Corneal Scraping: A Comprehensive Review of Indications, Techniques, Microbiological Diagnosis and Clinical Significance

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Abstract

Corneal scraping is a fundamental diagnostic and therapeutic ophthalmic procedure primarily performed in cases of infectious keratitis and corneal ulcers. It enables direct microscopic examination, microbiological culture, antimicrobial susceptibility testing, and targeted therapy. Infectious keratitis caused by bacteria, fungi, viruses, and parasites remains a major cause of corneal blindness worldwide, particularly in developing countries. Prompt and accurate diagnosis through corneal scraping significantly improves clinical outcomes and reduces complications such as corneal perforation and visual impairment. The procedure involves obtaining corneal specimens under aseptic precautions using sterile instruments after topical anesthesia. Various staining techniques including Gram stain, potassium hydroxide (KOH) mount, Giemsa stain, and culture on appropriate media play essential roles in organism identification. Recent advances such as polymerase chain reaction (PCR), confocal microscopy, and molecular diagnostics have further enhanced diagnostic accuracy. This review discusses the indications, methodology, microbiological processing, complications, recent advances, and clinical importance of corneal scraping in modern ophthalmology and microbiology practice.

Keywords: Corneal scraping, infectious keratitis, corneal ulcer, microbiological diagnosis, fungal keratitis, bacterial keratitis

Introduction

The cornea is a transparent avascular structure forming the anterior one-sixth of the eyeball and plays a vital role in maintaining visual acuity by refracting incoming light onto the retina.[1] Corneal infections and ulcers are major ophthalmic emergencies that can rapidly progress to corneal scarring, perforation, endophthalmitis, and permanent blindness if diagnosis and treatment are delayed.[2] Infectious keratitis is recognized as one of the leading causes of monocular blindness worldwide, particularly in developing and tropical countries where ocular trauma and agricultural exposure are common predisposing factors.[3]

Corneal scraping is considered the gold standard diagnostic procedure for microbial keratitis because it allows direct microbiological evaluation of infected corneal tissue.[4] The procedure enables microscopic examination, microbial culture, organism identification, and antimicrobial susceptibility testing, thereby facilitating targeted antimicrobial therapy.[5] Early etiological diagnosis through corneal scraping significantly improves clinical

outcomes and reduces unnecessary empirical use of broad-spectrum antibiotics.[6]

The epidemiology of infectious keratitis varies according to geographical location, climatic conditions, and socioeconomic factors.[7] In developed countries, bacterial keratitis predominates and is commonly associated with contact lens wear, ocular surgery, and ocular surface disease.[8] In contrast, fungal keratitis is more prevalent in tropical and subtropical regions such as India due to vegetative trauma, humid climate, and agricultural occupations.[9] Common bacterial pathogens include *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus pneumoniae*, and coagulase-negative staphylococci, whereas fungal pathogens mainly include *Fusarium* and *Aspergillus* species.[10]

Advancements in ophthalmic microbiology have improved the diagnostic utility of corneal scraping. Conventional staining techniques such as Gram stain, potassium hydroxide (KOH) mount, and Giemsa stain remain essential rapid diagnostic methods.[11] Culture on blood agar, chocolate agar, and Sabouraud dextrose agar continues to serve as the backbone for organism isolation and antimicrobial susceptibility testing.[12] Recent technologies including polymerase chain reaction (PCR), confocal microscopy, matrix-assisted laser desorption ionization-time of flight (MALDI-TOF), and next-generation sequencing have enhanced sensitivity and specificity, especially in culture-negative cases.[13]

Corneal scraping not only aids diagnosis but may also reduce microbial load and improve penetration of topical antimicrobial agents by removing necrotic tissue and debris.[14] Despite technological advances, appropriate specimen collection technique and prompt microbiological processing remain the cornerstones of successful diagnosis and management of infectious keratitis.[15]

Anatomy and Physiology of Cornea

The cornea consists of five major layers:

1. Epithelium
2. Bowman’s membrane
3. Stroma
4. Descemet’s membrane
5. Endothelium

Its avascular nature and transparent structure are maintained by endothelial pump mechanisms and orderly collagen arrangement. Any infectious or inflammatory insult may disrupt corneal transparency and vision.

Indications for Corneal Scraping

Corneal scraping is indicated in the following conditions:

- Suspected infectious keratitis
- Corneal ulcers larger than 2 mm
- Central corneal infiltrates
- Deep stromal infiltrates
- Non-healing corneal ulcers
- Atypical keratitis
- Contact lens-associated keratitis
- Suspected fungal keratitis
- Acanthamoeba keratitis

- Corneal ulcers unresponsive to empirical therapy
- Immunocompromised patients with corneal infection

Contraindications

Although relatively safe, corneal scraping should be performed cautiously in:

- Impending corneal perforation
- Very thin cornea
- Severe patient non-cooperation
- Pediatric patients requiring sedation

Etiological Agents of Infectious Keratitis

Bacterial Keratitis

Common bacterial pathogens include:

- *Pseudomonas aeruginosa*
- *Staphylococcus aureus*
- *Streptococcus pneumoniae*
- Coagulase-negative staphylococci
- *Moraxella* species

Fungal Keratitis

Frequently isolated fungi include:

- *Fusarium* species
- *Aspergillus* species
- *Candida albicans*

Viral Keratitis

Mainly caused by:

- Herpes simplex virus (HSV)
- Varicella-zoster virus (VZV)

Parasitic Keratitis

- *Acanthamoeba* species

Risk Factors for Infectious Keratitis

Several predisposing factors contribute to corneal infections:

- Ocular trauma
- Contact lens use
- Diabetes mellitus
- Topical steroid use
- Ocular surface disease
- Previous ocular surgery
- Agricultural occupation
- Dry eye syndrome
- Immunosuppression

Procedure of Corneal Scraping

Pre-Procedure Preparation

- Detailed ocular examination using slit lamp
- Informed consent
- Instillation of topical anesthetic such as proparacaine 0.5%
- Maintenance of strict aseptic precautions

Instruments Used

- Kimura spatula
- Sterile Bard-Parker blade No. 15
- Platinum spatula
- Sterile needles
- Calcium alginate swab

Technique

The patient is seated comfortably at the slit lamp. After topical anesthesia, the eyelids are gently separated using a sterile lid speculum if necessary. Necrotic material and discharge are removed carefully. The edge and base of the ulcer are scraped using a sterile instrument under magnification. Multiple scrapings are obtained for direct microscopy and culture.

The material is immediately inoculated onto culture media and smeared onto glass slides for staining.

Microbiological Processing of Corneal Scrapings

Direct Microscopy

Gram Stain

Used for detecting bacteria and some fungi.

Potassium Hydroxide (KOH) Mount

Useful for rapid identification of fungal hyphae.

Giemsa Stain

Helpful for identifying inflammatory cells, fungi, and acanthamoeba cysts.

Calcofluor White Stain

Enhances fungal and acanthamoeba visualization under fluorescence microscopy.

Culture Media Used

Organism	Culture Media
Bacteria	Blood agar, Chocolate agar
Fungi	Sabouraud dextrose agar
Acanthamoeba	Non-nutrient agar with *E. coli* overlay
Anaerobes	Anaerobic blood agar

Cultures are incubated under appropriate environmental conditions and monitored regularly.

Antimicrobial Susceptibility Testing

Culture isolates undergo antibiotic susceptibility testing using:

- Kirby-Bauer disc diffusion method
- Automated systems
- Minimum inhibitory concentration (MIC) testing

This helps guide targeted therapy and monitor antimicrobial resistance trends.

Clinical Features Suggestive of Specific Etiologies

Etiology	Clinical Features
Bacterial keratitis	Rapid progression, purulent discharge
Fungal keratitis	Feathery margins, satellite lesions
Viral keratitis	Dendritic ulcers
Acanthamoeba keratitis	Severe pain disproportionate to signs

Recent Advances in Diagnosis

Polymerase Chain Reaction (PCR)

PCR provides rapid detection of microbial DNA with high sensitivity.

In Vivo Confocal Microscopy

Allows visualization of fungal filaments and acanthamoeba cysts in real time.

Next-Generation Sequencing

Useful in culture-negative infections and polymicrobial keratitis.

MALDI-TOF Mass Spectrometry

Provides rapid microbial identification from culture isolates.

Therapeutic Role of Corneal Scraping

Apart from diagnosis, corneal scraping may also:

- Reduce microbial load
- Remove necrotic tissue
- Improve drug penetration
- Facilitate healing

Complications of Corneal Scraping

Although uncommon, complications may include:

- Corneal perforation
- Pain and discomfort
- Secondary infection
- Epithelial defects
- Bleeding

Proper technique minimizes these risks.

Role of Corneal Scraping in Fungal Keratitis

Fungal keratitis is highly prevalent in tropical regions. Early diagnosis through KOH mount and fungal culture is essential because delayed treatment can lead to devastating outcomes. Corneal scraping helps distinguish fungal keratitis from bacterial infections, thereby preventing inappropriate steroid or antibiotic use.

Importance in Antimicrobial Stewardship

Corneal scraping supports rational antimicrobial use by:

- Identifying causative organisms
- Preventing unnecessary broad-spectrum therapy
- Reducing antimicrobial resistance
- Improving treatment outcomes

Future Perspectives

Emerging technologies such as artificial intelligence-assisted microscopy, multiplex PCR panels, and nanotechnology-based diagnostics may further improve rapid pathogen identification and personalized ocular therapy.

Discussion

Corneal scraping remains an indispensable diagnostic procedure in the management of infectious keratitis and corneal ulcers.[1] Accurate identification of the causative organism is crucial because clinical manifestations alone are often insufficient to differentiate bacterial, fungal, viral, and parasitic keratitis.[2] Delayed or inappropriate therapy may result in severe complications including corneal perforation, endophthalmitis, and irreversible visual loss.[3]

In the present review, bacterial keratitis was identified as one of the most common causes of infectious corneal disease, particularly in developed countries and among contact lens users.[4] *Pseudomonas aeruginosa* has consistently been reported as a major pathogen associated with rapidly progressive corneal ulcers due to its aggressive proteolytic enzymes and biofilm-forming ability.[5] Studies by Bharathi et al. and Green et al. demonstrated that trauma, contact lens wear, and ocular surface disorders are important risk factors for bacterial keratitis.[6,7]

Fungal keratitis continues to represent a major ophthalmic challenge in tropical countries such as India.[8] Agricultural trauma involving vegetative matter is a predominant risk factor for fungal corneal ulcers.[9] *Fusarium* and *Aspergillus* species are the most frequently isolated fungi in several Indian studies.[10] The characteristic feathery-edged infiltrates and satellite lesions often suggest fungal etiology; however, microbiological confirmation through corneal scraping remains essential.[11] KOH mount has proven particularly valuable because it provides rapid visualization of fungal hyphae with high sensitivity.[12]

Acanthamoeba keratitis has emerged as an important infection among contact lens users.[13] Severe pain disproportionate to clinical findings is considered a characteristic feature of this condition.[14] Diagnosis is frequently delayed because of its resemblance to herpetic keratitis and poor clinical suspicion.[15] Corneal scraping with non-nutrient agar culture and confocal microscopy has significantly improved diagnostic accuracy.[13]

Microscopic examination and culture remain the cornerstone of laboratory diagnosis despite advances in molecular diagnostics.[11] Gram staining provides rapid preliminary identification of bacteria, whereas Giemsa stain aids in detecting inflammatory cells, fungi, and protozoal cysts.[12] Culture remains essential not only for pathogen isolation but also for antimicrobial susceptibility testing, which guides definitive therapy and supports antimicrobial stewardship practices.[5]

Recent molecular diagnostic modalities have enhanced the sensitivity of pathogen detection.[13] PCR-based methods can rapidly detect bacterial, fungal, viral, and parasitic DNA even in patients already receiving antimicrobial therapy.[14] Confocal microscopy provides real-time visualization of fungal filaments and

acanthamoeba cysts within the cornea.[15] MALDI-TOF and next-generation sequencing have also emerged as promising technologies for rapid organism identification in culture-negative cases.[13]

Therapeutically, corneal scraping contributes to reducing microbial burden and improving penetration of topical medications by removing necrotic debris.[14] Proper specimen collection technique is critical because inadequate or delayed processing may lead to false-negative results.[11] Collaboration between ophthalmologists and microbiologists therefore plays a vital role in improving diagnostic yield and treatment outcomes.[5]

Although corneal scraping is generally safe, complications such as corneal perforation, epithelial trauma, and secondary infection may occur if the procedure is performed improperly.[2] Careful patient selection, use of appropriate instruments, and strict aseptic precautions help minimize procedural complications.[1]

Overall, corneal scraping continues to be the gold standard diagnostic approach for infectious keratitis, especially in resource-limited settings where advanced molecular facilities may not be readily available.[10] Integration of conventional microbiological methods with newer molecular technologies may further improve early diagnosis, targeted therapy, and prevention of corneal blindness in the future.[13]

Conclusion

Corneal scraping remains an indispensable diagnostic procedure in ophthalmology and microbiology. It plays a critical role in the early identification of infectious keratitis and facilitates appropriate antimicrobial therapy. Despite advancements in molecular diagnostics, conventional microscopy and culture continue to be the backbone of diagnosis, especially in resource-limited settings. Proper technique, timely specimen processing, and interdisciplinary collaboration between ophthalmologists and microbiologists are essential for optimal patient outcomes. Future innovations may further enhance diagnostic accuracy and reduce the global burden of corneal blindness.

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