Clinical Spectrum, Etiological Profile, and Antifungal Susceptibility Pattern in Onychomycosis.

Abstract

Background: Onychomycosis is a common fungal infection of the fingernails and toenails caused by dermatophytes, non-dermatophyte moulds, and yeasts. Accurate clinical and mycological characterization is important for appropriate therapy, especially in view of emerging antifungal resistance.

Objective: To study the clinical spectrum of onychomycosis, identify common causative fungal agents, and assess antifungal susceptibility patterns to terbinafine, fluconazole, itraconazole, and griseofulvin.

Methods: This descriptive, observational study was conducted in the Dermatology, Venereology and Leprosy outpatient department of Rajkiya Medical College and Hospital, Jalaun, Orai, from November 2022 to October 2023. Patients with clinically suspected onychomycosis and positive direct microscopy were included. Nail specimens were examined using potassium hydroxide microscopy, fungal culture, and organism identification. Antifungal susceptibility was assessed for selected systemic agents.

Results: A total of 104 patients were enrolled. The mean age was 35.93 years, with an age range of 14 to 72 years. Males constituted 64 cases (62%) and females 40 cases (38%). Distal and lateral subungual onychomycosis was the most frequent clinical pattern, observed in 59 patients (57%), followed by mixed-pattern onychomycosis in 17 (16%), total dystrophic onychomycosis in 13 (13%), proximal onychomycosis in 11 (10%), and endonyx onychomycosis in 4 (4%). Fungal culture was positive in 55 patients (53%). Dermatophytes were the most common isolates, accounting for 35 culture-positive cases (64%), followed by non-dermatophyte moulds in 13 (24%) and yeasts in 7 (12%). *Trichophyton rubrum* was the leading isolate, followed by *Trichophyton mentagrophytes*, *Aspergillus* species, *Candida* species, *Epidermophyton floccosum*, and *Fusarium* species. Terbinafine showed the highest sensitivity (80%), followed by fluconazole (67%), itraconazole (58%), and griseofulvin (51%).

Conclusion: In this study, onychomycosis most commonly affected young and middle-aged adults and showed male predominance. Distal and lateral subungual onychomycosis was the most common clinical pattern, and dermatophytes, particularly *Trichophyton rubrum*, were the predominant etiological agents. Terbinafine demonstrated the highest in vitro sensitivity among the tested antifungals. Accurate clinical classification, laboratory confirmation, organism identification, and antifungal susceptibility testing may support more rational therapeutic decision-making.

Keywords

Onychomycosis; dermatophytes; *Trichophyton rubrum*; antifungal susceptibility; terbinafine; nail infection.

Introduction

Onychomycosis is a fungal infection of the nail unit involving the nail plate, bed, matrix, or surrounding structures. It is one of the most common nail disorders encountered in dermatology practice and may be caused by dermatophytes, non-dermatophyte moulds, and yeasts. Although often considered a cosmetic problem, onychomycosis may cause pain, nail dystrophy, functional impairment, psychosocial distress, recurrent infection, and secondary bacterial complications.

The clinical presentation varies according to the route and site of fungal invasion. Distal and lateral subungual onychomycosis is generally the most frequent pattern, while proximal, superficial, endonyx, mixed, and total dystrophic forms are also recognized. Laboratory confirmation is important because nail dystrophy may also result from psoriasis, lichen planus, trauma, contact dermatitis, and nail tumours.

Increasing reports of antifungal resistance in superficial mycoses, including onychomycosis, have highlighted the need for organism identification and susceptibility testing before selecting therapy. This study was undertaken to evaluate the clinical patterns, etiological agents, and antifungal susceptibility profile of onychomycosis in patients attending a tertiary-care centre.

Materials and Methods

Study design and setting: This descriptive, observational study was conducted in the outpatient Department of Dermatology, Venereology and Leprosy, Rajkiya Medical College and Hospital, Jalaun, Orai, Uttar Pradesh, over one year from November 2022 to October 2023.

Participants: Patients attending the dermatology outpatient department with nail changes clinically suggestive of onychomycosis were screened. Patients with onycholysis, onychodystrophy, subungual hyperkeratosis, nail-plate discoloration, thickening, or crumbling of the nail plate were included if direct microscopy using potassium hydroxide demonstrated fungal elements. Patients with negative microscopy or those who had received antifungal therapy during the preceding month were excluded.

Clinical assessment and specimen collection: Demographic data, relevant medical history, clinical pattern, and nail involvement were recorded. Nail samples were collected after cleansing the affected nail with alcohol. In distal and lateral subungual onychomycosis, the nail was clipped proximally and subungual debris was obtained. In proximal, superficial, total dystrophic, and candidal patterns, samples were collected from the clinically active site of infection.

Mycological examination: Nail scrapings and clippings were examined by potassium hydroxide microscopy. Culture was performed on Sabouraud dextrose agar with chloramphenicol and incubated at room temperature. Fungal growth was assessed periodically, and isolates were identified by colony morphology and microscopic characteristics using lactophenol cotton blue. Dermatophytes were further characterized using dermatophyte test medium, slide culture, trichophyton agar, and in vitro hair perforation tests where applicable.

Antifungal susceptibility and statistical analysis: Susceptibility to terbinafine, fluconazole, itraconazole, and griseofulvin was assessed among culture-positive isolates using the susceptibility

testing method applied in the laboratory. Data were analyzed descriptively using SPSS version 17.0, and categorical variables were compared using the chi-square test where appropriate.

Ethical considerations: The study was conducted in accordance with institutional ethical standards. Written informed consent was obtained from all participants before enrolment, and patient confidentiality was maintained throughout the study.

Results

A total of 104 patients were included. The mean age was 35.93 years, with a range of 14 to 72 years. Fifty-one patients (49%) were aged 30 years or below, 28 (27%) were aged 30–50 years, and 25 (24%) were aged 50 years or above. Males accounted for 64 cases (62%) and females for 40 cases (38%).

Table 1. Detailed demographic and nail-site distribution of study participants

Characteristic	Category	Number (%)
Age group	≤30 years	51 (49%)
Age group	30–50 years	28 (27%)
Age group	≥50 years	25 (24%)
Sex	Male	64 (62%)
Sex	Female	40 (38%)
Nail involvement in males	Fingernail only	22 (34%)
Nail involvement in males	Toenail only	40 (63%)
Nail involvement in males	Both fingernail and toenail	2 (3%)
Nail involvement in females	Fingernail only	28 (70%)
Nail involvement in females	Toenail only	8 (20%)
Nail involvement in females	Both fingernail and toenail	4 (10%)
Fingernail distribution	Thumb	45 (40%)
Fingernail distribution	Index finger	28 (26%)
Fingernail distribution	Middle finger	18 (16%)
Fingernail distribution	Ring finger	14 (13%)
Fingernail distribution	Little finger	6 (5%)
Toenail distribution	Great toe	53 (46%)
Toenail distribution	Second toe	32 (28%)
Toenail distribution	Third toe	13 (11%)

Toenail distribution	Fourth toe	8 (7%)
Toenail distribution	Fifth toe	10 (8%)
Total participants	**Overall sample**	**104 (100%)**

Distal and lateral subungual onychomycosis was the most common clinical pattern, seen in 59 patients (57%). Mixed-pattern onychomycosis was observed in 17 patients (16%), total dystrophic onychomycosis in 13 (13%), proximal onychomycosis in 11 (10%), and endonyx onychomycosis in 4 (4%). Toenail involvement was more frequent among males, whereas fingernail involvement was more common among females.

Table 2. Detailed clinical patterns of onychomycosis

Abbreviation	Clinical pattern	Total, n (%)	Male, n (%)	Female, n (%)	Clinical interpretation
DLSO	Distal and lateral subungual onychomycosis	59 (57%)	32 (50%)	27 (67.5%)	Most frequent pattern; usually begins at the distal or lateral nail edge and progresses proximally.
MO	Mixed-pattern onychomycosis	17 (16%)	13 (20%)	4 (10%)	Represents combined clinical patterns in the same patient or nail unit.
TDO	Total dystrophic onychomycosis	13 (13%)	9 (14%)	4 (10%)	Advanced disease with extensive nail plate destruction and dystrophy.
PO	Proximal onychomycosis	11 (10%)	9 (14%)	2 (5%)	Less common pattern beginning near the proximal nail fold or matrix region.
EO	Endonyx onychomycosis	4 (4%)	1 (2%)	3 (7.5%)	Uncommon form characterized by nail-plate invasion without marked nail-bed hyperkeratosis.
Total	**All clinical patterns**	**104 (100%)**	**64 (100%)**	**40 (100%)**	**DLSO was the predominant clinical pattern in both sexes.**

Culture was positive in 55 patients (53%) and negative in 49 patients (47%). Among culture-positive cases, dermatophytes were isolated in 35 cases (64%), non-dermatophyte moulds in 13 (24%), and yeasts in 7 (12%). *Trichophyton rubrum* was the predominant isolate, followed by *Trichophyton mentagrophytes*, *Aspergillus* species, *Candida* species, *Epidermophyton floccosum*, and *Fusarium* species.

Table 3. Detailed culture results and etiological distribution of isolates

Section	Category / isolate	Number	Percentage	Interpretation
Culture result among all clinically suspected cases	Culture positive	55	53% of total cases	Confirmed fungal growth was obtained in just over half of the study population.
Culture result among all clinically suspected cases	Culture negative	49	47% of total cases	Direct microscopy-positive cases without culture growth may reflect nonviable fungi, prior partial treatment, sampling variation, or culture limitations.
Etiological group among culture-positive cases	Dermatophytes	35	64% of culture-positive isolates	Dermatophytes were the predominant etiological group.
Etiological group among culture-positive cases	Non-dermatophyte moulds	13	24% of culture-positive isolates	Non-dermatophyte moulds formed the second most common group.
Etiological group among culture-positive cases	Yeasts	7	12% of culture-positive isolates	Yeasts were less frequent but clinically relevant, especially in nail infections involving chronic wet exposure.
Individual isolate	*Trichophyton rubrum*	19	34% of culture-positive isolates	Most common individual isolate.
Individual isolate	*Trichophyton mentagrophytes*	11	20% of culture-positive isolates	Second most common dermatophyte isolate.
Individual isolate	*Aspergillus* species	10	18% of culture-positive isolates	Most frequent non-dermatophyte mould group.
Individual isolate	*Candida* species	7	13% of culture-positive isolates	Principal yeast isolate group.
Individual isolate	*Epidermophyton floccosum*	5	9% of culture-positive isolates	Less common dermatophyte isolate.
Individual isolate	*Fusarium* species	3	6% of culture-positive isolates	Less frequent non-dermatophyte mould isolate.

Total	**Culture-positive isolates**	**55**	**100%**	***Trichophyton rubrum* was the leading isolate, and dermatophytes were the dominant etiological group.**

Terbinafine showed the highest sensitivity among the tested antifungal agents, with 44 isolates (80%) sensitive and 11 (20%) resistant. Fluconazole sensitivity was observed in 37 isolates (67%), itraconazole sensitivity in 32 isolates (58%), and griseofulvin sensitivity in 28 isolates (51%).

Table 4. Detailed antifungal susceptibility pattern among culture-positive isolates

Antifungal agent	Total isolates tested	Sensitive isolates, n (%)	Resistant isolates, n (%)	Sensitivity rank	Interpretation
Terbinafine	55	44 (80%)	11 (20%)	1	Showed the highest in vitro sensitivity among the tested agents in this study.
Fluconazole	55	37 (67%)	18 (33%)	2	Showed moderate in vitro sensitivity; interpretation should consider the causative organism and clinical context.
Itraconazole	55	32 (58%)	23 (42%)	3	Showed intermediate in vitro sensitivity, with resistance observed in a substantial proportion of isolates.
Griseofulvin	55	28 (51%)	27 (49%)	4	Showed the lowest in vitro sensitivity among the tested agents, with resistance observed in nearly half of isolates.
Overall finding	**55**	**Highest: terbinafine, 44 (80%)**	**Highest resistance: griseofulvin, 27 (49%)**	—	**Overall, terbinafine showed the highest in vitro sensitivity, whereas griseofulvin showed the least favourable susceptibility profile among the tested agents.**

Discussion

This study demonstrates that onychomycosis continues to be an important superficial fungal infection in dermatology practice, affecting predominantly young and middle-aged adults. The observed male predominance may reflect greater exposure to occupational trauma, occlusive footwear, and

environmental fungal reservoirs. The higher frequency of fingernail involvement among females may be related to wet work and repeated exposure to household detergents and water.

Distal and lateral subungual onychomycosis was the dominant clinical pattern, consistent with the usual route of fungal entry through the distal nail bed and lateral nail folds. Mixed and total dystrophic patterns reflected more extensive nail-unit involvement and may represent progression from earlier clinical forms. Although proximal and endonyx onychomycosis were less common, their recognition remains important because they may be associated with specific host or organism-related factors.

Dermatophytes were the leading etiological agents, and *Trichophyton rubrum* was the most frequent isolate, supporting its established role as the principal pathogen in nail dermatophytosis. The isolation of non-dermatophyte moulds and yeasts also emphasizes the changing etiological spectrum of onychomycosis and reinforces the need for culture-based diagnosis rather than reliance on clinical appearance alone.

Terbinafine showed the highest in vitro sensitivity in this study, followed by fluconazole, itraconazole, and griseofulvin. These findings support the continued utility of terbinafine as a systemic option for many dermatophyte-associated cases, while emphasizing that treatment selection should also consider the causative organism, clinical severity, extent of nail involvement, patient-related factors, and local susceptibility patterns, particularly when non-dermatophyte moulds or yeasts are isolated or when treatment failure is suspected.

Limitations

This study has certain limitations. It was conducted at a single tertiary-care centre with a relatively modest sample size, which may limit the generalizability of the findings to other populations or geographic settings. Antifungal susceptibility testing was performed only among culture-positive isolates; therefore, the susceptibility profile may not represent all clinically suspected cases. In addition, treatment response and long-term recurrence were not assessed, limiting the ability to correlate in vitro susceptibility patterns with clinical outcomes. Larger multicentre studies using standardized susceptibility methods and follow-up of therapeutic response are needed to further validate these findings.

Conclusion

In this study, onychomycosis showed male predominance and most commonly affected young and middle-aged adults. Distal and lateral subungual onychomycosis was the most common clinical pattern. Dermatophytes were the predominant etiological agents, with *Trichophyton rubrum* as the leading isolate. Terbinafine demonstrated the highest in vitro antifungal sensitivity among the agents tested. Accurate clinical classification, laboratory confirmation, organism identification, and antifungal susceptibility testing may support more rational therapeutic decision-making and help reduce treatment failure and recurrence.

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Conflicts of Interest

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