medical record system.. They were divided into two groups based on whether they received prophylactic levofloxacin eye drops after surgery. According to the postoperative medication plan, patients were divided into two groups. The study group (n=108) received levofloxacin eye drops (5ml, 24.4mg, 4 times a day, 1 drop each time, for continuous use for 1 week) in addition to postoperative basic care after the operation.(Wang *et al.,* 2025),

The control group (n=107) received the same postoperative basic care as the study group, but did not use any antibacterial eye drops. The postoperative basic care plans for both groups were the same, including: ice application to the surgical area (within 24 hours after the operation, 20 minutes each time, with an interval of 1 hour); daily cleaning of the incision with sterile normal saline followed by a small amount of erythromycin eye ointment; outpatient suture removal on the 5th day after the operation; avoiding water contact and wearing contact lenses in the surgical area within 1 week after the operation (Fig. 1).

Study design considerations and limitations

Grouping in this study was based on actual medication use documented in medical records. During the review period, a mandatory, standardized protocol for routine prophylactic use of topical antibiotics in blepharoplasty procedures was not established in the department. Prescribing decisions for levofloxacin eye drops primarily relied on the operating surgeon's individual experience and practice habits rather than a systematic assessment of specific high-risk patients (e.g., diabetics, smokers). This study aims to compare outcomes resulting from these choices in real-world clinical practice. Inherent limitations in this design are acknowledged: First, grouping was based on actual clinical prescribing patterns rather than random assignment, which may introduce selection bias. Although known confounders were controlled for through strict inclusion criteria and multivariate analysis (see below), the influence of unmeasured factors (e.g., minor unrecorded inflammation, variations in patient compliance) cannot be entirely ruled out. Second, retrospective analysis cannot establish causality. These limitations should be considered when interpreting the results.

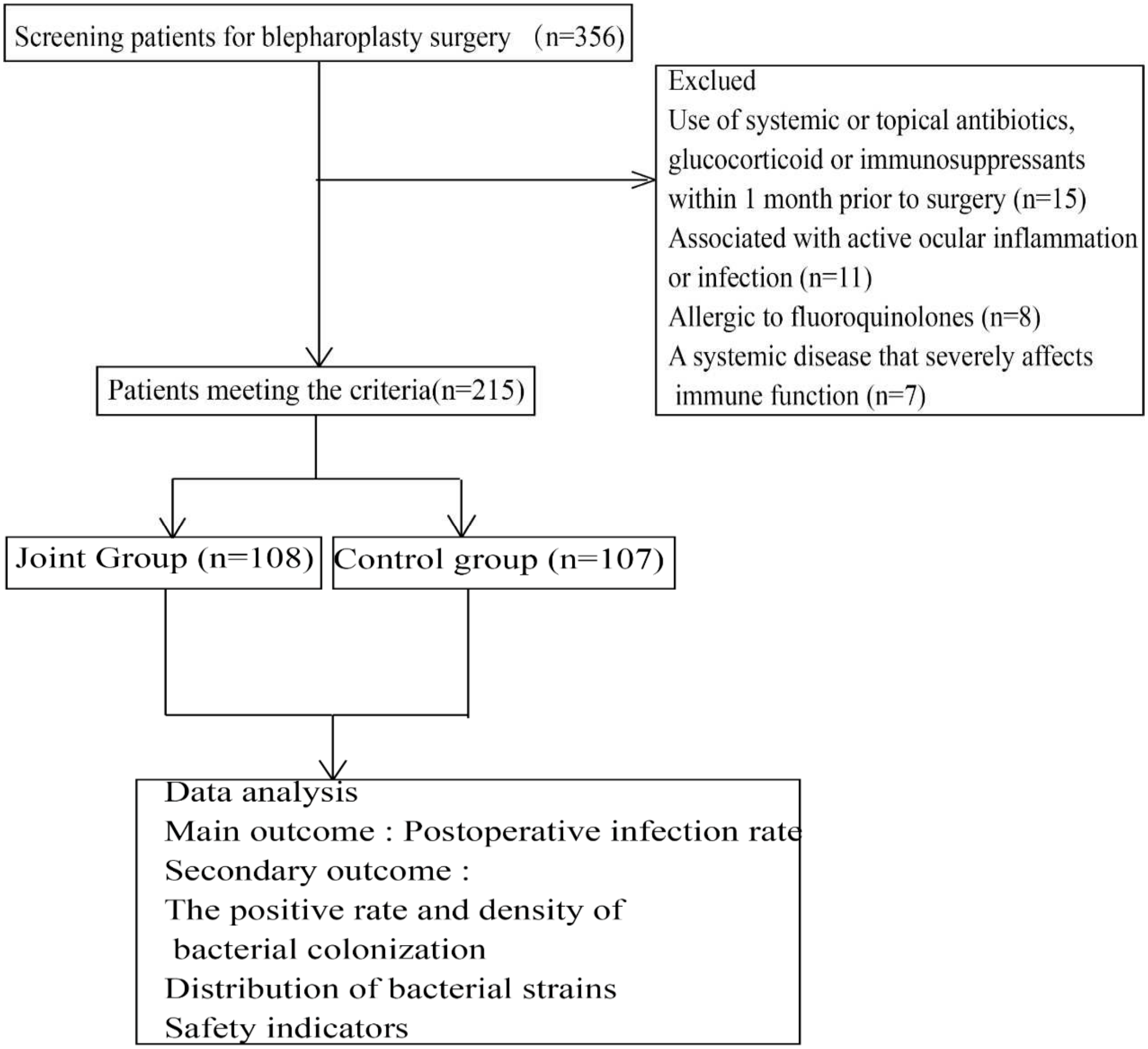

Fig. 1: Flowchart for screening and grouping of patients undergoing eyelid reshaping surgery
Firstly, from the initial screening of 356 patients, 215 research subjects were included based on the established criteria; subsequently, according to the actual postoperative treatment plans they received, the study group and the control group were naturally formed for a retrospective comparison; finally, by systematically collecting and analyzing the data on clinical infections and microbiological indicators of the two groups of patients, the potential impact of levofloxacin eye drops was evaluated.

Inclusion and exclusion criteria

Inclusion criteria (Elhamaky 2023): (1) Age range: 18 - 75 years old; (2) Diagnosed with eyelid skin laxity or the formation of eye bags and underwent elective blepharoplasty; (3) Complete clinical data and follow-up period of no less than 1 month.

Exclusion criteria (Cha *et al.,* 2019; Fenjan *et al.,* 2025): (1) Within one month before the surgery, had used systemic or local antibacterial drugs, glucocorticoids or immunosuppressants; (2) Had concurrent active inflammation or infection in the eyes; (3) Was known to be allergic to fluoroquinolone drugs; (4) Had a severe systemic disease that severely affected the immune function, such as AIDS, after organ transplantation or undergoing chemotherapy; (5) Had severe dry eye syndrome or ocular surface diseases; (6) Were lost to follow-up or had incomplete data during the follow-up period.

Laboratory testing and quality control

The conjunctival sac sample collection was performed by a fixed group of nurses using uniform-sized sterile swabs (Copan Company, Italy). The samples were collected by gently rotating the swabs around the lower fornix for 2 weeks. The sampling time was strictly controlled to be between 8:00 and 10:00 in the morning to avoid intra-day variations. The swabs were placed in Stuart transport medium immediately after collection and sent to the microbiology laboratory within 30 minutes. Sample processing followed standard operating procedures: swabs were streaked separately onto blood and chocolate plates (BD Company, USA) in a biosafety cabinet and incubated at 35°C for 48 hours. (Zhao, Chen and Fu 2020) Every day, two microbiology technicians independently perform colony counting and preliminary identification. The pure colonies are confirmed using the automated microbial identification system (VITEK 2, Bio-Rad Laboratories, France).

The culture-based microbiological method used in this study follows the standard protocol for clinical identification of common cultivable pathogens. Still, its detection capability is limited by the selection of culture media and culture conditions. Therefore, this method cannot detect non-cultivable microorganisms, viruses, fungi, or bacteria with concentrations below the culture detection threshold and may not fully reflect the full diversity and composition of the ocular surface microbial community. The limitations of this methodological choice should be considered when interpreting the results.

Medication adherence is evaluated through multiple pathways: reviewing eye drop dispensing records in nursing records, dispensing records in the outpatient pharmacy, and patients' self-reported medication use during follow-up. Adherence is defined as the actual usage reaching 80% to 120% of the theoretical usage. (Santer *et al.,* 2024).

Detection indicators

This study conducted a systematic analysis of the following detection indicators based on the retrospective collection of clinical data and laboratory information. The definitions and evaluation criteria for all indicators were established before data extraction to ensure consistent interpretation of results.

The primary indicator is the incidence of postoperative infection. In this retrospective analysis, the operational definition of postoperative infection must strictly follow the medical records and meet at least two of the following criteria: First, local infection signs recorded by the attending physician in the medical record, such as redness, swelling, heat and pain in the incision area, or the observation of purulent secretions; second, local treatment recorded in the nursing records, such as drainage of pus or increased dressing changes; third, positive bacterial culture reports from microbiological tests of incision secretions or conjunctival sac specimens. The time window for infection occurrence is limited to within 30 days after surgery. (Wang *et al.,* 2024)

The secondary outcome indicators include the following six aspects and the data are all extracted from historical records.

First, the situation of ocular surface bacterial colonization. This is obtained by reviewing the bacterial culture reports of the patients' conjunctival sacs before the operation, on the third day after the operation and on the seventh day after the operation. The records include the colonization rate (i.e., the percentage of positive specimens among the total specimens) and the colonization density. The colonization density is recorded in grades based on the colony count in the test report: no growth, mild colonization (1-10 CFU), moderate colonization (11-100 CFU), or severe colonization (>100 CFU).(Nascimento *et al.,* 2024) Second, the distribution of the colonized bacterial strains. By classifying and statistically analyzing the bacterial strain identification reports provided by the microbiology laboratory (VITEK 2 identification card reports), the composition ratios of common bacterial strains, including coagulase-negative staphylococci (e.g., Staphylococcus epidermidis), Staphylococcus aureus, Streptococcus species, Pseudomonas aeruginosa, and other Gram-negative bacilli, were examined.

Third, postoperative ocular surface irritation symptoms. By reviewing the patient's complaints in medical and nursing records, such as a sense of foreign body, burning sensation, eye itching, or photophobia, and classifying them as "symptomatic" or "asymptomatic" for statistical purposes.

Fourth, incision healing time. Defined as the number of days from the surgery date to the assessment by the physician in the outpatient record that the incision has reached grade A healing (i.e., excellent healing with no adverse reactions).

Fifth, drug-related adverse reactions. By systematically reviewing medical history records, nursing records, and pharmacy medication records, the focus was on whether there were records of ocular allergic reactions (such as eyelid edema and conjunctival congestion), aggravated local irritation symptoms, or other adverse events related to the use of levofloxacin eye drops.

Sixth, as a supplement, the basic demographic data (age, gender) and surgical information of the patients were retrospectively recorded to assess the baseline comparability between groups.

The original data for all these indicators were extracted from the hospital electronic medical record system (including HIS, LIS, EMR) and outpatient files, and were independently entered and cross-checked by two researchers to ensure their accuracy based on historical records.

Sample size calculation

The sample size for this study was determined using retrospective statistical estimation. By reviewing previously published literature, the sample size of this study was verified through a post hoc power analysis to assess its power to detect differences in the primary outcome indicators. The sample size calculation was based on the research of Juan A Viscardi *et al.,* (Viscardi and Giordano 2025)(2026) as the main reference, where the postoperative infection rate in the control group was 7.8% and in the experimental group was 2.4%. Using G*Power 3.1.9.7 for sample size estimation, with a significance level $\alpha = 0.05$ (two-sided) and a power of $1 - \beta = 0.80$, the calculation indicated that each group needed 178 cases and the two groups needed a total of 356 cases. Due to the limitations of the retrospective study, the actual sample size was 215 cases (joint group: 108 cases; control group: 107 cases), which did not reach the optimal sample size for a prospective design.

To evaluate the test power of the current sample size for the primary outcome indicators, this study conducted a post hoc power analysis. Based on the observed infection rates (jointgroup: 2.78%; control group: 11.21%) and the actual sample size, a post hoc power calculation was performed using G^*Power 3.1.9.7. Input parameters: p1 = 0.1121, p2 = 0.0278, n1 = 108, n2 = 107, $\alpha = 0.05$ (two-sided). The actual test power of this study was estimated to exceed 0.99. The results show that although the actual sample size did not reach the ideal value estimated in the literature (356 cases), the observed effect (a difference of 8.43 percentage points between the two groups) was much larger than the expected effect reported in the literature (5.4 percentage points). The current sample size still has sufficient statistical power to support the statistical analysis of the primary outcome indicators. The expected infection rate trend in the literature was highly consistent with the findings of this study (the infection rate in the intervention group was approximately three-quarters lower than that in the control group), further enhancing the robustness of the research conclusion.

Statistical analysis

Statistical analysis was conducted using SPSS 25.0 software. For the measurement data such as age, BMI, operation duration, bacterial colonization density, positive rate of bacterial colonization, distribution of ocular surface bacterial species on the 7th day,if they met the normal distribution, they were expressed as mean ± standard deviation; for the count data such as baseline information, postoperative infection rate, safety indicators, they were expressed as the number of cases and percentages. The comparison between groups was performed using the χ^2 test. The data from repeated measurements of bacterial colonization density were analyzed using repeated-measures analysis of variance and pairwise comparisons were conducted using the Bonferroni method. To control for potential confounding factors, a multivariate logistic regression analysis was performed to estimate the postoperative infection rate, with age, gender, history of diabetes and duration of surgery as covariates. All statistical tests were two-sided and a difference was considered statistically significant if $p < 0.05$.

Ethical statement

The ethical issues involved in this study have been thoroughly examined and properly addressed. The study protocol has been officially submitted to the ethics committee of The Affiliated Friendship Plastic Surgical Hospital of Nanjing Medical University and has received comprehensive review and approval (approval number: 20230206). Since this study is a retrospective analysis that does not involve any additional interventions for patients and all data are derived from previously anonymized medical records, the ethics committee, after deliberation, decided to waive the requirement for individual informed consent.

RESULTS

Baseline information

Through a retrospective data analysis of 215 patients who underwent blepharoplasty, this study obtained the following important findings: In terms of baseline data (Table 1), there were no statistically significant differences between the joint group and the control group in terms of age, gender distribution, body mass index, diabetes, jointrate of hypertension, smoking history, use of anticoagulant drugs, use of artificial tears, operation duration, anesthesia method and positive rate of preoperative ocular surface bacterial colonization ($p > 0.05$). This indicates that the two patient groups in this study were highly comparable before the intervention, effectively controlling for potential confounding factors and providing a reliable basis for subsequent evaluation of levofloxacin eye drops.

Main outcome

The analysis of the main outcome indicators (Table 2) showed that the postoperative infection rate in the joint group was significantly lower than in the control group (2.78% vs 11.21%, $p = 0.015$). This result, from the perspective of clinical endpoints, confirmed that the perioperative local application of levofloxacin eye drops could significantly reduce the risk of infection after eyelid surgery, with a 75% relative risk reduction.

Table 1: Statistical comparison of participants' demographic characteristics.

Baseline		Joint group (n = 108)	Control group (n = 107)	Effect size	*t*	*p*-value
Age (year)		58.48 ± 10.23	57.84 ± 11.10	2.577	0.440	0.660
Gender (n, %)	Male	42 (38.89)	46 (42.99)	0.374		0.541
	Female	66 (61.11)	61 (50.01)			
Diabetes mellitus management (n, %)		97 (89.81)	94 (87.85)	0.209		0.647
Combined with hypertension (n, %)		79 (73.15)	75 (70.09)	0.247		0.619
BMI (kg/m², $\bar{x} \pm s$)		23.74 ± 2.51	24.02 ± 2.81	2.756	-0.769	0.443
Duration of the surgery (minutes, $\bar{x} \pm s$)		65.33 ± 15.71	63.89 ± 14.78	0.000	0.697	0.487
Smoking history (n, %)		93 (86.11)	92 (85.98)	0.001		0.978
Preoperative use of anticoagulant drugs (n, %)		99 (91.67)	96 (89.72)	0.242		0.623
Using artificial tears before the operation (n, %)		83 (76.85)	85 (79.44)	0.211		0.646
Anaesthesia method (n, %)	Local area	87 (80.56)	90 (84.11)	0.467		0.494
	Surgical anesthesia	21 (19.44)	17 (15.89)			
Preoperative positive rate of ocular surface bacterial colonisation (n, %)	No	19 (17.59)	20 (18.69)	0.044		0.834
	Yes	89 (82.41)	87 (81.31)			

Note: BMI is Body Mass Index.

Table 2: Postoperative infection rate.

Parameters (n, %)		Test	Effect size	df	*p*-value
Joint group (n = 108)	3 (2.78)	chi square test	5.895	1	0.015
Control group (n = 107)	12 (11.21)				

Table 3: Comparison of the positive rate of ocular surface bacterial colonization.

Parameters (n, %)	Joint group (n = 108)	Control group (n = 107)	Test	Effect size	df	*p*-value
T_0	89 (82.41)	87 (81.31)	Chi-squared	0.044	1	0.834
T_1	25 (23.15)	79 (73.83)	Chi-squared	55.287	1	<.001
T_2	18 (16.67)	72 (67.29)	Chi-squared	56.597	1	<.001

Note: T_0 represents before the operation. T_1 represents 3 days after the surgery. T_2 represents 7 days after the surgery.

Table 4: Comparison of ocular surface bacterial colonization density (CFU, $\bar{x} \pm s$)

Parameters		T_0	T_1	T_2	η^2	Effect size	*p*-value
Planting density	Joint group (n = 108)	45.22 ± 20.26	5.23 ± 2.11$^{*\#}$	3.79 ± 1.92$^{*\#}$	0.643	190.532	<.001
	Control group (n = 107)	46.84 ± 22.05	48.48 ± 25.66	35.33 ± 20.41$^{\#}$	0.186	24.143	<.001
	F	0.540	51.709	137.539			
	p	0.464	<.001	<.001			

$F_{time} = 133.260$，$p_{time} = <.001$, $F_{group} = 272.397$, $p_{group} = <.001$, $F_{time*group} = 82.196$, $p_{time*group} = <.001$.

Note: T_0 represents before the operation. T_1 represents 3 days after the surgery. T_2 represents 7 days after the surgery. # Indicates compared with the baseline data of the same group. *Indicates compared with the conventional rehabilitation treatment group in the same period.

Secondary outcome

Regarding bacterial indicators, there was no significant difference in the preoperative positive rate of ocular surface bacterial colonization between the two groups (82.4% vs 81.3%; p = 0.832), and the baseline characteristics were comparable. On the 3rd and 7th days after surgery, the positive rate of colonization in the study group was 23.1% (25/108) and 16.7% (18/108), respectively, which were significantly lower than that of the control group (73.8% (79/107) and 67.3% (72/107)) and the differences were statistically significant (χ^2 values were 54.32 and 55.06, respectively, both $p < 0.001$) (Table 3). Similarly, in the colonization density indicator reflecting bacterial load (Table 4), the study group was also significantly lower than the control group at both time points after surgery ($p < 0.001$). These data provide a microbiological mechanistic explanation for the reduction in infection rate, suggesting that levofloxacin may exert a preventive effect by inhibiting the proliferation of ocular surface bacteria and reducing the bacterial load in the early postoperative period. Analysis of bacterial species distribution on the 7th day after surgery (Table 5) further revealed levofloxacin's antibacterial spectrum. The detection rates of common pathogenic bacteria, such as *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*, in the jointgroup were 4.6%, 1.9% and 0.9%, respectively, significantly lower than the 32.7%, 14.0% and 7.5% rates in the control group. This finding indicates that the broad-spectrum antibacterial activity of levofloxacin effectively changed the bacterial community composition of the postoperative ocular surface, significantly reducing the colonisation of potential pathogenic bacteria.

In terms of safety assessment (
Table **6**6), there was no statistically significant difference in the incidence of postoperative ocular surface irritation symptoms or in incision healing time between the two groups ($p > 0.05$). This indicates that levofloxacin eye drops effectively prevent infections without adversely affecting incision healing or causing additional adverse reactions, demonstrating good safety.

Logistic regression analysis

To account for potential confounding factors, a multivariate logistic regression model was used to analyze factors associated with postoperative infection. The variables included in the model were group (Joint Group/control group), age, gender, history of diabetes, duration of surgery, and preoperative ocular surface bacterial colonization status.

The regression analysis results showed that after adjusting for other confounding factors, the group factor remained an independent predictor of postoperative infection (Table 5). Compared with the control group, the postoperative infection risk in the joint group (receiving prophylactic treatment with levofloxacin eye drops) was significantly lower (OR = 0.23, 95% CI: 0.07 - 0.81, $p = 0.022$), indicating that the use of levofloxacin eye drops could reduce the postoperative infection risk by approximately 77% and its protective effect was independent of other confounding factors.

In addition, a history of diabetes was identified as an independent risk factor for postoperative infection (OR = 3.47, 95% CI: 1.14 - 10.55, $p = 0.028$), suggesting that patients with diabetes had a postoperative infection risk 3.47 times that of non-diabetic patients. Age, gender, duration of surgery, and preoperative bacterial colonization status did not show an independent association with postoperative infection in this study population (all $p > 0.05$), but age ($p = 0.096$) and preoperative bacterial colonization ($p = 0.152$) showed a trend. They may become significant factors in larger-sample-size studies.

The Hosmer-Lemeshow goodness-of-fit test for the model showed that $\chi^2 = 6.83$, $p = 0.555$, indicating a good model fit. The above multivariate analysis results further confirmed the findings of the single-factor analysis: levofloxacin eye drops have an independent protective effect on reducing postoperative infection, and this effect remains robust even after controlling for known confounding factors.

DISCUSSION

The preventive strategy for infection after eyelid surgery is based on the infection chain: surgical trauma disrupts the ocular surface barrier, increases bacterial colonization and allows opportunistic pathogens to overgrow. Levofloxacin eye drops may block the transition from colonization to infection. In this retrospective cohort study, the infection rate was lower in the levofloxacin group (2.78%) than in the non-use group (11.21%). Microbiological indicators, including colonization rate and density, provided mechanistic insights. Before surgery, colonization did not differ between groups. On postoperative days 3 and 7, the levofloxacin group had significantly lower colonization rates (23.15% and 16.67%) and densities (5.23 ± 2.11 CFU and 3.79 ± 1.92 CFU) than the control group (73.83% and 67.29%; 48.48 ± 25.66 CFU and 35.33 ± 20.41 CFU). This is also consistent with the conclusion reported by Esmail *et al. (2020)* that perioperative antibacterial eye drops can significantly alter the composition of the ocular surface microbiota. The study found that the positive rate of bacterial culture in the levofloxacin group was significantly lower than that in the iodine compound group one week after surgery, corroborating this finding and demonstrating the effectiveness of levofloxacin in eliminating potential pathogenic bacteria on the ocular surface after surgical intervention.(Matsuura *et al.,* 2024).

As shown in Table 5, Further analysis of bacterial strain distribution revealed that the detection rates of common pathogenic bacteria, such as *Staphylococcus epidermidis*, *Staphylococcus aureus*, and Pseudomonas aeruginosa, on the 7th day after joint treatment were significantly lower than those in the control group. This finding is of significant clinical importance, as these bacterial strains are the most common pathogens causing postoperative ocular infections. (Schilling *et al.,* 2024) Levofloxacin exerts a broad-spectrum effect on Gram-positive and Gram-negative bacteria by inhibiting bacterial DNA gyrase. The change in the bacterial spectrum observed in this study is a direct manifestation of its broad-spectrum antibacterial activity.

Table 6: Distribution of ocular surface colonizing bacteria on the 7th day after surgery (n, %).

Bacterial strain	Joint group (n = 108)	Control group (n = 107)	Test	Effect size	df	*p*-value
Staphylococcus epidermidis	5 (4.63)	35 (32.71)	Chi-squared	63.143	1	<.001
Golden staphylococcus	2 (1.85)	15 (14.02)				
Pseudomonas aeruginosa	1 (0.93)	8 (7.48)				
Streptococcus genus	3 (2.78)	6 (5.61)				
Other bacterial strains	7 (6.48)	8 (7.48)				
No bacterial growth	90 (83.33)	35 (32.71)				

Table 7: Comparison of safety indicators.

Parameters	Joint group (n = 108)	Control group (n = 107)	Test	95%CI		Effect size	df	*p*-value
				Lower	Upper			
Postoperative ocular surface irritation symptoms (n, %)	5 (4.63)	4 (3.74)	Chi-squared			0.106	1	0.744
Incision healing time (days, $\bar{x} \pm s$)	7.46 ± 1.21	7.73 ± 1.42	Chi-squared	-0.616	0.957	1.782	-1.441	0.151
Drug-related adverse reactions (n, %)	4 (3.70)	1 (0.93)	Chi-squared			1.814	1	0.178

Table 7: Multivariate logistic regression analysis of factors influencing postoperative infection.

Variable	Regression coefficient (B)	Standard error (SE)	Wald χ^2 value	*p*	OR	95%CI
Grouping (Joint group vs control group)	-1.468	0.642	5.227	0.022	0.23	0.07-0.81
Age (years)	0.035	0.021	2.778	0.096	1.04	0.99-1.08
Gender (Male vs Female)	0.382	0.458	0.696	0.404	1.47	0.60-3.60
Diabetes history (present vs absent)	1.245	0.567	4.821	0.028	3.47	1.14-10.55
Operation duration (minutes)	0.019	0.015	1.604	0.205	1.02	0.99-1.05
Preoperative bacterial colonization (positive vs negative)	0.892	0.623	2.051	0.152	2.44	0.72-8.27
Constant	-4.832	1.847	6.846	0.009	0.01	-

(Hurst *et al.,* 2002). It is worth noting that in a study by Xiangjia Zhu *et al.,* involving patients with meibomian gland dysfunction undergoing cataract surgery, changes in the composition and diversity of the ocular surface bacterial community were observed after using 5% levofloxacin eye drops, as assessed by 16S rRNA gene sequencing. This supports the conclusion of this study that levofloxacin can affect the composition of the ocular surface bacteria community from a more detailed molecular biology perspective. (Zhu *et al.,* 2021).

The core finding of this study is that levofloxacin eye drops reduced the infection rate after eyelid plasty from 11.21% in the control group to 2.78% in the combined group. This result aligns with the preventive effect of levofloxacin reported in other ocular surgeries and with the conclusion by Ashraf *et al*. (2020) that prophylactic antibiotics reduce infection risk in facial plastic surgery. Similarly, a study using povidone-iodine combined with levofloxacin also demonstrated strong preventive effects (Peyman, Hosseini and Narimani 2020). Postoperative infection reflects pathogenic bacteria overcoming host defenses (da Silva *et al*., 2026). Levofloxacin use was shown to be associated with reduced ocular surface bacterial load and changes in pathogen distribution, providing a potential mechanistic link to the observed reduction in infection. Notably, the infection rate in the control group of this study (11.21%) was higher than the 2.7% reported by Liu *et al*. (2020), possibly due to differences in geographic region, healthcare setting, or patient risk factors such as diabetes and smoking (Liu *et al.,* 2025). Nevertheless, the infection rate in the combined group dropped to 2.78%, representing a 75.2% relative risk reduction, supporting the protective value of levofloxacin in eyelid plasty.

As shown in table 6, levofloxacin eye drops are well tolerated. There were no statistically significant differences in the incidence of postoperative ocular surface irritation symptoms (such as foreign body sensation and burning sensation) and incision healing time between the two groups of patients ($p < 0.05$). This indicates that levofloxacin eye drops not only exert antibacterial effects but also do not cause significant additional stimulation of ocular surface tissues or delay incision healing. This finding is consistent with the generally recognised safety of levofloxacin in the treatment of ocular surface infectious diseases such as bacterial conjunctivitis and keratitis.(Yu *et al.,* 2025) Kenichiro Yamazaki *et al.,* published an article in 2022 stating that, after femtosecond laser-assisted cataract surgery, levofloxacin eye drops were used as one of the postoperative basic medications to prevent dry eye caused by the procedure. This further supports the broad safety and utility of levofloxacin during the perioperative period of double eyelid surgery. (Yamazaki *et al.,* 2022).

Existing studies on levofloxacin eye drops in ophthalmic surgery have mostly focused on internal procedures, such as cataract surgery, with limited research on external cosmetic procedures, such as eyelid plasty (Wu *et al*., 2024). This study attempts to expand the evaluation scope from clinical infection endpoints to the intermediate indicator of ocular surface bacterial colonization, which may be more sensitive to antibacterial effects and more controllable. This design may complement methods that rely solely on low-incidence infection events and provide a microbial-level perspective to explore the link between clinical outcomes and antimicrobial effects. Although levofloxacin has been applied preoperatively in patients with pterygium and meibomian gland dysfunction, that study focused primarily on postoperative dry eye rather than bacterial colonization and infection (Yin *et al.,* 2019). Therefore, by focusing on changes in the ocular surface microbiota, this study provides additional microbial evidence for the preventive use of levofloxacin in blepharoplasty.

The preventive use of levofloxacin eye drops should be carefully weighed within the framework of antibiotic management. In this study, the infection rate in the control group was 11.21%, higher than typical rates reported in the eyelid surgery literature, possibly due to a higher proportion of high-risk patients (e.g., diabetes). Diabetes was an independent risk factor for infection (OR = 3.47, 95% CI: 1.14–10.55), supporting a targeted approach. Thus, levofloxacin may offer benefit primarily in high-risk populations rather than as routine prophylaxis.

Microbiologically, levofloxacin reduced bacterial colonization and pathogen detection after surgery. However, this may affect ocular surface microbiota diversity and create niches for opportunistic pathogens—a risk that was not fully assessed during the 30-day follow-up.

Clinically, decision-making should be based on risk stratification, short-course therapy, dynamic monitoring of resistance and patient education. Prophylaxis should be reserved for high-risk patients, avoiding unnecessary antibiotic exposure in low-risk individuals.

Limitations of the study

This study has several notable limitations. Firstly, as a retrospective cohort study, the treatment groups were based on actual clinical medication records rather than random allocation, which may introduce confounding due to indications and selection bias. Although there were no statistically significant differences in all measurable baseline characteristics such as age, gender, diabetes, smoking history and preoperative bacterial colonization between the two groups and statistical adjustments for known confounding factors were made through multivariate regression, residual confounding (such as surgical details, physician technical differences, patient socioeconomic status, postoperative care meticulousness and medication adherence) that was not measured could not be completely excluded. Therefore, the results of this study should be regarded as evidence of the association between levofloxacin and favorable outcomes, rather than a definitive causal relationship. Additionally, as a single-center study, the generalizability of its results is limited.

Secondly, due to the limitations of the retrospective study design, only 215 cases were included, which did not reach the ideal sample size (356 cases) estimated from the literature. However, the post hoc test power re-evaluation showed that, based on the observed effect size, the current sample size still had sufficient statistical power for the primary outcome (>0.99). Additionally, subgroup analyses of some secondary outcome indicators may have insufficient statistical power.

Thirdly, in the control group setting, this study used patients receiving basic treatment as the control group, without a blank or placebo control. Given that levofloxacin eye drops are already a routine clinical medication, using "basic treatment" as the control is in line with clinical practice background, and the balance and comparability of the baseline data across the two groups verified the effectiveness of the control group. However, this design still cannot completely eliminate the influence of non-specific effects on the results.

Fourthly, for microbial detection methods, this study relied on standard aerobic bacterial culture techniques to assess the ocular surface microbiota. Although this method is a classic means of clinical microbiological detection, it has inherent limitations: it can only detect aerobic bacteria and cannot identify anaerobic bacteria, viruses, fungi and difficult-to-culture bacterial species, which may underestimate the true diversity and bacterial load of the ocular surface microbiota and cannot assess the overall impact of antibiotic intervention on the diversity of the microbiota and the interaction between the microbiota. Therefore, the understanding of the microbiota balance still remains at a preliminary level.

Fifthly, the follow-up period is only 30 days, which can effectively detect early infections but is insufficient to evaluate the long-term impact of the drug on the ocular surface microbiota and the risk of drug resistance development. At the same time, medication adherence assessment in a retrospective design mainly relies on medical records, which may affect the accuracy of the effect estimate. Routine fluoroquinolone exposure may increase selection pressure for bacterial resistance, and a 30-day follow-up period is insufficient to assess the long-term risk of resistance gene enrichment.

Nevertheless, this study provides valuable clinical insights into the preventive value of levofloxacin in blepharoplasty. Future studies need to conduct prospective, multicenter randomized controlled trials using advanced technologies, such as metagenomic sequencing, to dynamically monitor changes in the microbiota and antibiotic resistance genes, and to conduct long-term follow-up to verify these findings and develop more individualized perioperative antimicrobial management plans. Specifically, future research should further explore: (1) the differences in the benefits of prophylactic medication among patients with different risk stratifications; (2) the non-inferiority comparison between shorter treatment courses (such as 3 days) and 1-week courses; (3) the dynamic changes in the ocular surface microbiota based on metagenomics and their association with long-term infection risk; (4) the long-term impact of prophylactic use of levofloxacin on the local antibiotic resistance spectrum.

CONCLUSION

In summary, this retrospective cohort analysis confirmed that levofloxacin eye drops reduce postoperative infection rates in eyelid plasty by decreasing bacterial colonization density and altering the bacterial spectrum, without increasing adverse events or impairing wound healing. These findings link clinical benefits with microbiological effects, supporting rational perioperative antibiotic use. However, prophylaxis should follow antibiotic stewardship principles. The key lies in shifting from routine to precise prevention—targeting high-risk patients (diabetes, immunocompromised) based on preoperative assessment—to maximize clinical benefit while minimizing unnecessary antibiotic exposure and microbiological costs.

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Authors' contributions
Shu Wang: Developed and planned the study, performed experiments and interpreted results. Edited and refined the manuscript with a focus on critical intellectual contributions; Guoping Wu and Wenwen Zhang: Participated in collecting, assessing and interpreting the data. Made significant contributions to data interpretation and manuscript preparation. All authors have read and approved the final manuscript.

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This study was approved by the Ethics Committee of the Affiliated Friendship Plastic Surgical Hospital of Nanjing Medical University (Approval No.: 20230206). This study was performed in adherence with the RECORD guidelines. See supplementary file for the RECORD checklist.

Conflict of interest
The authors declare no financial conflicts of interest.

Supplementary data
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