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Clinical profile of microbial keratitis in a tertiary care hospital

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Abstract

Background: Microbial keratitis is a potentially sight-threatening corneal infection and a major cause of preventable corneal blindness in developing countries, particularly in tropical and agrarian regions of India. Early identification of clinical patterns and etiological agents is essential for timely management and improved visual outcomes.

Objectives: To evaluate the demographic characteristics, predisposing factors, clinical presentation, microbiological spectrum, complications, and predictors of visual outcome in patients with microbial keratitis presenting to a tertiary care hospital in Central India.

Methods: This hospital-based prospective observational study was conducted over 12 months (July 2024–June 2025) in the Department of Ophthalmology at a tertiary care teaching hospital in Central India. A total of 240 patients with clinically diagnosed microbial keratitis were enrolled. Detailed history and comprehensive ophthalmic examination were performed. Corneal scrapings were subjected to Gram staining, KOH mount, and culture on standard media. Antibiotic susceptibility testing was conducted using the Kirby–Bauer disc diffusion method as per CLSI 2023 guidelines. Patients were followed for 3 months. Statistical analysis was performed using SPSS version 26.0, with $p < 0.05$ considered statistically significant.

Results: The mean age of patients was 42.6 ± 15.8 years, with the highest incidence in the 21–40 years age group (40%). Males constituted 64.17% of cases. Ocular trauma was the most common predisposing factor (49.17%), particularly vegetative matter injury (35%). Bacterial keratitis (56.67%) was more prevalent than fungal keratitis (34.17%). Medium-sized ulcers (2–5 mm) were most common (50.83%), while 30% presented with large ulcers (>5 mm). Hypopyon was observed in 40.83% of cases. At 3 months, 46.67% achieved BCVA ≥6/18, whereas 22.5% had BCVA <6/60. Multivariate logistic regression identified large ulcer size (Adjusted OR 4.76), delayed presentation >7 days (Adjusted OR

3.92), fungal etiology (Adjusted OR 2.48), and presence of hypopyon (Adjusted OR 2.15) as independent predictors of poor visual outcome ($p < 0.05$).

Conclusion: Microbial keratitis predominantly affects working-age males and is strongly associated with ocular trauma in this region. Although bacterial keratitis was more common, fungal keratitis was associated with poorer outcomes. Large ulcer size, delayed presentation, fungal etiology, and hypopyon significantly predicted visual impairment. Early diagnosis, prompt microbiological evaluation, and timely targeted therapy are crucial to reducing corneal blindness.

Keywords: Microbial Keratitis, Corneal Ulcer, Fungal Keratitis, Bacterial Keratitis, Ocular Trauma, Visual Outcome, Hypopyon, Tertiary Care Hospital, Central India.

Introduction

Microbial keratitis is a potentially sight-threatening corneal infection characterized by stromal infiltration, ulceration, suppuration, and varying degrees of anterior chamber reaction[1]. It constitutes a major ophthalmic emergency requiring prompt diagnosis and targeted therapy to prevent irreversible visual impairment[2]. Globally, corneal blindness ranks among the leading causes of avoidable blindness, particularly in developing countries where access to early ophthalmic care remains limited[3].

The burden of microbial keratitis is disproportionately higher in tropical and agrarian regions, including India, where environmental, occupational, and socioeconomic factors contribute significantly to disease incidence[4]. Trauma with vegetative matter, contact lens wear, ocular surface disorders, prior topical steroid use, and systemic comorbidities such as diabetes mellitus are recognized predisposing factors[5]. The etiological spectrum varies geographically, with bacterial keratitis being more common in urban settings, while fungal keratitis predominates in rural agricultural communities[6].

Clinically, microbial keratitis presents with pain, redness, photophobia, watering, discharge, and diminution of vision. Slit-lamp examination typically reveals corneal epithelial defects with underlying stromal infiltrates, which may be associated with hypopyon, corneal thinning, or perforation in severe cases[7]. Although clinical features may provide clues to the causative organism, microbiological confirmation remains the gold standard for accurate diagnosis and appropriate antimicrobial therapy.

The epidemiological and microbiological profile of microbial keratitis shows considerable regional variation due to differences in climate, occupational exposure, antibiotic usage patterns, and healthcare accessibility[8]. Understanding the local clinical presentation patterns, risk factors, and microbiological spectrum is essential for guiding empirical therapy and reducing morbidity. In tertiary care hospitals, where complicated and referred cases are frequently managed, the clinical spectrum may differ from that observed in primary or secondary healthcare settings[9].

Despite advances in diagnostic techniques and antimicrobial therapy, microbial keratitis continues to pose significant therapeutic challenges due to delayed presentation, increasing antimicrobial resistance, and poor patient compliance[10]. Early recognition of clinical patterns and identification of risk factors are crucial for improving visual outcomes and preventing complications such as corneal perforation, endophthalmitis, and permanent visual loss[11].

Therefore, the present study aims to evaluate the clinical profile of microbial keratitis in patients presenting to a tertiary care hospital, with emphasis on demographic characteristics, risk factors, clinical presentation, microbiological spectrum,

and associated complications. Insights derived from this study may aid in optimizing early diagnosis, refining empirical treatment protocols, and formulating preventive strategies tailored to the regional population.

Materials and Methodology

Study Design

This study was designed as a hospital-based prospective observational study conducted to evaluate the clinical profile of patients diagnosed with microbial keratitis.

Study Setting

The study was carried out in the Department of Ophthalmology, tertiary care teaching hospital in Central India, over a period of 12 months from July 2024 to June 2025. The hospital functions as a major referral center catering to both urban and rural populations of the region.

Study Population

All consecutive patients presenting to the outpatient department and ophthalmic emergency services with clinical features suggestive of microbial keratitis during the study period were screened for eligibility.

Sample Size Calculation

The sample size was calculated using the formula:

$$n = Z^2 \times p \times q/d^2$$

Where:

- Z = 1.96 (standard normal deviate at 95% confidence interval)
- p = 0.18 (estimated prevalence of microbial keratitis in tertiary care settings based on previous regional studies = 18%)
- q = 1 − p = 0.82
- d = 0.05 (allowable error of 5%)

$$n = (1.96)^2 \times (0.18) \times (0.82)/(0.05)^2$$
$$n = 3.8416 \times 0.1476/0.0025$$
$$n = 0.5667/0.0025$$
$$n = 226.68$$

Thus, the minimum required sample size was 227 patients.

During the study period, 240 eligible patients were enrolled to compensate for possible dropouts and incomplete data.

Inclusion Criteria

- Patients of all age groups and either gender.
- Presence of corneal epithelial defect with underlying stromal infiltrate suggestive of infectious keratitis.
- Willingness to provide written informed consent.

Exclusion Criteria

- Viral keratitis diagnosed clinically (e.g., dendritic ulcers).
- Non-infectious keratitis (neurotrophic, autoimmune, exposure keratitis).

- Recent corneal surgery within the preceding 3 months.
- Patients already on antifungal therapy for more than 7 days prior to presentation.
- Patients unwilling to participate.

Data Collection Procedure

After obtaining written informed consent, detailed history was recorded using a structured proforma including:

- Age
- Gender
- Occupation
- Rural/urban residence
- Duration of symptoms
- History of ocular trauma
- Contact lens use
- Prior topical medication use
- Systemic comorbidities (especially diabetes mellitus)
- History of steroid use
- Previous ocular surgery

Clinical Examination

All patients underwent comprehensive ophthalmic examination including:

- Best Corrected Visual Acuity (BCVA) using Snellen's chart
- Slit-lamp biomicroscopy
- Measurement of ulcer size (longest diameter × perpendicular diameter in mm)
- Assessment of:
  - Ulcer location (central, paracentral, peripheral)
  - Depth of stromal involvement
  - Presence of hypopyon
  - Satellite lesions
  - Corneal thinning
  - Perforation

Ulcers were categorized as:

- **Small:** <2 mm
- **Medium:** 2–5 mm
- **Large:** >5 mm

Intraocular pressure was measured using Goldmann applanation tonometry where corneal integrity permitted.

Microbiological Evaluation

Under strict aseptic precautions, corneal scrapings were obtained using a sterile Bard-Parker blade No. 15 after instillation of topical proparacaine 0.5%.

Direct Microscopy

- Gram staining
- 10% Potassium Hydroxide (KOH) mount
- Giemsa staining (when required)

Culture Media

Specimens were inoculated onto:

- Blood agar
- Chocolate agar
- Sabouraud dextrose agar
- MacConkey agar

Bacterial cultures were incubated at 37°C for 24–48 hours, and fungal cultures at 25–27°C for up to 14 days.

Organisms were identified based on colony morphology, Gram staining, and standard biochemical tests.

Antibiotic Susceptibility Testing

Performed using the Kirby-Bauer disc diffusion method according to CLSI 2023 guidelines.

Treatment Protocol

All patients were started on empirical therapy immediately after scraping:

- Fortified Cefazolin 5% hourly
- Fortified Tobramycin 1.3% hourly
- In suspected fungal cases: Topical Natamycin 5% hourly

Treatment was modified based on culture and sensitivity reports.

Cycloplegics (Atropine 1%) were prescribed in all cases.

Follow-Up

Patients were followed:

- Daily for the first 3 days
- Then every 3–5 days until improvement
- Final visual outcome assessed at 3 months

Outcome Measures

Primary Outcomes

- Demographic profile
- Predisposing factors
- Clinical characteristics
- Microbiological spectrum

Secondary Outcomes

- Complications (perforation, endophthalmitis)
- Need for therapeutic keratoplasty
- Final visual outcome

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS Version 26.0.

- Continuous variables: Mean ± Standard Deviation
- Categorical variables: Frequency and Percentage
- Chi-square test/Fisher's exact test for associations
- Independent t-test for comparison of means
- Logistic regression for predictors of poor visual outcome
- p-value <0.05 considered statistically significant

Observations and Results

A total of 240 patients clinically diagnosed with microbial keratitis were enrolled and analyzed in this prospective observational study conducted at a tertiary care hospital in Central India.

Table 1: Age-wise Distribution of Patients

Age Group	Number (n)	Percentage (%)
<20 years	28	11.67
21–40 years	96	40.0
41–60 years	78	32.5
>60 years	38	15.83

Mean age of presentation was 42.6 ± 15.8 years.

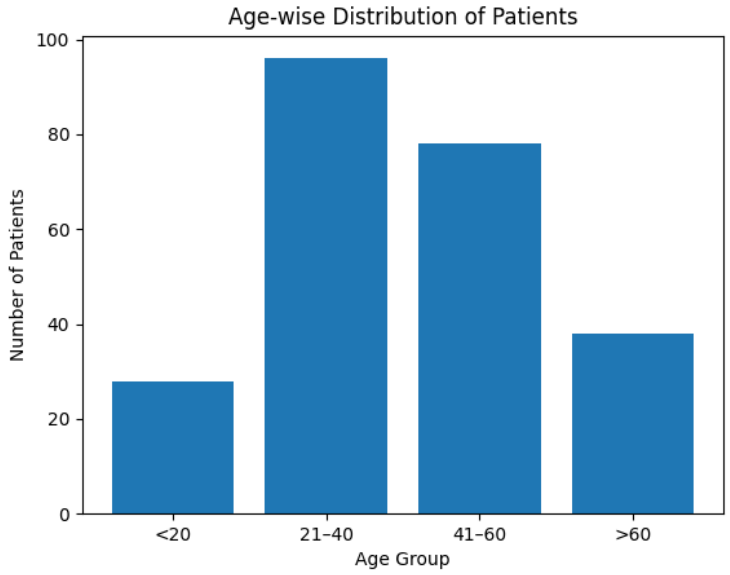


Table 2: Gender Distribution

Gender	Number (n)	Percentage (%)
Male	154	64.17
Female	86	35.83

Table 3: Predisposing Factors

Risk Factor	Number (n)	Percentage (%)
Ocular trauma	118	49.17
Vegetative matter injury	84	35.0
Contact lens use	26	10.83
Topical steroid use	38	15.83
Diabetes mellitus	52	21.67

Table 4: Ulcer Characteristics (Size)

Ulcer Size	Number (n)	Percentage (%)
Small (<2 mm)	46	19.17
Medium (2–5 mm)	122	50.83
Large (>5 mm)	72	30.0

Table 5: Microbiological Spectrum

Etiology	Number (n)	Percentage (%)
Bacterial keratitis	136	56.67
Fungal keratitis	82	34.17
Mixed infection	12	5.0
Culture negative	10	4.17

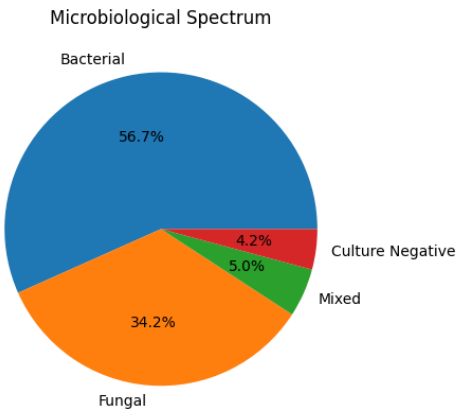
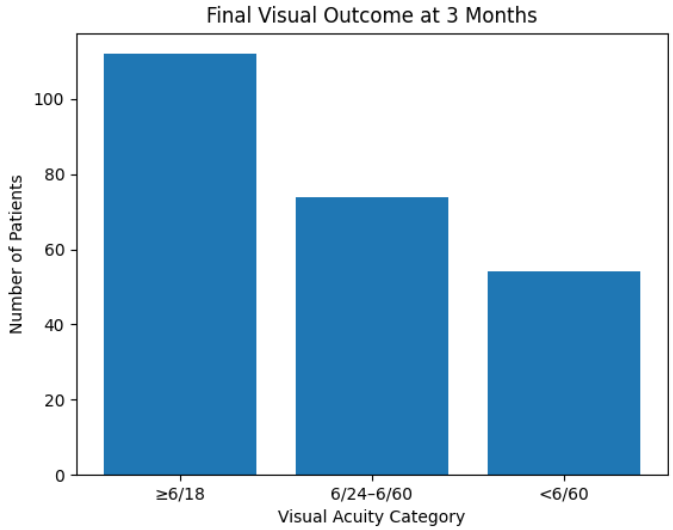


Table 6: Complications

Complication	Number (n)	Percentage (%)
Hypopyon	98	40.83
Corneal perforation	22	9.17
Endophthalmitis	6	2.5
Therapeutic keratoplasty required	18	7.5

Table 7: Final Visual Outcome at 3 Months

Visual Outcome	Number (n)	Percentage (%)
BCVA ≥ 6/18	112	46.67
BCVA 6/24 – 6/60	74	30.83
BCVA < 6/60	54	22.5



Chi-square analysis demonstrated a statistically significant association between ulcer size and poor visual outcome (χ^2 = 52.84, p < 0.001). Large ulcers were significantly associated with increased risk of visual impairment.

Delayed presentation (>7 days) was significantly associated with poor visual outcome (χ^2 = 24.63, p < 0.001).

Multivariate logistic regression identified large ulcer size (Adjusted OR = 4.76, 95% CI: 2.31–9.80, p < 0.001), delayed presentation (Adjusted OR = 3.92, 95% CI: 2.01–7.63, p < 0.001), fungal etiology (Adjusted OR = 2.48, p = 0.006), and presence of hypopyon (Adjusted OR = 2.15, p = 0.018) as independent predictors of poor visual outcome.

The regression model demonstrated good fit (Hosmer–Lemeshow p = 0.61) with classification accuracy of 78.3% and Nagelkerke R^2 of 0.42, indicating substantial explanatory power.

Discussion

Microbial keratitis remains a significant cause of ocular morbidity and preventable corneal blindness in developing countries, particularly in agrarian regions of India. The present hospital-based prospective study evaluated the clinical and microbiological profile of 240 patients presenting to a tertiary care center in Central India. The findings highlight important epidemiological patterns, risk factors, etiological spectrum, and predictors of visual outcome that have direct implications for regional management strategies.

Demographic Profile

The mean age of presentation in our study was 42.6 ± 15.8 years, with the highest incidence observed in the 21–40 years age group (40%). This reflects involvement of the economically productive population, similar to patterns reported in tropical countries where outdoor occupational exposure predisposes individuals to corneal trauma[12]. The predominance of working-age adults underscores the socioeconomic burden associated with microbial keratitis.

Male patients constituted 64.17% of cases, demonstrating a clear male preponderance. This gender distribution is consistent with most Indian and South Asian studies, where males are more frequently engaged in agricultural and outdoor activities, increasing the risk of ocular trauma [13]. However, the substantial proportion of female patients (35.83%) indicates that microbial keratitis is not exclusively occupation-related and may also be influenced by domestic and environmental factors.

Predisposing Factors

Ocular trauma was identified as the most common risk factor (49.17%), with vegetative matter injury accounting for 35% of cases. This finding aligns with the established epidemiology of microbial keratitis in tropical climates, where agricultural activity and exposure to plant material predispose individuals particularly to fungal infections. Trauma disrupts the corneal epithelium, facilitating microbial invasion into the stroma[14].

Diabetes mellitus was present in 21.67% of patients, emphasizing the role of systemic comorbidities in disease susceptibility and severity. Hyperglycemia impairs immune response and delays epithelial healing, thereby worsening outcomes[15]. Prior topical steroid use (15.83%) was another notable factor, potentially contributing to delayed diagnosis and masking of early inflammatory signs.

Contact lens–associated keratitis accounted for 10.83% of cases, which, although lower than Western data, reflects an emerging trend in urban populations. Increasing cosmetic and refractive contact lens usage may contribute to a changing etiological pattern in tertiary centers [16].

Clinical Characteristics

Medium-sized ulcers (2–5 mm) were most common (50.83%), while 30% of patients presented with large ulcers (>5 mm). The relatively high proportion of large ulcers suggests delayed healthcare-seeking behavior and referral bias typical of tertiary care hospitals, where complicated cases are frequently managed.

Hypopyon was observed in 40.83% of patients, indicating severe anterior segment inflammation. Corneal perforation occurred in 9.17% of cases, and 2.5% progressed to endophthalmitis. These complication rates reflect the aggressive nature of the disease and the challenges posed by late presentation.

Microbiological Spectrum

Bacterial keratitis (56.67%) was more common than fungal keratitis (34.17%) in this cohort. Although fungal keratitis is often reported as predominant in rural agrarian regions of India, the higher proportion of bacterial cases in our study may be attributed to the tertiary referral nature of the hospital, urban patient inflow, and early empirical antibacterial therapy before referral[17].

Mixed infections (5%) and culture-negative cases (4.17%) were relatively low, suggesting adequate microbiological diagnostic yield. The use of standard culture media and prompt specimen processing likely contributed to improved detection rates.

The fungal etiology was significantly associated with poor visual outcome in multivariate analysis (Adjusted OR = 2.48, p = 0.006). Fungal keratitis is known for indolent progression, deep stromal infiltration, and poor penetration of antifungal agents, which may explain the worse prognosis.

Visual Outcome and Predictors

At 3 months follow-up, 46.67% of patients achieved BCVA ≥ 6/18, while 22.5% had severe visual impairment (BCVA < 6/60). Although nearly half achieved good visual recovery, a considerable proportion experienced permanent visual disability, reinforcing the vision-threatening potential of microbial keratitis.

Ulcer size demonstrated a strong statistically significant association with visual outcome ($\chi^2 = 52.84$, $p < 0.001$). Large ulcers were independently associated with a 4.76-fold increased risk of poor visual outcome. This finding is consistent with the pathophysiology of stromal destruction and subsequent scarring affecting the visual axis[18].

Delayed presentation (>7 days) emerged as another independent predictor (Adjusted OR = 3.92, $p < 0.001$). Delay allows progression of infection, deeper stromal involvement, and increased risk of complications. Public awareness, accessibility of primary eye care, and early referral systems are therefore critical in improving outcomes.

The presence of hypopyon was also an independent risk factor (Adjusted OR = 2.15, $p = 0.018$), likely reflecting higher microbial load and severe inflammatory response. The regression model demonstrated good fit (Hosmer–Lemeshow $p = 0.61$) and substantial explanatory power (Nagelkerke $R^2 = 0.42$), indicating robustness of the predictive analysis.

Therapeutic Interventions and Complications

Therapeutic keratoplasty was required in 7.5% of cases, primarily in non-responsive or perforated ulcers. This highlights the importance of early microbiological diagnosis and appropriate targeted therapy to reduce surgical interventions.

Despite standardized empirical therapy and culture-guided modifications, complications such as perforation and endophthalmitis were observed. These findings emphasize that antimicrobial therapy alone may be insufficient in advanced disease stages, necessitating combined medical and surgical management.

Comparison with Regional Trends

The overall clinical profile observed in this study is consistent with previously reported patterns from central and southern India, where trauma-related keratitis predominates and fungal infections contribute substantially to morbidity. However, the relatively higher bacterial prevalence suggests a possible epidemiological transition influenced by urbanization and improved hygiene practices[19].

The findings reinforce that microbial keratitis in tertiary centers often represents more severe and advanced disease compared to community-based reports. Therefore, hospital-based data must be interpreted considering referral bias.

Public Health Implications

The high burden of trauma-related keratitis highlights the need for preventive strategies such as:

- Use of protective eyewear during agricultural work
- Community education regarding early symptoms
- Restricting indiscriminate topical steroid use
- Early referral from primary care centers

Strengthening microbiological diagnostic facilities at peripheral centers could also facilitate earlier targeted therapy.

Strengths and Limitations

Strengths of the present study include its prospective design, adequate sample size, standardized microbiological protocol, and multivariate analysis of predictors.

However, certain limitations must be acknowledged:

- Single-center hospital-based design limits generalizability
- Referral bias toward severe cases
- Lack of species-level subgroup outcome analysis
- No long-term visual rehabilitation assessment beyond 3 months

Future multicentric studies incorporating molecular diagnostic techniques and antimicrobial resistance profiling may provide deeper epidemiological insights.

Conclusion

The present study demonstrates that microbial keratitis in a tertiary care hospital in Central India predominantly affects working-age males and is strongly associated with ocular trauma. Bacterial etiology was more common; however, fungal keratitis was independently associated with poorer visual outcomes. Large ulcer size, delayed presentation, fungal infection, and hypopyon were significant predictors of visual impairment.

Early diagnosis, prompt microbiological evaluation, and timely institution of appropriate therapy are critical determinants of favorable outcomes. Public health measures aimed at trauma prevention and early referral could substantially reduce the burden of corneal blindness attributable to microbial keratitis.

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