Epidemiology, Management Strategies and Outcomes of Corneal Ulcers

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Abstract

Background: Corneal ulcers are a leading cause of preventable visual impairment, particularly in developing countries. Variations in epidemiology, etiology, and outcomes are influenced by regional, occupational, and socioeconomic factors.

Aim: To study the epidemiology, management strategies, and clinical outcomes of corneal ulcers in patients attending a tertiary care hospital.

Methods: This OPD-based cross-sectional study included 150 patients with clinically and microbiologically confirmed corneal ulcers. Epidemiological data, risk factors, etiological profile, clinical features, management strategies, and outcomes were analyzed. Patients were followed for up to six months. Statistical analysis was performed using appropriate tests, with $p \leq 0.05$ considered significant.

Results: Most patients were aged 41–60 years (48.66%) with a slight male predominance (54%). The majority belonged to lower socioeconomic strata (71.3%). Ocular trauma was the most common predisposing factor (74.7%). Fungal keratitis was the predominant etiology (54%), followed by bacterial (25.3%) and viral keratitis (16%). Morphological features showed a strong correlation with etiology ($p < 0.001$). Surgical intervention was required in 4.7% of cases, limited to bacterial and fungal ulcers. Favorable visual outcomes (≥6/60) were achieved in 74.6% of patients. Delayed presentation, larger ulcer size, fungal etiology, prolonged healing time, and poor compliance were significantly associated with poor outcomes ($p < 0.001$).

Conclusion: Corneal ulcers predominantly affect middle-aged individuals from lower socioeconomic backgrounds, with trauma-related fungal keratitis being the most common etiology. Early diagnosis, appropriate management, and good treatment compliance result in favorable outcomes. Preventive strategies and early referral are crucial to reduce corneal-related visual impairment.

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Keywords: Corneal ulcer, Infectious keratitis, Fungal keratitis, Visual outcome, Epidemiology

Introduction

The cornea is a transparent, avascular structure essential for optimal visual acuity, contributing significantly to the refractive power of the eye. It comprises six distinct layers that provide strength, transparency, and protection. Disruption of the corneal epithelium with extension of inflammation into deeper layers leads to the development of a corneal ulcer. Owing to its avascular nature, the cornea relies on tears and surrounding tissues for nutrition and immune defense, rendering it vulnerable to infection and delayed healing. [1,2]

Corneal ulcers may progress rapidly, particularly in infectious etiologies, and can result in permanent scarring, irregular astigmatism, corneal perforation, or irreversible vision loss if not treated promptly. Patients frequently experience severe pain, photophobia, redness, watering, and cosmetic disfigurement, significantly impairing quality of life. [3, 4]

Globally, corneal diseases account for approximately 1.5–2 million new cases of unilateral blindness annually, representing a major public health concern. [4, 5] The burden is disproportionately higher in low- and middle-income countries due to poverty, occupational exposure, limited access to eye care, delayed presentation, and injudicious use of topical medications. [5-7] Variations in climate, geography, and occupational practices significantly influence the epidemiology and microbiological profile of corneal ulcers. [8, 9]

In tropical regions, particularly in South Asia and Africa, fungal keratitis constitutes nearly 40–60% of cases, largely associated with agricultural trauma and humid climatic conditions. [10, 11] In contrast, bacterial keratitis predominates in temperate regions, often linked to contact lens use. Viral keratitis, primarily caused by herpes simplex virus, exhibits a recurrent course worldwide, while Acanthamoeba keratitis is increasingly reported with rising contact lens usage. [12-15]

Early identification of the causative organism through clinical evaluation and laboratory investigations is essential for appropriate management. Corneal scraping with smear examination and culture remains the cornerstone of diagnosis, while advanced techniques such as PCR and confocal microscopy are useful in atypical or non-responsive cases.

Management requires prompt initiation of intensive antimicrobial therapy, supplemented by supportive care. Surgical intervention is reserved for non-healing ulcers or complications such as corneal thinning and perforation.

Given the regional variability in etiology and outcomes, the present study was undertaken to evaluate the epidemiological profile, management strategies, and clinical outcomes of corneal ulcers in a tertiary care setting.

Aims and Objectives

Aim

To study the epidemiology, management strategies, and outcomes of corneal ulcers.

Objectives

1. To evaluate corneal ulcers in relation to age, sex, etiology, and predisposing factors.
2. To correlate morphological features of corneal ulcers with causative organisms.
3. To assess management strategies and final clinical outcomes.

Materials and Methods

Study Design and Setting

An OPD-based cross-sectional study was conducted in the Department of Ophthalmology, Santosh Medical College and Hospital, Ghaziabad.

Sample Size

A total of 150 patients were included, calculated using the standard prevalence-based formula with a confidence level of 95% and allowable error of 5%.

Study Population

Patients attending the ophthalmology outpatient department with clinical features of corneal ulcer.

Inclusion Criteria

- Clinically and microbiologically confirmed cases of bacterial, fungal, or viral corneal ulcers
- Patients who provided informed consent

Exclusion Criteria

- Non-infectious keratitis (nutritional, allergic)
- Patients unwilling to participate

Ethical Considerations

Approval was obtained from the Institutional Medical Ethics Committee.

Statistical Analysis

Data were analyzed using statistical software. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± SD. A p-value ≤ 0.05 was considered statistically significant.

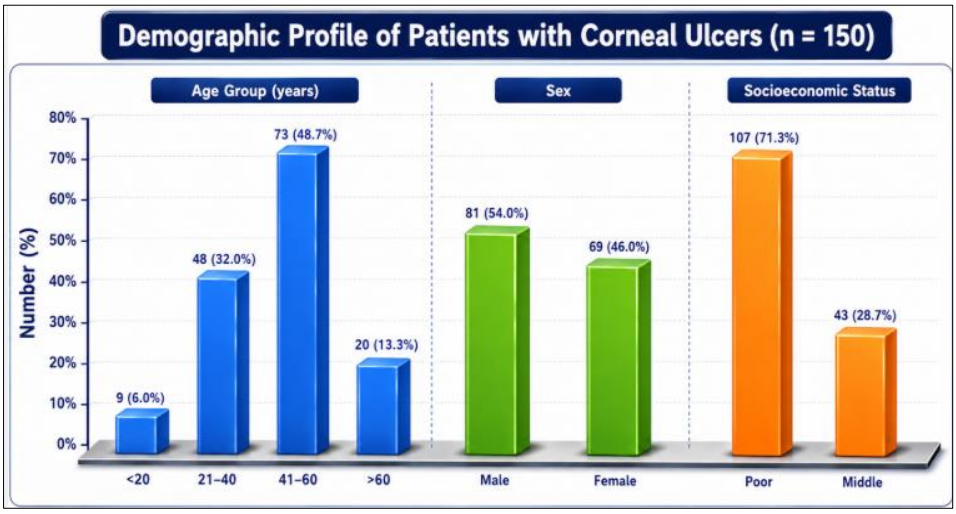
Results

A total of 150 patients with clinically and microbiologically confirmed corneal ulcers were included in the study.

The demographic characteristics of the study population are summarized in Table 1. The majority of patients belonged to the 41–60-year age group (73 patients, 48.7%), followed by the 21–40-year age group (48 patients, 32.0%). Patients below 20 years constituted the smallest proportion (6.0%). Males comprised 54.0% of cases, while females accounted for 46.0%. A large proportion of patients belonged to the lower socioeconomic group (71.3%), with the remaining 28.7% from the middle socioeconomic class.

Table 1: Demographic Profile of Patients with Corneal Ulcers (n = 150)

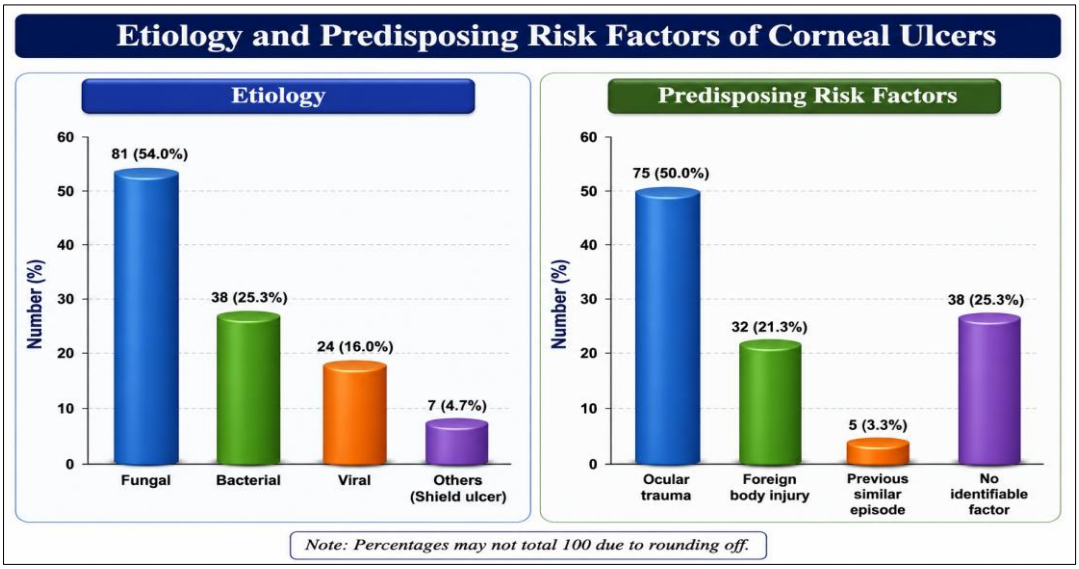
Variable	Category	Number (%)
Age group (years)	<20	9 (6.0)
	21–40	48 (32.0)
	41–60	73 (48.7)
	>60	20 (13.3)
Sex	Male	81 (54.0)
	Female	69 (46.0)
Socioeconomic status	Poor	107 (71.3)
	Middle	43 (28.7)



The etiological distribution and predisposing factors are presented in Table 2. Fungal keratitis was the most common etiology, observed in 81 patients (54.0%), followed by bacterial keratitis in 38 patients (25.3%) and viral keratitis in 24 patients (16.0%). Shield ulcers constituted 4.7% of cases.

Table 2: Etiology and Predisposing Risk Factors of Corneal Ulcers

Parameter	Number (%)
Etiology	
Fungal	81 (54.0)
Bacterial	38 (25.3)
Viral	24 (16.0)
Others (Shield ulcer)	7 (4.7)
Predisposing factors	
Ocular trauma	75 (50.0)
Foreign body injury	32 (21.3)
Previous similar episode	5 (3.3)
No identifiable factor	38 (25.3)



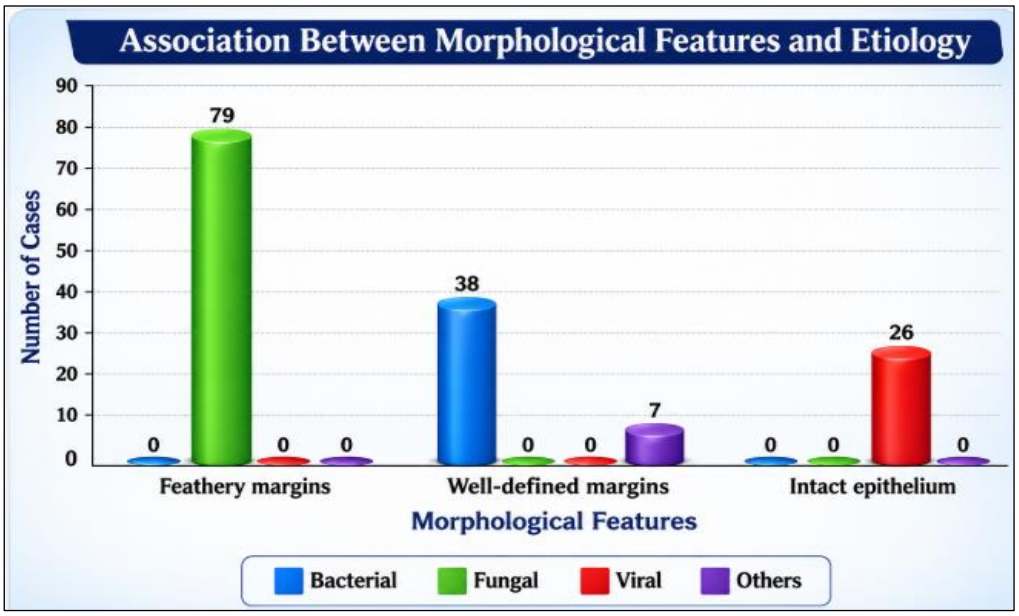
A predisposing risk factor was identified in 112 patients (74.7%). Ocular trauma was the most frequent risk factor, present in 75 patients (50.0%), followed by foreign body injury in 32 patients (21.3%). A previous similar episode was noted in 3.3% of patients, while no identifiable risk factor was found in 25.3% of cases.

The association between morphological features of corneal ulcers and etiology is shown in Table 3. Feathery margins were observed in 79 patients and were exclusively associated with fungal keratitis. Well-defined margins were noted in 45 patients and were predominantly seen in bacterial ulcers and shield ulcers. Intact epithelium was observed in 26 patients, all of whom had viral keratitis. The association between morphology and etiology was statistically highly significant ($p < 0.001$).

Table 3: Association Between Morphological Features and Etiology

Morphology	Bacterial	Fungal	Viral	Others	Total
Feathery margins	0	79	0	0	79
Well-defined margins	38	0	0	7	45
Intact epithelium	0	0	26	0	26

p-value < 0.001

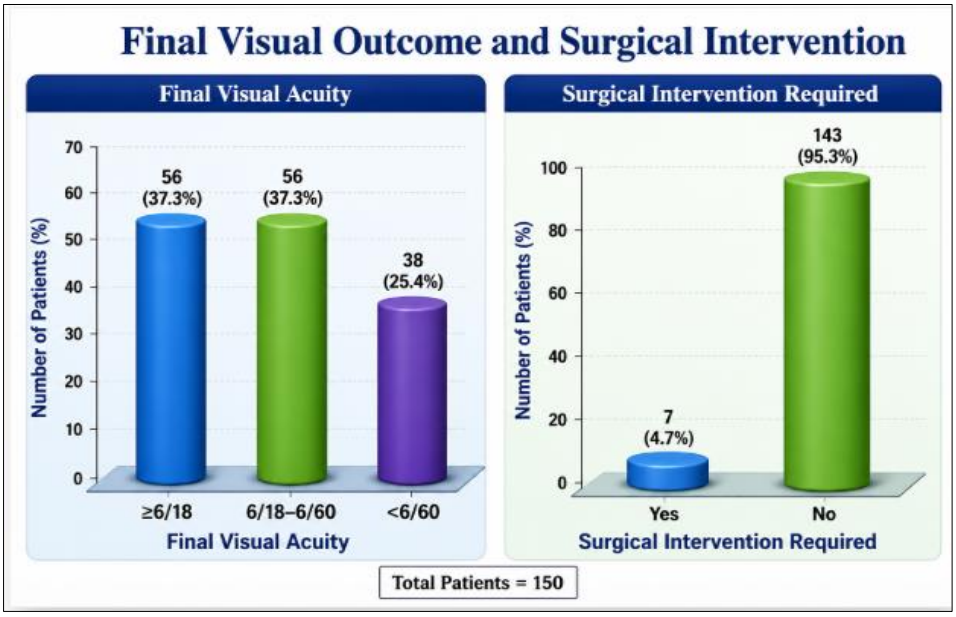


Final visual outcomes and the requirement for surgical intervention are summarized in Table 4. A best-corrected visual acuity of ≥6/18 was achieved in 56 patients (37.3%), while another 56 patients (37.3%) attained visual acuity between 6/18 and 6/60. Poor visual outcome (<6/60) was observed in 38 patients (25.4%).

Surgical intervention was required in 7 patients (4.7%), whereas the remaining 143 patients (95.3%) were managed successfully with medical treatment alone.

Table 4: Final Visual Outcome and Surgical Intervention

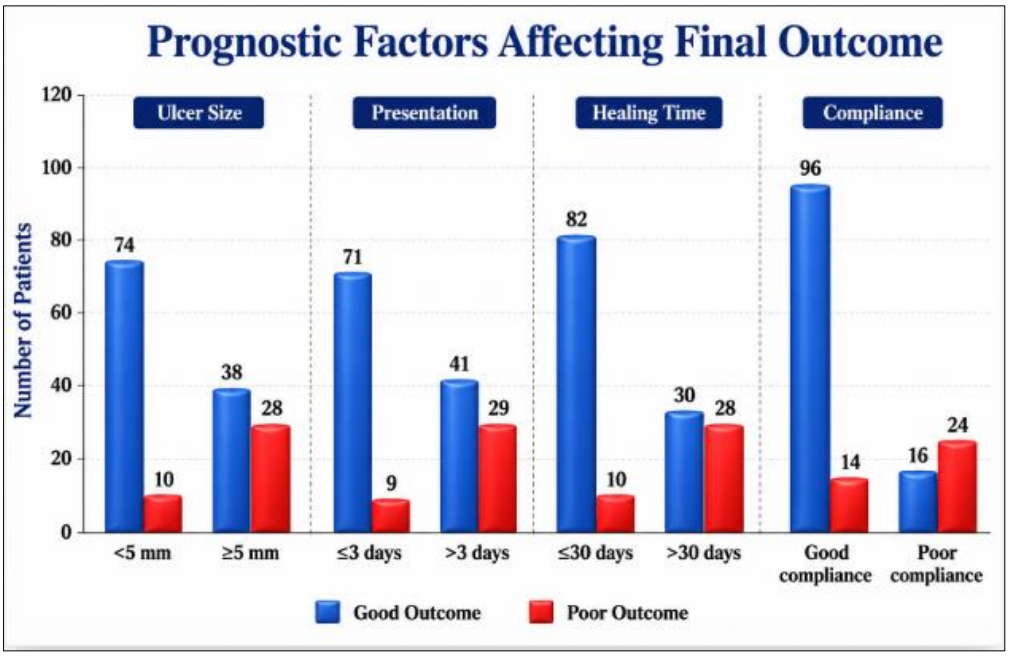
Parameter	Number (%)
Final visual acuity	
≥6/18	56 (37.3)
6/18–6/60	56 (37.3)
<6/60	38 (25.4)
Surgical intervention required	
Yes	7 (4.7)
No	143 (95.3)



The association between various prognostic factors and final visual outcome is presented in Table 5. Ulcer size <5 mm, early presentation (≤3 days), healing within 30 days, and good treatment compliance were significantly associated with favorable outcomes ($p < 0.001$ for all). In contrast, larger ulcer size (≥5 mm), delayed presentation (>3 days), prolonged healing time (>30 days), and poor compliance were significantly associated with poor visual outcomes.

Table 5: Prognostic Factors Affecting Final Outcome

Prognostic Factor	Good Outcome	Poor Outcome	p-value
Ulcer size <5 mm	74	10	<0.001
Ulcer size ≥5 mm	38	28	
Presentation ≤3 days	71	9	<0.001
Presentation >3 days	41	29	
Healing ≤30 days	82	10	<0.001
Healing >30 days	30	28	
Good compliance	96	14	<0.001
Poor compliance	16	24	



Discussion

Corneal ulceration continues to be a major cause of ocular morbidity and preventable visual impairment worldwide, particularly in developing countries where occupational exposure, trauma, delayed presentation, and limited access to specialized care remain common.[1, 2] The present OPD-based cross-sectional study evaluated 150 patients with corneal ulcers to analyze epidemiology, etiological factors, clinical features, management strategies, and outcomes, and the findings are discussed in comparison with previous studies.

In the present study, the majority of patients belonged to the 41–60-year age group (48.66%), followed by the 21–40-year group (32%). Patients below 20 years constituted only 6%, while those above 60 years accounted for 13.33%. This age distribution closely mirrors findings reported by Srinivasan *et a;l.*[7], Khare *et a;l.*[8], Baruah *et a;l.*[9], and Barik *et a;l.*[10], all of whom observed a higher incidence of corneal ulcers among individuals in the economically productive age group. The predominance of middle-aged adults in the present study may be attributed to increased occupational exposure and outdoor activity. In contrast, studies from developed regions such as Ibrahim *et a;l.*[4] and Kodali *et a;l.*[15] reported a higher mean age, reflecting differences in healthcare access, life expectancy, and etiological patterns such as contact lens–related keratitis.

Sex-wise distribution in the present study showed a slight male predominance, with males constituting 54% and females 46% of cases. This finding is consistent with studies by Srinivasan *et a;l.*[7], Laspina *et a;l.*[5], Khare *et a;l.*[8], Baruah *et a;l.*[9], Jibia *et a;l.*[16], and Barik *et a;l.*[10], which attributed male predominance to increased agricultural and manual labor exposure. In contrast, Ibrahim *et a;l.*[4] reported a slight female predominance in southern England, largely attributed to higher contact lens usage among women, highlighting regional differences in risk factors.

Socioeconomic analysis revealed that 71.3% of patients in the present study belonged to the poor socioeconomic group. Similar observations were made by Laspina *et a;l.*[5] and Jibia *et a;l.*[16], who emphasized that poverty, self-medication, delayed presentation, and lack of protective measures significantly contribute to disease burden. These findings underscore socioeconomic disadvantage as a key determinant in the epidemiology of corneal ulcers.

Ocular trauma was identified as the most common predisposing factor in the present study, being present in 74.7% of patients. These findings are comparable to those reported by Srinivasan *et a;l.*[7], Khare *et a;l.*[8], and Barik *et a;l.*[10], where trauma exceeded 50–70% of cases. In contrast, studies from developed regions such as Ibrahim *et a;l.*[4] identified

contact lens use as the leading risk factor, reflecting lifestyle and occupational differences.

Etiologically, fungal keratitis was the most common cause in the present study, accounting for 54% of cases, followed by bacterial keratitis (25.3%) and viral keratitis (16%). Shield ulcers constituted 4.7% of cases. This predominance of fungal keratitis is consistent with studies from tropical regions such as Srinivasan *et a;l.* [7], Khare *et a;l.* [8], Barik *et a;l.* [10], and Leck *et a;l.* [6], where fungal ulcers were strongly associated with trauma involving vegetative matter. In contrast, Ibrahim *et a;l.* [4] and Austin *et a;l.* [11] reported bacterial keratitis as the predominant etiology in temperate regions.

Morphological analysis in the present study demonstrated a strong correlation between lesion morphology and etiology. Feathery margins were exclusively associated with fungal keratitis, while well-defined margins were predominantly associated with bacterial and shield ulcers, and intact epithelium was seen only in viral keratitis. The association between morphology and etiology was highly significant ($p < 0.001$). These findings corroborate observations by Mohan *et a;l.* [12], Diananti *et a;l.* [13], and Austin *et a;l.* [11], who emphasized the diagnostic value of slit-lamp morphology in early etiological differentiation.

Clinical feature analysis showed Descemet's membrane folds in a majority of patients, while keratic precipitates and slough were less frequent. Hypopyon and satellite lesions were uncommon. This contrasts with studies focusing on severe ulcers such as Diananti *et a;l.* [13] and Li *et a;l.* [14], where hypopyon and perforation were more frequent, reflecting referral-based populations. The low prevalence of severe anterior segment signs in the present study likely reflects its OPD-based nature.

Microbiological culture was performed in 96% of patients, indicating good diagnostic compliance. Culture status did not show a statistically significant association with outcome, similar to findings reported in earlier epidemiological studies. [7, 5]

Surgical intervention was required in 7 out of 150 patients (4.7%) and was limited to bacterial and fungal ulcers complicated by corneal thinning or perforation. All cases were successfully managed with cyanoacrylate tissue adhesive and bandage contact lens, with preservation of globe integrity. Similar outcomes have been reported by Diananti *et a;l.* [13], Li *et a;l.* [14], and Alam *et a;l.* [24], where early surgical intervention prevented progression to devastating complications.

Diabetes mellitus was present in a substantial proportion of patients and was associated with a higher rate of poor outcomes, although this association was not statistically significant. Chang *et a;l.*[17] identified diabetes as an independent risk factor for corneal ulcer development; however, the lack of significance in the present study may be attributed to effective treatment and the OPD-based case selection.

Final visual outcome analysis showed that 74.6% of patients achieved a visual acuity of ≥6/60, while 25.4% had poor outcomes. Poor visual outcomes were more frequent in fungal keratitis, followed by bacterial and viral ulcers, with a statistically significant association between etiology and outcome. Similar findings have been reported by Khare *et a;l.* [8], Kodali *et a;l.* [15], and Jibia *et a;l.* [16].

Prognostic analysis demonstrated that larger ulcer size, delayed presentation, prolonged healing time, fungal etiology, and poor treatment compliance were significantly associated with poor outcomes. These findings are in agreement with studies by Kodali *et a;l.*[15], Xu *et a;l.*[18], and Wang *et a;l.*[19], which emphasized early risk stratification and prompt intervention.

Healing analysis revealed that fungal ulcers required significantly longer healing time compared to bacterial and viral ulcers, consistent with previous reports highlighting the chronic nature of fungal keratitis. [7, 10] Recurrence was observed in viral keratitis, reflecting the known recurrent course of herpetic disease, as described in earlier literature. [21]

Overall, the present study corroborates existing evidence that corneal ulcers predominantly affect middle-aged individuals from lower socioeconomic backgrounds in tropical regions, with trauma-related fungal keratitis being the most common etiology. Early presentation, smaller ulcer size, prompt initiation of appropriate therapy, and good treatment compliance were the strongest determinants of favorable outcomes. The findings reinforce the importance of early diagnosis, timely management, and preventive strategies to reduce corneal-related visual impairment. [1, 23]

Conclusion

Corneal ulcers continue to be a major cause of ocular morbidity and preventable visual impairment, particularly in tropical and resource-limited settings. The present study demonstrates that corneal ulcers predominantly affect middle-aged individuals from lower socioeconomic backgrounds, with ocular trauma being the most frequent predisposing factor. Fungal keratitis emerged as the most common etiological agent, reflecting regional climatic conditions and occupational exposure.

Distinct clinical and morphological features showed strong correlation with underlying etiology, facilitating early clinical diagnosis and timely initiation of appropriate therapy. The majority of patients responded favorably to medical management, with a low requirement for surgical intervention when cases were detected early and managed appropriately. Visual and anatomical outcomes improved progressively during follow-up.

Adverse outcomes were significantly associated with fungal etiology, larger ulcer size, delayed presentation, prolonged healing time, and poor treatment compliance, whereas early presentation and smaller ulcers were predictive of better prognosis. Although diabetes mellitus was commonly observed, it did not independently influence final outcome in this cohort. Overall, the study emphasizes the importance of early recognition, prompt referral, accurate etiological identification, patient education, and regular follow-up. Preventive strategies focusing on ocular trauma prevention and strengthening primary eye care services are essential to reduce the burden of corneal-related visual impairment.

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