

Research Article

Epidemiological and Microbial Profile of Corneal Ulcer: An Observational Study in a Tertiary Care Hospital

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ABSTRACT

Background: Corneal ulcer is a vision-threatening ocular emergency requiring early diagnosis and prompt microbiological evaluation for appropriate treatment. This study assessed the epidemiological and microbial profile of corneal ulcer in a tertiary care hospital.

Materials and Methods: This observational study was conducted over one year in the Departments of Ophthalmology and Microbiology, CIMS, Bilaspur. Forty patients aged 18-90 years with clinically diagnosed corneal ulcer were included. Clinical examination was followed by corneal scraping for Gram staining, KOH wet mount, bacterial and fungal culture, and antimicrobial susceptibility testing.

Results: The mean age of the participants was 47.9 ± 11.97 years. Most patients were females (60%), belonged to rural areas (90%), and were farmers (52.5%). Ocular trauma was the commonest predisposing factor (95%), predominantly due to vegetative matter (52.5%). Fungal keratitis (62.5%) was more common than bacterial keratitis (22.5%). *Aspergillus* species (30.0%) and *Fusarium* species (27.5%) were the predominant fungal isolates, whereas *Staphylococcus aureus* (15.0%) was the commonest bacterial isolate. Natamycin (92.3%) and vancomycin (100%) showed the highest antimicrobial sensitivity among fungal and bacterial isolates, respectively.

Conclusion: Corneal ulcer predominantly affected rural agricultural populations and was strongly associated with vegetative ocular trauma. Fungal keratitis was the predominant etiology, highlighting the importance of early microbiological diagnosis and targeted antimicrobial therapy to prevent vision loss.

INTRODUCTION

Corneal ulcer, commonly referred to as microbial keratitis when caused by an infectious agent, is a potentially sight-threatening ophthalmic emergency characterized by an epithelial defect with underlying stromal infiltration and inflammation. It may be caused by bacteria, fungi, viruses, protozoa, or polymicrobial agents [1]. Disruption of the corneal epithelial barrier following trauma, contact lens wear, ocular surgery, or pre-existing ocular surface disease facilitates microbial invasion. Subsequent microbial proliferation and host inflammatory responses may lead to progressive stromal destruction, ulceration, and, in severe cases, corneal perforation [2]. The epidemiological pattern of corneal ulcer varies according to geographical location, climatic conditions, occupation, socioeconomic status, and associated risk factors [3,4]. Ocular trauma, particularly involving vegetative or soil-contaminated material, is an important predisposing factor

among agricultural populations [5,6]. Other recognized risk factors include contact lens wear, chronic ocular surface disease, previous ocular surgery, topical corticosteroid use, diabetes mellitus, and systemic immunosuppression [7,8]. Indian studies have demonstrated considerable regional variation in demographic characteristics and predisposing factors, reflecting differences in environmental and occupational exposure [9,10]. Bacteria and fungi constitute the major microbial causes of infectious corneal ulceration [6]. Common bacterial pathogens include *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, *Klebsiella*, *Acinetobacter*, and *Nocardia* species [11,12]. Their relative distribution varies geographically, with *Pseudomonas aeruginosa* being particularly important because of its potential to cause rapidly progressive corneal destruction [5,7]. Fungal keratitis is especially prevalent in tropical and subtropical regions with substantial

agricultural exposure. Filamentous fungi, predominantly *Fusarium* and *Aspergillus* species, are major causative organisms, although dematiaceous fungi and yeasts may also be encountered [12]. Regional differences in bacterial and fungal isolates emphasize the importance of locally generated microbiological data. Microbiological examination of corneal scrapings plays a crucial role in establishing the etiological diagnosis. Direct microscopy provides rapid preliminary information, while culture facilitates organism identification and guides appropriate antimicrobial therapy [9]. However, microbiological yield may be influenced by sampling technique, organism load, prior antimicrobial exposure, and laboratory facilities, resulting in variable culture positivity across tertiary-care studies [10]. Delayed diagnosis or inappropriate treatment may result in corneal scarring, stromal destruction, perforation, endophthalmitis, and permanent visual impairment [9]. Large or deep ulcers, central corneal involvement, delayed presentation, and severe infection are associated with poorer clinical and visual outcomes and may necessitate surgical intervention [9]. Understanding the local epidemiological characteristics, predisposing factors, and microbial spectrum is therefore essential for early diagnosis, appropriate empirical treatment, and prevention of vision-threatening complications. The present observational study was designed to evaluate the epidemiological and microbial profile of corneal ulcer among patients presenting to a tertiary care hospital.

MATERIALS AND METHODS

This was an observational study conducted jointly in the Department of Ophthalmology and Department of Microbiology, Chhattisgarh Institute of Medical Sciences (CIMS), Bilaspur, Chhattisgarh. The study was conducted over a period of one year after obtaining clearance from the Institutional Scientific Committee. A total of 40 patients with corneal ulcer who fulfilled the eligibility criteria and provided consent for corneal scraping were included.

Study population

Patients aged 18–90 years presenting to the Ophthalmology Department with a clinical diagnosis of corneal ulcer were assessed for eligibility. Patients willing to participate and provide informed consent were enrolled. Patients with descemetocoele, perforated

corneal ulcer, viral ulcer/keratitis, or peripheral ulcerative keratitis were excluded.

Sample SIZE

The minimum sample size was calculated using the formula for estimation of a population proportion:

$$n = Z^2_{1-\alpha} \times p \times (1 - p) / d^2$$

Considering a prevalence of 65% ($p=0.65$), 95% confidence level ($Z=1.96$), and allowable error of 15% ($d=0.15$), the calculated sample size was 38.84, which was rounded to 40 patients.[13]

Data Collection and Clinical Evaluation

Data were collected using a predesigned structured proforma. Demographic characteristics including age, gender, residence (rural/urban), and occupation were recorded. A detailed history was obtained regarding presenting symptoms, duration of symptoms, previous episodes, history of ocular trauma, systemic comorbidities, ocular comorbidities, and topical corticosteroid use. Systemic comorbidities evaluated included diabetes mellitus and anaemia, while ocular risk factors included lagophthalmos, dry eye, dacryocystitis, and topical steroid use.

All patients underwent detailed slit-lamp examination. The ulcer was assessed for shape (circular, oval, or geographical), location (central, paracentral, or peripheral), base (necrotic or non-necrotic), stromal abscess, margin, satellite lesions, hypopyon, and size in millimetres. Relevant blood investigations included complete blood count, fasting blood sugar, post-prandial blood sugar, and HbA1c.

Corneal Scraping and Microbiological Examination

Corneal scraping was performed under topical anaesthesia and aseptic precautions using a No. 15 surgical blade. The collected specimen was directly inoculated onto blood agar, chocolate agar, and Sabouraud dextrose agar (SDA). Separate glass slides were prepared for Gram staining, Giemsa staining, and potassium hydroxide (KOH) wet mount.

Bacterial cultures were incubated aerobically at 37°C. Chocolate agar plates were incubated in a candle jar to provide approximately 3–5% carbon dioxide. Blood agar, chocolate agar, and broth cultures were examined daily for up to 72 hours and were considered negative if no growth was detected. Fungal cultures on SDA were incubated at 25°C, observed for growth for up to one week, and discarded thereafter if no growth was observed.

Microbial culture was considered significant when the same organism grew on two or more media, confluent growth occurred at the inoculation site on a solid medium, growth on one medium was consistent with findings on direct microscopy, or the same organism was isolated from repeated corneal scrapings. Bacterial isolates were identified according to microscopic morphology, staining characteristics, and biochemical properties. Fungal isolates were identified by colony characteristics on SDA and microscopic morphology using lactophenol cotton blue.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing of bacterial isolates was performed by the agar disk diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines. *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, and *Pseudomonas aeruginosa* ATCC 27853 were used as reference strains.

Diagnostic Performance of Microbiological Investigations

Culture was considered the gold standard for microbiological diagnosis. The diagnostic performance of Gram staining for bacterial infection and KOH wet mount for fungal infection was assessed by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 22.0. Continuous variables were summarized as mean $\pm$ standard deviation (SD), while categorical variables were expressed as frequency and percentage. Categorical variables were compared using the Chi-square test, as appropriate. Sensitivity, specificity, PPV, and NPV of the microbiological investigations were calculated using culture as the reference standard. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 100 patients with corneal ulcer were screened, of whom 60 were excluded based on predefined criteria. The final analysis included 40 patients.

The mean age of the participants was 47.9 ± 11.97 years, with the highest proportion belonging to the 46–55-year age group (37.5%). Females constituted 60.0% of the study population. More than half of the participants were farmers (52.5%), and the majority were from rural areas (90.0%) (Table 1).

Ocular trauma was the most common predisposing factor, reported in 95.0% of patients. Vegetative or organic matter was the most frequent traumatic agent (52.5%), followed by soil or dust exposure (30.0%). Topical corticosteroid use was reported in 52.5% of patients. Anaemia and diabetes mellitus were present in 42.5% and 10.0% of patients, respectively (Table 2).

The right eye was affected in 55.0% of patients. At presentation, 65.0% had visual acuity ranging from hand movements to perception of light. Corneal ulcers were most commonly paracentral (50.0%), irregular in shape (65.0%), and medium-sized (3–6 mm) in 45.0% of patients. A necrotic ulcer base was present in 72.5% (Table 3; Figure 1).

Circumcorneal congestion was present in all patients. Undermined ulcer edges and overhanging margins were observed in 62.5% and 65.0%, respectively. Mid-stromal involvement was the most common depth of involvement (47.5%). Immobile hypopyon was present in 45.0%, while 32.5% had anterior chamber cells and flare (Table 4).

Fungal organisms predominated microbiologically. KOH mount was positive in 62.5% of cases, with septate hyphae being the commonest finding (57.5%). *Aspergillus* spp. (30.0%) and *Fusarium* spp. (27.5%) were the predominant fungal isolates. Bacterial culture was positive in 22.5% of patients, with *Staphylococcus aureus* (15.0%) being more common than *Pseudomonas aeruginosa* (7.5%). *Acanthamoeba* was isolated in one patient (2.5%) (Table 5; Figure 2).

Among antifungal agents, natamycin showed the highest sensitivity (92.3%), followed by voriconazole (80.8%). Among bacterial isolates, all were sensitive to vancomycin (100.0%), while moxifloxacin showed 88.9% sensitivity (Table 6; Figure 3).

Table 1. Demographic and epidemiological characteristics of study participants (N=40)

Characteristic	n (%)
Age group (years)	
≤ 35	5 (12.5)
36–45	11 (27.5)

46–55	15 (37.5)
56–65	7 (17.5)
>65	2 (5.0)
Mean age ± SD (years)	47.9 ± 11.97
Gender	
Female	24 (60.0)
Male	16 (40.0)
Occupation	
Farmer	21 (52.5)
Housewife	13 (32.5)
Labourer	5 (12.5)
Student	1 (2.5)
Residence	
Rural	36 (90.0)
Urban	4 (10.0)

Table 2. Predisposing factors among patients with corneal ulcer (N=40)

Predisposing factor	n (%)
Ocular trauma	
Any trauma	38 (95.0)
Vegetative/organic matter	21 (52.5)
Soil/dust	12 (30.0)
Fingernail/cattle tail	3 (7.5)
Metallic/inert foreign body	2 (5.0)
No trauma	2 (5.0)
Topical steroid use	21 (52.5)
History of pond bathing	1 (2.5)
Systemic factors	
Diabetes mellitus	4 (10.0)
Controlled diabetes	2 (5.0)
Uncontrolled diabetes	2 (5.0)
Anaemia	17 (42.5)
Mild anaemia	4 (10.0)
Moderate anaemia	13 (32.5)
Ocular factors	
Acute dacryocystitis	2 (5.0)
Chronic dacryocystitis	7 (17.5)
Lid oedema alone	21 (52.5)
Lid oedema + meibomitis	12 (30.0)
Lid oedema + blepharitis	7 (17.5)

Table 3. Clinical profile of corneal ulcer among study participants (N=40)

Clinical characteristic	n (%)
Affected eye	
Right	22 (55.0)
Left	18 (45.0)
Visual acuity	
6/60–<3/60	3 (7.5)
2/60–counting fingers	11 (27.5)
Hand movements–PL present	26 (65.0)
Ulcer location	
Central	16 (40.0)
Paracentral	20 (50.0)
Peripheral	4 (10.0)
Ulcer shape	

Irregular	26 (65.0)
Oval	9 (22.5)
Circular	5 (12.5)
Ulcer size	
Small (1–3 mm)	16 (40.0)
Medium (3–6 mm)	18 (45.0)
Large (>6 mm)	6 (15.0)
Necrotic ulcer base	29 (72.5)
Satellite lesions present	10 (25.0)
Immune ring present	7 (17.5)

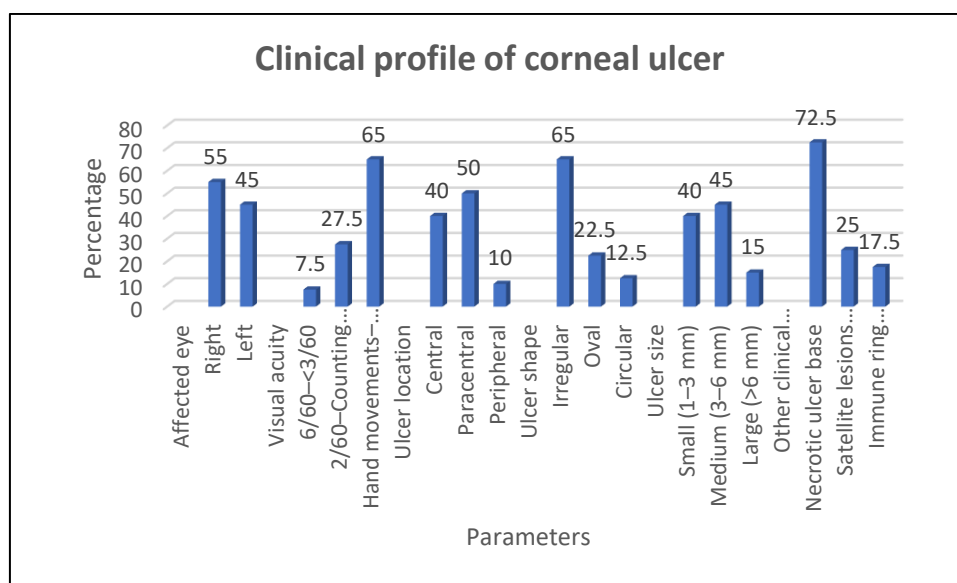


Figure 1. Clinical profile of corneal ulcer among study participants (N=40)

Table 4. Anterior segment findings among study participants (N=40)

Finding	n (%)
Superficial + circumcorneal congestion	40 (100.0)
Ulcer edge	
Undermined	25 (62.5)
Sloping	15 (37.5)
Ulcer margin	
Overhanging	26 (65.0)
Rolled out	14 (35.0)
Stromal involvement	
Superficial	16 (40.0)
Mid-stromal	19 (47.5)
Deep	5 (12.5)
Corneal vascularization	
Superficial	8 (20.0)
Deep	4 (10.0)
Absent	28 (70.0)
Anterior chamber	
Clear	3 (7.5)
Cells and flare	13 (32.5)
Mobile hypopyon	6 (15.0)
Immobile hypopyon	18 (45.0)
Pupil	
Central circular, reactive	15 (37.5)
Sluggish reaction	21 (52.5)

Irregular	4 (10.0)
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Table 5. Microbiological profile of corneal ulcer (N=40)

Microbiological finding	n (%)
Gram stain	
Gram-positive cocci	6 (15.0)
Gram-negative bacilli	3 (7.5)
No organism seen	31 (77.5)
Bacterial culture isolates	
<i>Staphylococcus aureus</i>	6 (15.0)
<i>Pseudomonas aeruginosa</i>	3 (7.5)
KOH mount	
Septate hyphae	23 (57.5)
Aseptate hyphae	2 (5.0)
No organism seen	15 (37.5)
Fungal culture isolates	
<i>Aspergillus</i> spp.	12 (30.0)
<i>Fusarium</i> spp.	11 (27.5)
<i>Candida</i> spp.	1 (2.5)
<i>Curvularia</i> spp.	1 (2.5)
No fungal growth	15 (37.5)
Protozoal isolate	
<i>Acanthamoeba</i>	1 (2.5)

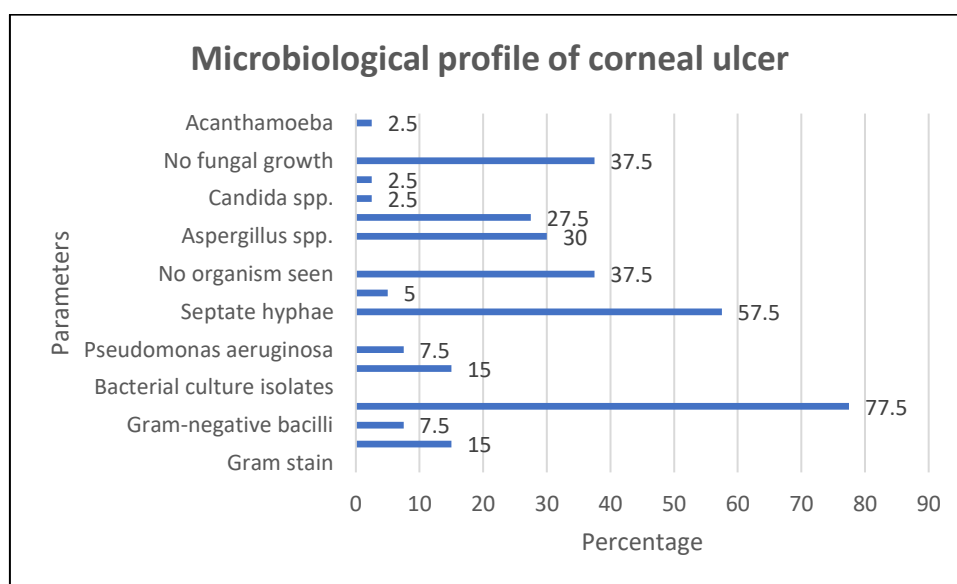


Figure 2. Microbiological profile of corneal ulcer

Table 6. Antimicrobial susceptibility pattern of bacterial and fungal isolates

Antimicrobial agent	Sensitive, n (%)	Resistant, n (%)
Antifungal agents (n=26)		
Natamycin	24 (92.3)	2 (7.7)
Voriconazole	21 (80.8)	5 (19.2)
Fluconazole	12 (46.2)	14 (53.8)
Itraconazole	10 (38.5)	16 (61.5)
Antibiotics (n=9)		
Vancomycin	9 (100.0)	0 (0.0)
Moxifloxacin	8 (88.9)	1 (11.1)
Gatifloxacin	7 (77.8)	2 (22.2)
Polymyxin B	7 (77.8)	2 (22.2)

Ciprofloxacin	7 (77.8)	2 (22.2)
Chloramphenicol	6 (66.7)	3 (33.3)
Ceftriaxone	5 (55.6)	4 (44.4)

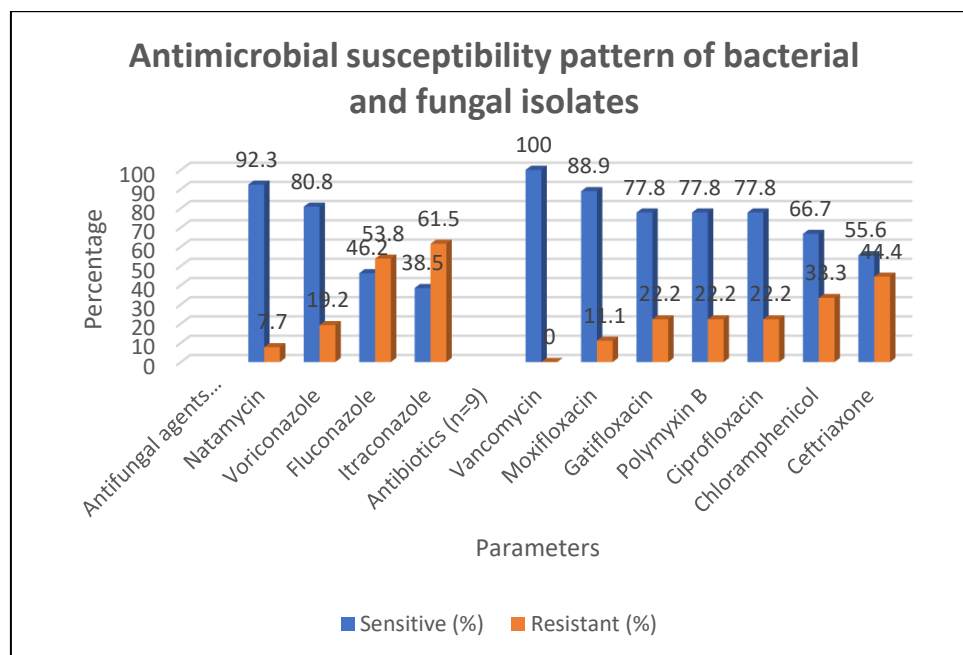


Figure 3. Antimicrobial susceptibility pattern of bacterial and fungal isolates

DISCUSSION

The present observational study evaluated the epidemiological profile, predisposing factors, clinical characteristics, microbiological spectrum, and antimicrobial susceptibility of corneal ulcers in patients attending a tertiary care centre in Bilaspur, Chhattisgarh. The findings demonstrate that corneal ulcer predominantly affected middle-aged individuals from rural agricultural backgrounds, with ocular trauma being the principal risk factor and fungal pathogens constituting the predominant etiological agents.

The mean age of the study population was 47.9 ± 11.97 years, with the highest proportion of patients belonging to the 46–55-year age group. Similar observations have been reported by Kusumesh et al., Waghmare et al., and Siddaiah et al., who also found microbial keratitis to occur predominantly among economically productive adults exposed to occupational hazards.[3–5] Unlike most Indian studies that demonstrated male predominance,[3–5,7,8,11,12] females constituted 60% of patients in the present study, possibly reflecting greater participation of women in agricultural activities and cattle rearing in this region.

Most patients were from rural areas (90%), and farmers constituted the largest occupational group (52.5%). Comparable rural

predominance has been reported by Kusumesh et al., Baruah et al., Perween et al., and Bhattacharjee and Chakravarty.[4,6,8,11] These findings highlight the close association between corneal ulceration and agricultural exposure in tropical regions.

Ocular trauma was identified in 95% of patients, with vegetative or organic matter accounting for more than half of all injuries. Similar findings have been reported by Siddaiah et al., Kusumesh et al., Lune et al., and Perween et al., confirming trauma as the major predisposing factor for microbial keratitis.[3,4,7,8] Vegetative trauma is particularly important because it directly inoculates fungal spores into the cornea, explaining the predominance of fungal keratitis observed in the present study.

Topical corticosteroid use before presentation was noted in 52.5% of patients, a higher proportion than reported by Kusumesh et al.[4] Steroid misuse suppresses local immunity, delays epithelial healing, masks clinical features, and promotes progression of both bacterial and fungal keratitis, emphasizing the need for stricter regulation of over-the-counter steroid preparations.

Among systemic risk factors, anaemia was present in 42.5% of patients and diabetes mellitus in 10%. Diabetes is a recognized risk factor for infectious keratitis because impaired

immunity and delayed epithelial healing predispose to severe infection.[4,7] Chronic dacryocystitis (17.5%) was the commonest ocular comorbidity and may serve as a persistent reservoir for pathogenic microorganisms.[4] Most patients presented with advanced disease, characterized by poor visual acuity, necrotic ulcer base, mid-stromal involvement, hypopyon, and irregular ulcers. Similar observations have been reported in previous Indian studies, indicating that delayed presentation remains an important determinant of disease severity and visual outcome.[4,7,9] Microbiological evaluation demonstrated fungal predominance, with fungal isolates accounting for 62.5% of cases compared with 22.5% bacterial isolates. Similar fungal predominance has been reported by Kusumesh et al., Lune et al., Perween et al., Bhattacharjee and Chakravarty, and Shahi et al.[4,7,8,11,12] The predominance of fungal keratitis in the present study is likely attributable to the high prevalence of vegetative trauma, rural residence, and inappropriate steroid use. Among fungal isolates, *Aspergillus* species (48%) were most frequently isolated, followed closely by *Fusarium* species (44%), while *Candida* and *Curvularia* were uncommon. Similar distributions have been reported by Kusumesh et al. and Perween et al., where *Aspergillus* and *Fusarium* predominated.[4,8] Among bacterial isolates, *Staphylococcus aureus* (66.7%) was the commonest pathogen, followed by *Pseudomonas aeruginosa* (33.3%), findings comparable with those of Siddaiah et al., Kusumesh et al., Waghmare et al., and Shahi et al.[3–5,12] Antimicrobial susceptibility testing demonstrated excellent activity of vancomycin (100%) and high sensitivity to moxifloxacin (88.9%) among bacterial isolates. Natamycin showed the highest antifungal sensitivity (92.3%), followed by voriconazole (80.8%), whereas fluconazole and itraconazole demonstrated comparatively lower activity. These findings are consistent with previous Indian studies supporting vancomycin for Gram-positive bacterial keratitis and natamycin as the drug of choice for filamentous fungal keratitis.[12, 14–16]

CONCLUSION

Corneal ulcer predominantly affected middle-aged individuals from rural agricultural backgrounds, with ocular trauma by vegetative matter being the most important predisposing factor. Fungal keratitis, particularly due to

Aspergillus and *Fusarium* species, was more common than bacterial keratitis, while *Staphylococcus aureus* was the leading bacterial isolate. Early microbiological diagnosis with prompt institution of appropriate antimicrobial therapy, especially natamycin for fungal keratitis and vancomycin/moxifloxacin for bacterial keratitis, is essential to improve visual outcomes and prevent vision-threatening complications.

Limitations

The study was conducted at a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. In addition, the short study duration and limited number of culture-positive isolates restricted detailed analysis of antimicrobial resistance patterns and clinical outcomes.

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