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Original Research Article

Comparative Analysis of Clinical Outcomes in Fungal and Bacterial Keratitis: A Retrospective Study

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Abstract:

Background: Microbial keratitis is a vision-threatening ocular emergency, particularly prevalent in tropical regions, where fungal infections are common. Early differentiation between fungal and bacterial keratitis is essential for appropriate management and improved outcomes.

Aim: To evaluate and compare the clinical profile, microbiological spectrum, and outcomes of fungal and bacterial keratitis.

Methodology: This hospital-based retrospective comparative study was conducted in the Department of Ophthalmology, Patna Medical College and Hospital, including 90 patients with microbiologically confirmed infectious keratitis. Clinical details, risk factors, microbiological findings, treatment, and outcomes were analyzed using descriptive and inferential statistics.

Results: Fungal keratitis (55.6%) was more prevalent than bacterial keratitis (44.4%). The most affected age group was 41–60 years (38.9%). Vegetative trauma (42.2%) was the leading risk factor, predominantly in fungal cases, while contact lens use was more common in bacterial infections. Aspergillus spp. (44%) and Staphylococcus aureus (35%) were the most common fungal and bacterial isolates, respectively. Healing with corneal scarring occurred in 66.7% of cases; however, complications such as perforation and therapeutic keratoplasty were more frequent in fungal keratitis.

Conclusion: Fungal keratitis predominates in this region and is associated with more severe complications, underscoring the need for early microbiological diagnosis and targeted therapy.

Keywords: Microbial keratitis, Fungal keratitis, Bacterial keratitis, Corneal ulcer, Visual outcome.

Introduction

Microbial keratitis serves as an ocular emergency which can ‘result in permanent vision loss through its corneal inflammation that results from bacterial and fungal infections [1]. The condition exists as a primary reason for corneal blindness throughout the world because agricultural accidents and late medical treatment and few specialized eyes care centers exist in developing nations. The cornea functions as the eye's transparent outermost layer which lacks blood vessels, making it vulnerable to infections that occur after its epithelial layer gets damaged. Pathogenic microorganisms can start to penetrate the corneal stroma after the epithelial barrier gets damaged, which will cause corneal ulcerations and stromal necrosis and permanent eyesight loss through corneal perforation. The people living in tropical and subtropical areas, especially India, face a high risk of microbial keratitis because their climate supports fungal development and their agricultural work exposes them to eye injuries from plant materials [2].

Bacterial keratitis shows three main symptoms which start suddenly and develop quickly while producing strong inflammatory reactions [3]. People who wear contact lenses and have ocular surface disease and experience trauma and previous eye operations and use topical corticosteroids meet common risk factors for the condition. The most common pathogens that cause infections include Staphylococcus aureus and Streptococcus pneumoniae which are Gram-positive bacteria and Pseudomonas aeruginosa which is a Gram-negative bacterium [4]. Bacterial keratitis presents itself through four main symptoms which include pain and redness and purulent discharge and a well-defined stromal infiltrate

that shows an overlying epithelial defect. The use of proper topical antibiotics results in positive treatment outcomes during most situations but the use of delayed or incorrect medical treatment creates a risk for major complications which include corneal thinning and perforation and endophthalmitis.

Fungal keratitis develops more slowly than other conditions but usually occurs after people sustain injuries that expose them to organic material from plant debris. Filamentous fungi, particularly Fusarium and Aspergillus species, are common etiological agents in tropical climates, whereas yeasts such as Candida species are more frequently encountered in temperate regions and in patients with ocular surface disease or immunosuppression [5]. The clinical presentation of fungal keratitis includes feathery-edged infiltrates and satellite lesions and dry-looking ulcers and hypopyon which occurs in some cases. Diagnosing and treating fungal infections presents greater challenges than bacterial keratitis because antifungal agents do not effectively penetrate the infection site and microbiological tests require time to deliver results and fungi develop natural resistance. Fungal keratitis leads to extended treatment periods because patients need multiple surgical procedures which include therapeutic penetrating keratoplasty, and they experience worse visual results [6].

Understanding the comparative clinical characteristics and outcomes of fungal versus bacterial keratitis is essential for guiding management strategies and improving patient prognosis [7]. The different populations studied in this research show distinct variations in their demographic characteristics, risk factors, clinical symptoms, microbiological findings, treatment results, hospital stay lengths, and final visual acuity achievements. Through their examination of existing clinical records retrospective studies show how diseases progress and how doctors choose treatments and what factors influence patient outcomes in real-world medical situations. The research proves valuable in environments where researchers cannot perform prospective randomized trials because of ethical challenges or limited resources or because the situation is developing.

The results of microbial keratitis depend on various factors which include the infectious agent's virulence, the patient's corneal infiltrate size and depth at their first assessment, the duration until proper treatment began, the patient's immune system strength, and their treatment compliance [8]. Bacterial keratitis, when diagnosed early and treated promptly with broad-spectrum antibiotics, often shows relatively rapid clinical improvement and favorable visual recovery. Pseudomonas aeruginosa and other highly destructive organisms create serious dangers because their infections require immediate medical intervention. Fungal keratitis presents a different pattern because it develops slow recovery times while maintaining continuous epithelial damage and producing more medical issues. Fungal infections require surgical treatment more frequently because it includes both therapeutic keratoplasty and evisceration for severe cases.

In areas where bacterial and fungal keratitis occur at high rates, medical professionals face difficulties when they attempt to identify the cause of these conditions through their clinical assessment. The gold standard for absolute diagnosis requires laboratory validation which uses corneal scraping and smear examination and culture methods, but doctors begin treatment based on clinical judgment before microbiological results become available. The research demonstrates that healthcare professionals need to understand local disease patterns and treatment success rates because this knowledge will assist them in choosing effective initial treatment methods. Hospitals can use their archived patient data to conduct studies that identify common infectious agents, reveal how those agents respond to drugs, and record the rates of complications and visual outcomes for each infection type.

The clinical study needs to compare fungal and bacterial keratitis outcomes through its retrospective research. The research analyzes patient demographics combined with predisposing factors and microbiological findings and therapeutic interventions and visual outcomes to show how the two groups experience different disease severity and treatment response and prognosis. The research results will create evidence-based clinical protocols which will improve diagnosis accuracy and decrease time until proper treatment starts and result in decreased corneal blindness cases. The healthcare system requires outcome comparison data to develop better management methods which help them allocate resources in areas where microbial keratitis creates the most impact.

Methodology

Study Design: This study was a hospital-based retrospective observational comparative study conducted to evaluate and compare the clinical and microbiological outcomes of fungal and bacterial keratitis cases.

Study Area: The study was conducted in the Department of Ophthalmology, Patna Medical College and Hospital, Patna, Bihar, India.

Study Duration: The study was carried out over a period of 7 months from March 2025 to September 2025.

Study Participants: A total of 90 patients diagnosed with infectious keratitis were included in the study.

Inclusion Criteria

- Patients diagnosed clinically and microbiologically with fungal or bacterial keratitis.

- Patients of all age groups and both genders.
- Patients with complete medical records, including microbiological reports and treatment outcomes.
- Patients who underwent corneal scraping and laboratory investigations.

Exclusion Criteria

- Patients with viral keratitis (e.g., herpes simplex keratitis).
- Patients with mixed infections where differentiation between fungal and bacterial etiology was not clearly established.
- Patients with sterile corneal ulcers or non-infective keratitis.
- Patients with incomplete medical or laboratory records.
- Post-surgical keratitis cases with inadequate follow-up data.

Sample Size: The total sample size comprised 90 patients, divided into two groups based on microbiological diagnosis: fungal keratitis and bacterial keratitis.

Procedure: Hospital records of patients who were diagnosed with microbial keratitis throughout the study were examined after obtaining institutional approval. The clinical information (including demographic factors, risk factors (trauma, contact lens use or steroid use), presenting visual problem, visual acuity upon presentation, size and location of corneal ulcer, hypopyon, treatment and final visual outcome) was put in a structured proforma.

Corneal scrapings in each instance had been obtained aseptically with the spatula of Kimura under slit-lamp examination following instillation with 4% xylocaine eye drops at the base and the periphery of the corneal ulcer. The direct examination of the microscopes was done using a 10 percent of potassium hydroxide (KOH) wet mount to identify the fungal elements. Gram staining was done on smears to determine bacteria or fungal hyphae or pseudohyphae or yeast cells.

In the case of fungal culture, it was inoculated on plain Sabouraud dextrose agar (SDA) and SDA with antibiotics like cycloheximide (500 mg/L), chloramphenicol (50 mg/L) and gentamicin (20 mg/L). The incubation of the culture media was done in isolation at 25°C and 37°C and then followed up to a maximum of four weeks. Diagnosis of fungi was done using both the macroscopic morphology of the colonies based on the following characteristics: the texture, the color and the growth rate, as well as microscopic morphology based on lactophenol cotton blue mounts. Microculture slide was used to observe filamentous fungi thoroughly. Identification of yeast isolates was done by germ tube test, spores growing in corn meal agar, urease production and sugar fermentation and assimilation test.

In the case of bacterial culture, the culture was inoculated on Blood agar and MacConkey agar and left to incubate at 37°C. The identification of bacterial isolates was conducted based on traditional biochemical tests. The cultures were regarded as positive when the identical organism grew on either one or several solid media or when the growth was conducive to actual observation under a microscope.

The outcome of the treatment was defined to be healed scar, therapeutic keratoplasty, perforation, or poor visual outcome. The cases of fungal and bacterial keratitis were compared.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 27.0. Descriptive statistics such as frequencies, percentages, mean, and standard deviation were calculated. Categorical variables between fungal and bacterial keratitis groups were compared using the Chi-square test or Fisher's exact test where appropriate. Continuous variables were compared using the independent t-test. A p-value of less than 0.05 was considered statistically significant.

Result

Table 1 shows the distribution of patients according to the type of keratitis among the total sample of 90 cases. The majority of patients were diagnosed with fungal keratitis, accounting for 50 cases (55.6%), indicating that fungal infection was the more prevalent cause of keratitis in the study population. In contrast, bacterial keratitis was observed in 40 patients (44.4%), representing a slightly lower proportion. The findings suggest that fungal keratitis constituted the predominant clinical presentation compared to bacterial keratitis in this cohort, highlighting the need for careful microbiological evaluation and prompt antifungal management in suspected cases.

Table 1: Distribution of Patients According to Type of Keratitis (N = 90)

Type of Keratitis	Frequency (n)	Percentage (%)
Fungal Keratitis	50	55.6
Bacterial Keratitis	40	44.4
Total	**90**	**100**

Table 2 shows the age-wise distribution of 90 patients categorized into fungal (n=50) and bacterial (n=40) infections. The highest proportion of patients belonged to the 41–60 years age group, accounting for 35 cases (38.9%), with 20 fungal and 15 bacterial infections, indicating that middle-aged individuals were most commonly affected. This was followed by the 21–40 years age group comprising 32 patients

(35.6%), including 18 fungal and 14 bacterial cases, reflecting a substantial burden among young adults. Patients aged above 60 years constituted 12 cases (13.3%), equally distributed between fungal and bacterial infections (6 each). The least affected group was those below 20 years, with 11 patients (12.2%), including 6 fungal and 5 bacterial cases. Overall, the findings suggest that infections were more prevalent among adults between 21 and 60 years of age.

Table 2: Age Group Distribution of Patients (N = 90)				
Age Group (Years)	**Fungal (n=50)**	**Bacterial (n=40)**	**Total (n=90)**	**Percentage (%)**
<20	6	5	11	12.2
21–40	18	14	32	35.6
41–60	20	15	35	38.9
>60	6	6	12	13.3
Total	**50**	**40**	**90**	**100**

Table 3 shows the distribution of predisposing risk factors among 90 patients, categorized into fungal (n=50) and bacterial (n=40) cases. The most common risk factor overall was vegetative trauma, observed in 38 patients (42.2%), with a markedly higher occurrence in fungal cases (28) compared to bacterial cases (10), indicating trauma as a major contributor particularly to fungal infections. Foreign body or dust exposure was reported in 15 patients (16.7%), fairly distributed between fungal (7) and bacterial (8) infections. Contact lens use and steroid use each accounted for 11 cases (12.2%). Contact lens use was more commonly associated with bacterial infections (9) than fungal (2), while steroid use showed a relatively similar distribution between fungal (5) and bacterial (6) cases. Additionally, 15 patients (16.7%) had no identifiable risk factor, suggesting that infections may also occur without obvious predisposing conditions.

Table 3: Predisposing Risk Factors Among Patients (N = 90)				
Risk Factor	**Fungal (n=50)**	**Bacterial (n=40)**	**Total (n=90)**	**Percentage (%)**
Trauma (Vegetative)	28	10	38	42.2
Foreign Body/ Dust	7	8	15	16.7
Contact Lens Use	2	9	11	12.2
Steroid Use	5	6	11	12.2
No Identified Factor	8	7	15	16.7
Total	**50**	**40**	**90**	**100**

Table 4 presents the microbiological profile of isolates, categorizing them into fungal (n = 50) and bacterial (n = 40) organisms. Among the fungal isolates, Aspergillus spp. constituted the highest proportion with 22 cases (44%), indicating it as the predominant fungal pathogen. This was followed by Fusarium spp., accounting for 15 isolates (30%), while Candida spp. contributed 8 cases (16%). Other fungal organisms comprised 5 isolates (10%). In the bacterial group, Staphylococcus aureus was the most frequently isolated organism with 14 cases (35%), followed closely by Pseudomonas aeruginosa with 12 cases (30%). Streptococcus spp. accounted for 8 isolates (20%), whereas other bacterial organisms represented 6 cases (15%). Overall, the table highlights a higher predominance of Aspergillus spp. among fungi and Staphylococcus aureus among bacteria in the study population.

Table 4: Microbiological Profile of Isolates		
A. Fungal Isolates (n = 50)		
Fungal Organism	**Frequency (n)**	**Percentage (%)**
Aspergillus spp.	22	44
Fusarium spp.	15	30
Candida spp.	8	16
Others	5	10
Total	**50**	**100**
B. Bacterial Isolates (n = 40)		
Bacterial Organism	**Frequency (n)**	**Percentage (%)**
Staphylococcus aureus	14	35
Pseudomonas aeruginosa	12	30
Streptococcus spp.	8	20
Others	6	15
Total	**40**	**100**

Table 5 shows the distribution of clinical outcomes among patients with fungal and bacterial keratitis out of a total of 90 cases. The majority of patients, 60 (66.7%), healed with a corneal scar, with equal numbers in both fungal (30) and bacterial (30) groups, indicating that scarring was the most common outcome irrespective of etiology. Therapeutic keratoplasty was required in 11 patients (12.2%), more frequently in fungal keratitis (8 cases) compared to bacterial keratitis (3 cases), suggesting relatively severe disease in fungal infections. Corneal perforation occurred in 9 patients (10%), again more common in fungal cases (7) than bacterial cases (2). Poor visual outcome (<6/60) was observed in 10 patients (11.1%), equally distributed between fungal and bacterial groups (5 each). Overall, fungal keratitis showed a higher tendency toward complications requiring surgical intervention.

Table 5: Clinical Outcomes in Fungal vs Bacterial Keratitis (N = 90)

Outcome	Fungal (n=50)	Bacterial (n=40)	Total (n=90)	Percentage (%)
Healed with Scar	30	30	60	66.7
Therapeutic Keratoplasty	8	3	11	12.2
Corneal Perforation	7	2	9	10
Poor Visual Outcome (<6/60)	5	5	10	11.1
Total	**50**	**40**	**90**	**100**

Discussion

Corneal scarring caused by infectious keratitis functions as one of the main preventable factors which lead to monocular blindness throughout the globe. The study found that 90 patients with fungal keratitis accounted for 55.6 percent of cases while 44.4 percent had bacterial keratitis which shows that fungal causes were more common. This finding is comparable to the report by Rautaraya B et al. (2011) [9], who documented fungal keratitis in 53% of culture-positive cases in Eastern India. Similarly, Gupta A et al. (2014) [10] found that North India had a 58% fungal infection rate which proves that tropical and subtropical regions support fungal pathogen growth. Studies from temperate regions found that bacteria dominated the cases while fungal keratitis accounted for less than 30% of cases which showed how different geographical areas behaved differently.

The study results demonstrated that people from the 41 to 60 age range constituted the highest participation rate with 38.9% whereas people from the 21 to 40 age range followed closely with 35.6%. The research findings match those of Bharathi MJ et al. (2003) [11] who discovered that 36% of fungal keratitis cases affected people from the 31 to 40 age range and Gopinathan U et al. (2009) [12] who showed that fungal keratitis cases reached their highest point during the 30 to 50 age range. The study showed that our group of patients developed bacterial keratitis at higher rates among elderly people who matched the findings of Ibrahim MM et al. (2011) [13] who reported that 52% of bacterial keratitis cases happened to people older than 50 years. The difference between the two groups results from two factors which include age-related ocular surface disorders and previous surgical procedures and existing health conditions like diabetes mellitus.

The study found that vegetative trauma served as the primary predisposing factor which resulted to 42.2% of cases. Basak SK et al. (2005) [14] found agricultural trauma in 40% of fungal keratitis cases which produced results that matched those of our study. Saha R et al. (2006) [15] found that 44% of cases showed association with plant material injury which produced results that matched our findings. Our study found that contact lens usage created stronger links to bacterial keratitis which matched the results of Moriyama AS and Hofling-Lima AL (2008) [16] study which found that 35 to 40 percent of contact lens cases developed bacterial keratitis. Environmental exposure causes fungal keratitis while human behavior and medical treatment create risks for bacterial infections.

The study established Aspergillus species as the major fungal isolate which occurred in 44% of cases while Fusarium species followed as the second most common fungus. The study results show partial agreement with Gupta A et al. (2014) research which found Fusarium to be the dominant isolate at 34%. Bharathi MJ et al. (2003) found Aspergillus species to occur in 47% of fungal cases which matches our results directly. Regional climatic variations probably cause this difference. Staphylococcus aureus and Pseudomonas aeruginosa emerged as the most prevalent bacterial isolates with Staphylococcus aureus reaching 35% and Pseudomonas aeruginosa reaching 30%. The study conducted by Sherwal BL et al. (2008) [17] found similar bacterial patterns which showed Staphylococcus aureus occurred in 32% of cases and Pseudomonas in 28% of cases thus showing that Indian tertiary hospitals maintain consistent bacterial patterns.

Clinical outcomes in our study showed that 66.7% of patients achieved healing through corneal scarring treatment. Scarring functions as an indication that an infection has been controlled however it results in visual impairment. Prajna NV et al. (2013) [18] found that fungal keratitis leads to worse clinical outcomes than bacterial keratitis because it requires a longer time for re-epithelialization which takes 15 days while bacterial keratitis takes 7 days

and it has a higher rate of perforation. Our research discovered that fungal keratitis leads to more corneal perforations which match the 7 to 10 percent perforation rates that previous Indian studies have reported. The study found that 11.1% of patients experienced poor visual outcomes which showed an equivalent pattern to the 12-15% severe visual impairment rate that Gopinathan U et al. (2009) reported.

The results showed that our patients had sterile cultures although their microscopy tests showed positive results which matched the 10–15% culture negativity rate reported by Rautaraya B et al. (2011). The researchers found that previous use of topical antibiotics or steroids decreased culture results which showed the need to collect corneal scrapings before starting empirical treatment.

The current study confirms existing research which shows that tropical regions experience higher rates of fungal keratitis which leads to more severe structural damage than bacterial keratitis. Bacterial keratitis shows better healing results and improved outcomes when patients receive immediate antibiotic treatment yet fungal keratitis presents treatment difficulties because of its hidden nature and weak antifungal drug absorption and ability to develop resistance. The combination of early microbiological testing and regional epidemiological knowledge and protective eyewear use during agricultural activities serves as the primary method to decrease health complications.

Conclusion

The present study demonstrates that fungal keratitis was more prevalent than bacterial keratitis, accounting for 55.6% of cases, with adults between 21 and 60 years being most commonly affected. Vegetative trauma emerged as the leading predisposing factor, particularly for fungal infections, whereas contact lens use was more associated with bacterial keratitis. Microbiologically, Aspergillus spp. and Staphylococcus aureus were the predominant fungal and bacterial isolates, respectively. Although the majority of patients healed with corneal scarring, fungal keratitis showed a greater tendency toward severe complications such as corneal perforation and the need for therapeutic keratoplasty. These findings emphasize the importance of early microbiological diagnosis, prompt targeted therapy, and preventive strategies to reduce visual morbidity associated with infectious keratitis.

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