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Onychoscopy: a quick and effective tool for diagnosing onychomycosis in a resource-poor setting

Neirita Hazarika[1]✉, Payal Chauhan[2], Divyalakshmi C[1], Naveen Kumar Kansal[1], Yogesh Arvind Bahurupi[3]

[1]Department of Dermatology, Venereology, and Leprosy, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India. [2]Department of Dermatology, Venereology, and Leprosy, Himalayan Institute of Medical Sciences, Rishikesh, Uttarakhand, India. [3]Department of Community and Family Medicine, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India.

Abstract

Introduction: Onychomycosis is the most prevalent nail disease. Although clinical diagnosis of onychomycosis is easy, fungal culture as a confirmatory test requires an equipped laboratory and is time-consuming. Onychoscopy is a simple, quick, and inexpensive technique and may help clinicians increase the diagnostic accuracy of onychomycosis. The aim of this study was to identify common onychoscopic patterns of onychomycosis and correlate them with clinical subtypes of onychomycosis.
Methods: This study was performed in the dermatology outpatient department of a tertiary care hospital in northern India for 6 months. Clinically diagnosed cases of onychomycosis were confirmed by potassium hydroxide (KOH) mount. After obtaining informed written consent, these patients underwent onychoscopy with DermLite II hybrid m, 3Gen, polarized mode, 10× magnification. The common onychoscopic patterns were recorded and the data analyzed.
Results: The study included 60 confirmed cases of onychomycosis. The common onychoscopic patterns observed were jagged edges with spikes of the onycholytic area in 65.5% of cases, longitudinal striae in 77.6%, distal irregular termination or a "ruin pattern" in 82.7%, and chromonychia in 62.1%. Clinical types of onychomycosis showed a statistically significant association with chromonychia ($p = 0.000$), jagged edges with spikes ($p = 0.015$), and distal irregular termination ($p = 0.016$).
Conclusions: Onychoscopy can be a complementary tool in clinical diagnosis of onychomycosis to alleviate the need for direct microscopy and culture.

Keywords: distal lateral subungual onychomycosis (DLSO), nail fungus, onychomycosis, onychoscopy, total dystrophic onychomychosis (TDO)

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Introduction

Onychomycosis is the most prevalent nail disease, amounting to about 50% of all onychopathies (1). Important differential diagnosis of onychomycosis includes psoriasis, trauma, lichen planus, and eczema. An accurate diagnosis is important, and it is desirable to confirm the presence of hyphae by microscopy or culture. Sensitivity values are reported from 23 to 84.6% for culture, about 44 to 100% for potassium hydroxide (KOH) mount, and about 81 to 91.6% for biopsy. Currently, there is no consensus on the most appropriate combination of tests that can increase the sensitivity and specificity of diagnosis. The sensitivity values reported for test combinations are 57% for biopsy and KOH, and 98.3% for biopsy and culture (2).

Onychoscopy is dermoscopic examination of the nail apparatus, which includes the nail plate surface and the free edge, nail matrix, nail bed, periungual folds, and hyponychium. It forms a link between naked eye examination and nail histopathology, opening the potential to prevent biopsy (3).

Piracini et al. were the first to use dermoscopy to support the diagnosis of fungal infection of nails. Their retrospective study of 57 patients sought to identify and describe dermoscopic signs specific for distal subungual onychomycosis that could differentiate it from traumatic mycologically negative onycholysis (4).

Very few studies are available in the literature on onychoscopic findings of onychomycosis in Indian patients. The aim of this study was to identify common onychoscopic patterns of onychomycosis prevalent in this part of India, explore their correlation with clinical subtypes of onychomycosis, and contribute to knowledge of the use of onychoscopy as a simple, quick, and reliable diagnostic aid for clinical diagnosis of onychomycosis in the outpatient department setting.

Materials and methods

This was an outpatient-based, observational, cross-sectional study conducted for 6 months using the STROBE checklist, after obtaining institutional ethical clearance. Patients were recruited after providing informed written consent (in Hindi or English) for inclusion in the study as well as separate consent for photography.

The aim of the study was to identify common onychoscopic patterns in nails affected by onychomycosis and to describe their correlation to the clinical subtypes of onychomycosis. The inclusion criteria were all treatment-naive patients presenting to the dermatology outpatient department for the first time and clinically diagnosed with onychomycosis. Children below 18 years, patients already partially treated for onychomycosis, patients with clinical diagnosis of onychomycosis but negative on KOH mount were excluded from the study.

Nail clippings of all patients were taken for KOH mounting. Only patients with a positive KOH mount were recruited for the study. Images of the affected nail were obtained with a Canon PowerShot G1x® camera. Onychoscopy was performed with DermLite II hybrid m, 3Gen, polarized mode, 10× magnification. An IPhone camera was used to capture the images. The image from the most clinically dystrophic nail unit, whether fingernail

✉ Corresponding author: neiritahazarika@yahoo.com

or toenail, from each patient was taken for analysis. The demographic, clinical, and onychoscopic findings of each patient were recorded and analyzed.

Statistical analysis was performed using SPSS software (version 23; SPSS Inc., Chicago IL, USA); descriptive statistics were used to describe continuous variables, and a chi-squared (or Fisher's exact) test was used to examine the relationship between categorical variables. A p-value < 0.05 was considered significant.

Table 1 | **Clinico-dermographic characteristics of the study population.**

Variable	*n* (%)
Sex	
Male	47 (78)
Female	13 (22)
Age (years)	
1–20	6 (10)
21–40	31 (52)
41–60	18 (30)
61–80	5 (8)
80–100	0
Occupation	
Agricultural worker	16 (27)
Office worker	10 (17)
Student	11 (18)
Other semiskilled worker	14 (23)
Housewife	4 (7)
Retired	1 (2)
Unemployed	4 (7)
Occlusive footwear use › 10 hours	
Present	41 (68)
Absent	19 (32)
History of prior trauma to affected nail	
Present	22 (37)
Absent	38 (63)

Results

This study included 60 cases of onychomycosis, confirmed by KOH mount. Males (n = 47, 78.3%) outnumbered females. The majority (n = 31, 51.7%) were between 21 and 30 years old. A history of occlusive footwear use (≥ 10 hours) was present in 68.3% (n = 41). A history of prior trauma to the affected nail was present in 36.7% (n = 22). Distal lateral subungual onychomycosis (DLSO), at 56.7% (n = 34), was the predominant clinical subtype encountered, followed by total dystrophic onychomycosis (TDO), constituting 40.0% (n = 24). One case each of white superficial onychomycosis (WSO) and proximal subungual onychomycosis (PSO) was encountered, and both were excluded from the statistical tests. The endonyx type of onychomycosis was not encountered. The clinico-demographic characteristics of all patients are shown in Table 1.

The onychoscopic findings observed were jagged edges with spikes of the onycholytic area in 65.5% (n = 38/58), longitudinal striae in 77.6% (n = 45/58), distal irregular termination or a "ruin pattern" in 82.7% (n = 48/58), and chromonychia in 62.1% (n = 36/58). A linear edge of onycholysis was seen in 8.6% (n = 5/58). Figure 1 shows the images of different onychoscopic findings.

Onycholysis (97.1%) and jagged edges with spikes (79.4%) were more common in DLSO. Predominant findings in TDO were

Table 2 | **Relation between clinical types of onychomycosis and onychoscopic findings.**

Variable	Onychomycosis type				Total	Pearson's chi-squared test
	Distal lateral	White superficial**	Proximal subungual**	Total dystrophic		
Number of cases	34	1	1	24	60	
Dermoscopic features						
Jagged edges with spikes	27	0	0	11	38	0.015
Longitudinal striae: "aurora borealis"	26	0	0	19	45	0.100
Distal irregular termination "ruin pattern"	26	0	0	22	48	0.016
Chromonychia	12	0	0	24	36	0.000
Linear edge of onycholysis	3	0	0	2	5	0.979

**Excluded from statistical tests.

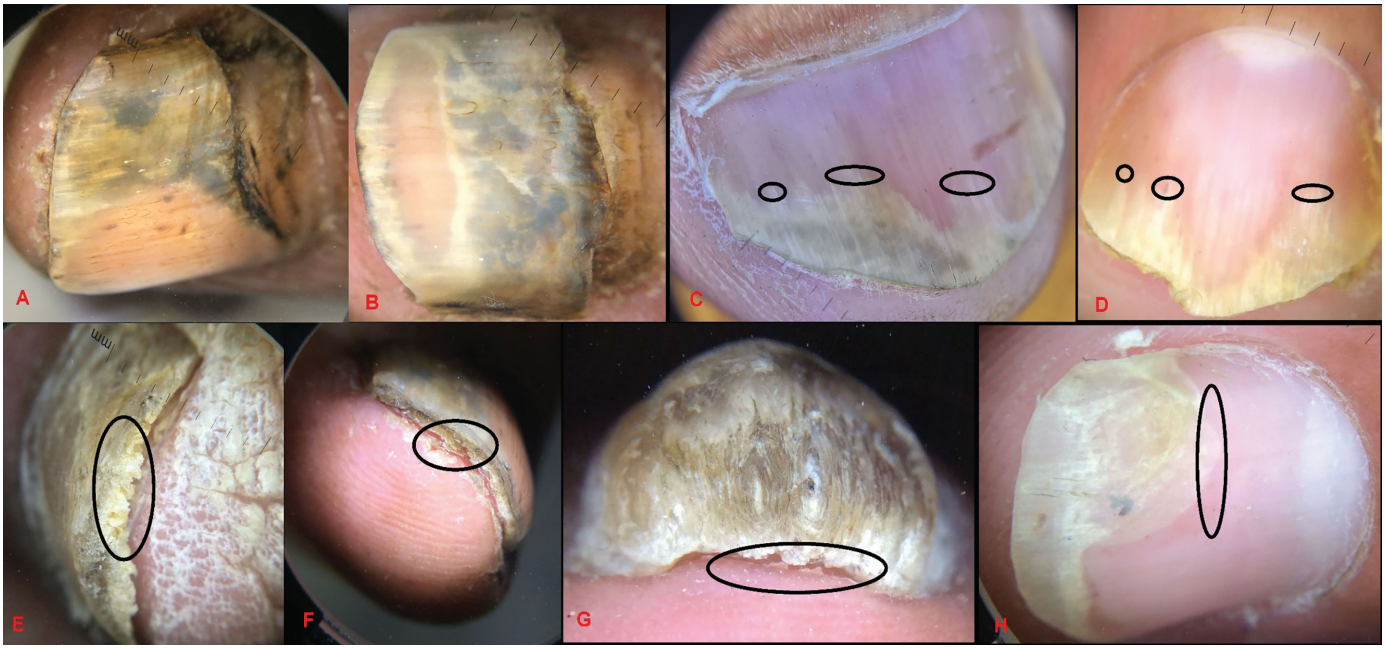

Figure 1 | Panels A and B show longitudinal striae of multiple colors resembling the "aurora borealis pattern"; Panels C and D show jagged proximal edges of onycholysis with a longitudinal spike pattern marked with O; Panels E, F, and G show distal irregular termination of subungual hyperkeratosis, also called the "ruin pattern"; Panel H shows psoriatic onycholysis, which lacks the longitudinal spikes usually seen in onychomycosis.

chromonychia (100%), longitudinal striae (79.2%), and distal irregular termination (91.7%). A statistically significant association was seen between the clinical type of onychomycosis and chromonychia ($p = 0.000$), jagged edges with spikes ($p = 0.015$), and distal irregular termination ($p = 0.016$); see Table 2.

Discussion

Dermoscopic examination for onychomycosis was first performed by Piraccini et al. (4). They identified specific onychoscopic signs for onychomycosis; that is, a jagged proximal edge with spikes of the onycholytic area and longitudinal striae. In contrast to onychomycosis, traumatic onycholysis consisted of linear edges without peaks in the area of onycholysis (4).

In this study, males (78.3%) outnumbered females; this was similar to the findings of Yorulmaz et al. (5). However, a female preponderance of onychomycosis has been reported in few other studies (6–8). Male preponderance in this study may be due to the fact that the majority of patients were agricultural workers (26.7%), followed closely by semiskilled workers (drivers, shopkeepers, masons, mechanics, cooks, or barbers) at 23.3%; both of these are male-dominated occupations in this part of India. These occupations also require working in hot, humid, and moist conditions. Lifestyle, including wearing occlusive footwear, environmental conditions, and nail injuries have been listed as among the factors predisposing to onychomycosis occurrence and relapse (9). A history of occlusive footwear use (≥ 10 hours) was present in 68.3% of our patients, and prior trauma to the affected nail was present in 36.7% of the patients.

Among the clinical types of onychomycosis in this study, DLSO was seen in 56.7%. DLSO is the most common type of onychomycosis, with a prevalence of 43.2% to 85% (5, 8, 10). TDO was seen in 40% ($n = 24$) of patients in this study, which was consistent with other studies (5, 10). Only one case each of WSO and PSO were encountered. WSO is less common and is estimated to comprise less than 10% cases of onychomycosis (11). PSO is the most infrequent form of onychomycosis in the general population; however, it is common in AIDS patients and is considered an early clinical marker of HIV infection (12).

The onychoscopic feature of jagged edges with spikes is defined as jagged edges with spikes of the whitish longitudinal lines, seen on the proximal side of the onycholytic area and extending proximally in the nail plate (13). In this study, jagged edges with spikes were seen in 65.5% of the total cases. They were seen more in DLSO (77.6%, $n = 27/34$), and this association was statistically significant ($p = 0.015$). The onychoscopic feature of longitudinal striae refers to longitudinal lines with irregular matted pigmentation of different colors (i.e., white, yellow, orange, and brown, hence also called the "aurora borealis pattern") that can be seen in the onycholytic nail plate (3, 14). In this study, longitudinal striae were seen in 77.6%, as in other studies (6–8). De Crignis et al. (15) postulated that the longitudinal striae pattern is a result of the direction of fungal invasion. The fungus moves across the nail bed along the rete ridges, in a proximal direction from the distal end, and it forms the specific longitudinal striae pattern. The various colors in longitudinal striations are secondary to colony formation, flakes, or subungual debris (10).

Longitudinal striae and jagged spikes are the most common finding in onychomycosis on onychoscopy, and they aid clinical diagnosis of onychomycosis in cases of negative laboratory results (16). Nada et al. (8) stated that, in positive KOH nails, 80.9% had spikes and 90.4% had longitudinal striations. According to these authors, the best diagnostic dermoscopic finding in onychomycosis is longitudinal striations because they have the highest sensitivity, specificity, and accuracy values. In contrast, Piraccini et al. (4) stated that spikes are a better diagnostic onychoscopic finding in onychomycosis than longitudinal striations, although both spikes and longitudinal striations had the high specificity (100%).

Distal irregular termination or a "ruin appearance" refers to the end of the thickened nail plate ending with an irregular and crumbly appearance (13). In this study, distal irregular termination was seen in 82.7% of cases. De Crignis (15) reported distal irregular termination in 88% (1). In this study, association of distal irregular termination with the clinical type of onychomycosis was statistically significant ($p = 0.016$). According to Kaynak et al. (13), in nails with a ruin appearance, fungus can be found 4.3 times more often, and this onychoscopic finding had high positive predictive values.

In this study, 8.6% ($n = 5$) of the cases had a linear edge of onycholysis. Three of these cases gave a history of preceding nail trauma. In a study by Chetana et al. (6), the presence of a linear edge pattern was seen in DLSO, which they attributed to trauma preceding onychomycosis. Piraccini et al. (4) stated that traumatic onycholysis has a linear edge of onycholysis without a sharp spiked border unlike onychomycotic onycholysis, which has jagged proximal edges with spikes. In the five cases with a linear edge of onycholysis in this study, trauma to the nail may have been one of the preceding events prior to the development of onychomycosis.

Chromonychia was seen in 62.1% of patients in this study, and the colors ranged from white, green, and yellow to brown and black. This was similar to the findings by Chetana et al. (6), whereas Nada et al. (8) described chromonychia in 95%. Karaarslan et al. stated that multicolored, matte black, matte white, or yellow to brown pigmentation, black pigment aggregates, a black reverse triangle, superficial transverse striation, and a blurred appearance of pigmentation were the exclusive dermoscopic features of chromonychia in onychomycosis (17).

Fungal melanonychia shows brown or black discoloration of the nail plate caused by a fungal infection that has been proven mycologically or histopathologically (18). This melanonychia is due to some strains of dermatophytes producing a soluble, nongranular melanin that stains the nail plate brown to black (19). In infections with *Trichophyton rubrum*, this pigmentation is caused by a diffusible black pigment produced by the fungus, thought to be a dopamelanin (20, 21). In infections with *Scytalidium dimidiatum*, this pigmentation results from the presence of large numbers of pigmented hyphae. Fungal melanonychia is an important differential diagnosis of the nail unit melanoma. In fungal melanonychia, the pigmentation is wider distally at the hyponychium than proximally because most onychomycoses extend from the distal to proximal portion of the nail. In contrast, a wider diameter at the proximal end of the nail, resulting in a triangular shape of melanonychia, can be seen in melanomas (22). In addition, multiple, longitudinal, irregular bands of different colors (i.e., black, brown, and gray) with irregular spacing and thickness, and disruption of parallelism are characteristic onychoscopic features of nail unit melanoma. In addition, performing dermoscopy on the cuticle may reveal pigment within the skin of the cuticle that is otherwise not visible to the unaided eye. This is known as the micro-Hutchinson sign and is indicative of melanoma. In addition, pigmentation on the hyponychium with a parallel ridge pattern is

also highly suggestive of melanoma (22).

The onychoscopic features of the other differential diagnoses of onychomycosis (i.e., nail psoriasis and nail lichen planus) are quite distinctive from onychomycosis. In nail psoriasis, onychoscopy shows an erythematous border of onycholysis with globose, dilated blood vessels surrounded by a prominent halo. Salmon patches appear as irregular red to orange patches. Splinter hemorrhages are seen as longitudinal brown, black, or purple linear hemorrhages oriented along the direction of nail growth. The hyponychium and proximal nail fold in nail psoriasis show a characteristic vascular pattern of psoriasis in onychoscopy. In lichen planus of the nails, the onychoscopic findings described are trachyonychia, pitting, pterygium, red lunula, chromonychia, nail fragmentation, splinter hemorrhages, onycholysis, and subungual keratosis (3).

To summarize, in KOH-positive nails, jagged edges with spikes of the onycholytic area were seen in 65.5%, longitudinal striae in 77.6%, and distal irregular termination or a "ruin pattern" in 82.7% of the total cases in this study. These onychoscopic findings have been described as exclusive to onychomycosis in previous studies (4, 8, 16). Jagged edges with spikes (79.4%) were more common in DLSO, whereas the predominant findings in TDO were chromonychia (100.0%), longitudinal striae (79.2%), and distal irregular termination (91.7%). The strong point of this study was that all cases were mycologically confirmed cases of onychomycosis. The small sample size is a limitation of this study.

Mycological testing for confirmation of onychomycosis requires trained personnel and diagnostic tools. The simplest setup of a microscope, KOH, and so on may not be available in small clinics or primary healthcare facilities in resource-poor countries. It is also difficult to refer patients to specialized centers for economic reasons. In addition, the results of fungal culture take 4 to 6 weeks. Thus, for routine purposes, mycological testing for onychomycosis may not be a viable option before treatment. In this scenario, the use of onychoscopy as a complimentary aid in diagnosis of onychomycosis can alleviate the need for fungal microscopy. Mycological testing can also be avoided when onychoscopy does not show diagnostic signs of onychomycosis. However, fungal cultures remain necessary in order to obtain an etiological diagnosis of onychomycosis; antifungal sensitivity studies are also required when an antifungal drug fails and in recurrences.

In conclusion, onychoscopy can serve as a quick and effective tool to aid clinical diagnosis of onychomycosis in a resource-poor setting like India.

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