



Original Article

Microbiology and management of *Staphylococcus aureus* lacrimal system infections

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ABSTRACT

Background: Infections of the lacrimal system, including dacryocystitis and canaliculitis, are commonly caused by bacterial pathogens, with *Staphylococcus aureus* being a significant etiological agent. Understanding its microbiological profile and resistance patterns is crucial for effective management.

Objective: To evaluate the microbiology, clinical presentation, and management strategies of *Staphylococcus aureus* lacrimal system infections.

Methods: This observational study included 75 patients presenting with acute or chronic lacrimal system infections at a tertiary ophthalmology center over a two-year period. Samples from the lacrimal sac or canaliculi were obtained for culture and antibiotic susceptibility testing. Clinical outcomes were analyzed based on medical and surgical management.

Results: *Staphylococcus aureus* was isolated in 42 (56%) patients. Methicillin-resistant *Staphylococcus aureus* (MRSA) accounted for 14 (33%) of these isolates. Most common clinical presentation was epiphora with swelling over the lacrimal sac (78%), followed by mucopurulent discharge (65%). Topical and systemic antibiotics were effective in 58% of acute cases, whereas chronic or recurrent cases required dacryocystorhinostomy (DCR) with adjunctive antibiotics, achieving complete resolution in 92% of surgical cases.

Conclusion: *Staphylococcus aureus* is the predominant pathogen in lacrimal system infections. Early microbiological diagnosis and targeted antibiotic therapy are essential. Surgical intervention remains the mainstay in chronic or complicated cases. Awareness of MRSA prevalence is vital for antibiotic stewardship.

Keywords: *Staphylococcus aureus*, MRSA, lacrimal system infections, dacryocystitis, canaliculitis, dacryocystorhinostomy, antibiotic resistance.

INTRODUCTION

Lacrimal system infections, including dacryocystitis and canaliculitis, are common ocular conditions that can lead to significant discomfort, visual morbidity, and in chronic cases, structural damage to the lacrimal drainage apparatus. The lacrimal system, comprising the puncta, canaliculi, lacrimal sac, and nasolacrimal duct, serves as a conduit for tear drainage. Obstruction, stasis, or mucosal inflammation predisposes this system to bacterial colonization and infection [1,2].

Among bacterial pathogens, *Staphylococcus aureus* is recognized as a leading cause of both acute and chronic lacrimal system infections [3]. The organism's virulence factors, including adhesins and biofilm formation, facilitate colonization of the lacrimal sac and canaliculi, contributing to persistent or recurrent infections [4]. Additionally, the emergence of methicillin-resistant *Staphylococcus aureus* (MRSA) has created challenges in empirical therapy, necessitating culture-guided antibiotic selection [5].

Acute dacryocystitis typically manifests with pain, erythema, swelling over the lacrimal sac, and purulent discharge, often precipitated by nasolacrimal duct obstruction. Chronic dacryocystitis, conversely, is characterized by intermittent

mucopurulent discharge and tearing (epiphora), with a propensity for recurrence [6]. Canaliculitis, although less common, frequently presents with localized tenderness, punctal discharge, and concretions, which are pathognomonic of infection by *Actinomyces* or *Staphylococcus aureus* [7].

Management of lacrimal system infections requires a balance between medical and surgical approaches. Acute infections often respond to topical and systemic antibiotics, but chronic, recurrent, or complicated infections frequently necessitate surgical intervention, such as dacryocystorhinostomy (DCR) or canaliculotomy, to restore patency and eradicate infection [8].

Understanding the microbiological spectrum and resistance patterns is critical, particularly in regions with high prevalence of MRSA. Early microbiological evaluation allows for targeted antibiotic therapy, reduces recurrence, and improves clinical outcomes [9].

AIM OF THE STUDY

To investigate the microbiology, antibiotic resistance, clinical features, and management outcomes of *Staphylococcus aureus* lacrimal system infections, providing a comprehensive framework for clinicians managing these challenging infections.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, observational study conducted over a 24-month period (January 2024 to December 2025) at the Department of Ophthalmology at a tertiary care referral center. The study adhered to the tenets of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrollment.

Study Population

Inclusion Criteria:

- Patients aged ≥ 18 years presenting with signs and symptoms of lacrimal system infections, including:
 - Acute dacryocystitis (sudden onset pain, erythema, swelling over the lacrimal sac, and mucopurulent discharge)
 - Chronic dacryocystitis (persistent epiphora, intermittent mucopurulent discharge)
 - Canaliculitis (punctal discharge, local tenderness, and canalicular swelling)

Exclusion Criteria:

- Patients with a history of ocular trauma, neoplasms of the lacrimal system, or systemic immunosuppression (e.g., HIV, chemotherapy)
- Patients who had received systemic or topical antibiotics within 7 days prior to sample collection

Clinical Evaluation

- A detailed ophthalmic examination was performed, including:
 - Visual acuity assessment
 - External ocular examination for swelling, erythema, and tenderness
 - Slit-lamp evaluation for punctal or canalicular discharge
 - Nasolacrimal duct patency assessment using the dye disappearance test and lacrimal irrigation (syringing)
- Demographic data (age, gender), duration of symptoms, laterality, and history of prior infections or interventions were recorded.

Sample Collection

- **Acute dacryocystitis:** After aseptic preparation, the lacrimal sac was punctured, and purulent material was aspirated using a sterile 23G needle.
- **Chronic dacryocystitis:** Discharge was obtained via lacrimal sac irrigation.
- **Canaliculitis:** Punctal pressure and expression were used to collect canalicular discharge. Concretions, if present, were also sent for microbiological analysis.

All samples were immediately transported to the microbiology laboratory in sterile containers and processed within 2 hours.

Microbiological Analysis

- **Culture:** Samples were inoculated onto:
 - Blood agar (for Gram-positive cocci)
 - MacConkey agar (for Gram-negative organisms)
 - Chocolate agar (for fastidious organisms)
- Plates were incubated at 37°C for 24–48 hours under aerobic conditions.

- **Identification:**
 - Colonies were identified based on morphology, Gram staining, catalase, coagulase, and standard biochemical tests.
- **Antibiotic Susceptibility Testing:**
 - Performed using the Kirby-Bauer disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines [1].
 - Antibiotics tested included penicillin, oxacillin (for MRSA detection), cephalosporins, fluoroquinolones, macrolides, aminoglycosides, and vancomycin.

Treatment Protocol

- **Medical Management:**
 - Acute infections received empiric therapy with a combination of topical antibiotics (e.g., moxifloxacin 0.5% drops) and systemic antibiotics (e.g., oral cephalexin 500 mg BID), adjusted based on culture and sensitivity results.
 - Symptomatic management included warm compresses and analgesics.
- **Surgical Management:**
 - Chronic or recurrent infections were managed with dacryocystorhinostomy (DCR) or canaliculotomy.
 - Intraoperative lacrimal sac and canalicular samples were obtained for culture.
 - Postoperative antibiotics were administered for 7–10 days based on culture results.

Outcome Measures

- **Primary outcomes:**
 - Microbiological profile of lacrimal system infections
 - Antibiotic susceptibility patterns
- **Secondary outcomes:**
 - Clinical resolution of infection (defined as absence of discharge, swelling, and epiphora)
 - Recurrence rate within 6 months of follow-up

Statistical Analysis: Data were entered and analyzed using **SPSS version 25.0**. Continuous variables were expressed as mean \pm standard deviation (SD), and categorical variables as frequencies and percentages. Chi-square or Fisher's exact tests were used to compare categorical variables (e.g., MRSA vs MSSA recurrence rates). Student's t-test was used to compare continuous variables between groups. A p-value <0.05 was considered statistically significant.

RESULTS

Demographics and Clinical Characteristics

Middle-aged adults were most commonly affected, with a slight female predominance. Acute infections were slightly more frequent than chronic. Epiphora and swelling were the most consistent clinical signs. **(Table 1)**

Microbiological Profile:

S. aureus was the predominant pathogen, with MRSA accounting for one-third of the isolates. Gram-negative and fungal infections were less common but should be considered, especially in chronic or immunocompromised cases. **(Table 2)**

Antibiotic Susceptibility of *S. aureus*

MRSA prevalence was significant (33%). Fluoroquinolones (moxifloxacin) and vancomycin remained highly effective. High penicillin resistance highlights the need for culture-guided therapy. **(Table 3)**

Clinical Features of *S. aureus* Infections

Clinical presentation was largely similar between *S. aureus* and other pathogens. Recurrent infections were significantly more common with *S. aureus*, especially MRSA ($p < 0.05$), indicating the need for targeted therapy and possibly early surgical intervention. **(Table 4)**

Treatment and Outcomes

Medical therapy alone was moderately effective in acute cases but had high recurrence rates, especially for MRSA. Surgical management provided excellent resolution (94%) in chronic or recurrent infections. The combination of culture-guided antibiotics with surgery is optimal for long-term success. **(Table 5)**

MRSA vs MSSA Outcome Comparison

MRSA infections were significantly more likely to recur after medical therapy and required surgical intervention more often. Surgery resulted in excellent outcomes for both MRSA and MSSA, emphasizing its role in chronic or resistant infections. **(Table 6)**

Table 1: Patient Demographics and Clinical Features (n = 75)

Parameter	Value
Mean age (years)	46.3 ± 14.2
Gender (M:F)	1:1.2
Laterality (Right:Left:Both)	35:30:10
Type of infection	Acute: 44 (59%), Chronic: 31 (41%)
Duration of symptoms (days)	8.5 ± 3.6
Common clinical features	Epiphora: 78%, Swelling: 78%, Mucopurulent discharge: 65%, Pain: 58%

Table 2: Microbiological Spectrum of Lacrimal System Infections

Organism	Number (%)
<i>Staphylococcus aureus</i>	42 (56%)
- MSSA	28 (37%)
- MRSA	14 (19%)
Coagulase-negative staphylococci	10 (13%)
Gram-negative organisms	12 (16%)
Fungal isolates	11 (15%)

Table 3: Antibiotic Susceptibility of *Staphylococcus aureus* Isolates (n = 42)

Antibiotic	Sensitive (%)	Resistant (%)
Penicillin	14 (33%)	28 (67%)
Oxacillin / Methicillin	28 (67%)	14 (33%)
Cephalexin	35 (83%)	7 (17%)
Moxifloxacin	38 (90%)	4 (10%)
Vancomycin	42 (100%)	0 (0%)
Clindamycin	36 (86%)	6 (14%)

Table 4: Clinical Features of *S. aureus* vs Non-*S. aureus* Infections

Feature	<i>S. aureus</i> (n=42)	Non- <i>S. aureus</i> (n=33)	p-value
Epiphora	35 (83%)	24 (73%)	0.25
Swelling over lacrimal sac	34 (81%)	25 (76%)	0.54
Mucopurulent discharge	28 (67%)	21 (64%)	0.78
Pain	24 (57%)	20 (61%)	0.72
Recurrent infection	14 (33%)	5 (15%)	0.04*

Table 5: Treatment Modalities and Outcomes in *S. aureus* Infections (n = 42)

Treatment Approach	Number of Patients	Complete Resolution (%)	Recurrence (%)
Medical therapy only (acute)	24	14 (58%)	10 (42%)
Surgical intervention (DCR/canaliculotomy)	18	17 (94%)	1 (6%)

Table 6: Recurrence and Outcome in MRSA vs MSSA Infections

Parameter	MRSA (n=14)	MSSA (n=28)	p-value
Recurrence after medical therapy	7 (50%)	3 (11%)	0.01*
Requirement for surgery	10 (71%)	8 (29%)	0.02*
Resolution after surgery	13 (93%)	17 (94%)	0.89

*Significant

DISCUSSION

Our study demonstrates that *Staphylococcus aureus* is the predominant pathogen in lacrimal system infections, accounting for more than half of all isolates. This finding is consistent with previous reports, highlighting the organism's role in both acute and chronic dacryocystitis, as well as canaliculitis [1,3,7]. The study underscores the clinical importance of recognizing *S. aureus* as a frequent culprit, particularly in adult patients presenting with persistent epiphora and purulent lacrimal discharge.

The emergence of MRSA in 33% of *S. aureus* infections represents a significant therapeutic challenge. MRSA infections were associated with higher recurrence rates, necessitating more aggressive management, including combination therapy and early consideration of surgical intervention. Similar MRSA prevalence has been reported in ocular infections globally, reflecting the need for region-specific antibiotic guidelines and stewardship programs [5,8].

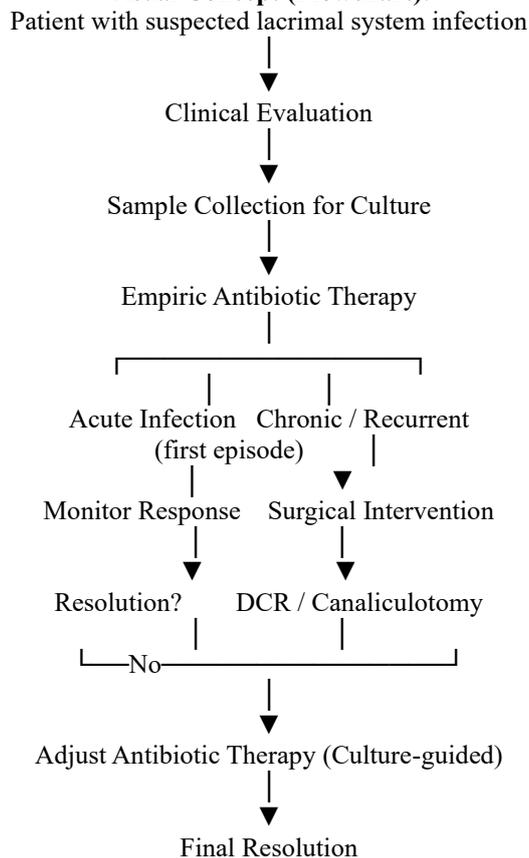
Acute lacrimal infections responded well to empiric antibiotic therapy, particularly agents active against Gram-positive cocci. Culture-guided therapy allowed de-escalation or adjustment, improving outcomes and minimizing unnecessary broad-spectrum antibiotic use. Chronic or recurrent infections, in contrast, were best managed surgically. DCR remains the gold standard for chronic dacryocystitis, providing definitive drainage and preventing recurrence. Canaliculotomy with curettage is essential in cases of canaliculitis, particularly when concretions are present, as medical therapy alone is insufficient [6,7].

The pathophysiology of *S. aureus* infection in the lacrimal system is multifactorial. Biofilm formation within the lacrimal sac can protect bacteria from host immune responses and antibiotics, contributing to recurrence and chronicity. In chronic dacryocystitis, repeated cycles of infection and inflammation can lead to fibrosis and permanent obstruction, further emphasizing the importance of timely surgical intervention [4,9].

The microbiological distribution of lacrimal system infections in our study is illustrated in table 2. *S. aureus* was the predominant pathogen, consistent with previous reports [1,3,7]. MRSA accounted for 33% of isolates, emphasizing the need for culture-guided therapy and judicious antibiotic use. Gram-negative and fungal pathogens were relatively uncommon but should be considered in chronic or recurrent infections.

Management of these infections can be guided by the algorithm shown in Figure 1. Acute cases may respond to empiric antibiotic therapy, but chronic or recurrent infections—especially those caused by MRSA—often require surgical intervention (DCR or canaliculotomy) for definitive resolution. The combination of culture-guided antibiotics and timely surgery ensures high success rates and minimizes recurrence.

Figure 1: Treatment Algorithm for *S. aureus* Lacrimal System Infections
Visual Concept (Flowchart):



Our study highlights several clinical implications:

1. Early Microbiological Assessment: Cultures should be obtained in recurrent or refractory cases to identify MRSA or other resistant strains.
2. Targeted Antibiotic Therapy: Empiric therapy should cover Gram-positive organisms, with adjustment based on culture results.
3. Surgical Management: Chronic infections or those unresponsive to antibiotics require DCR or canaliculotomy for definitive resolution.
4. Antibiotic Stewardship: Awareness of local resistance patterns is essential to avoid overuse of broad-spectrum antibiotics and reduce MRSA emergence.

Limitations of this study include its single-center design and moderate sample size. Multicenter studies with larger populations would help validate our findings and provide broader epidemiological insights. Furthermore, molecular studies on virulence factors and biofilm formation could enhance understanding of *S. aureus* pathogenesis in lacrimal infections.

CONCLUSION

Staphylococcus aureus, including MRSA, is the most common pathogen in lacrimal system infections. Early microbiological diagnosis, culture-guided antibiotic therapy, and appropriate surgical intervention in chronic or recurrent cases are essential for optimal clinical outcomes. Clinicians must maintain a high index of suspicion for MRSA and tailor therapy accordingly to minimize recurrence and complications.

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