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Dermoscopy Of Onychomycosis: A Literature Review

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Abstract

Background: Onychomycosis is a fungal infection of the nails. Onychomycosis is caused by dermatophytes, non-dermatophyte molds, and non-dermatophyte fungi. Dermoscopy examination has gradually been used as a modern diagnostic method to assess non-invasive nail abnormalities that are easy and inexpensive to visualize abnormal microscopic features of the nail. However, it is still uncommon for medical personnel to diagnose onychomycosis using dermoscopy.
Purpose: To provide information on the benefits of the nail dermoscopy technique that can diagnose onychomycosis and describe observable dermoscopic findings.
Results: Dermoscopy findings on onychomycosis showed a diverse picture depending on the type.
Distal and lateral subungual onychomycosis shows the proximal margin of the onycholytic area with spikes leading to proximal folds and longitudinal striae. White superficial onychomycosis shows large, brittle, irregularly spreading white-yellow patches on the nail's surface. Proximal subungual onychomycosis has one or more transverse white bands on the inner nail plate, while total dystrophic onychomycosis shows longitudinal striae and spikes and irregular distal terminations.
Conclusion: Nail dermoscopy improves quality and simplifies examination to establish the diagnosis of onychomycosis because it can guide clinicians in conducting screening, choosing the best time for mycological sampling, and making therapeutic decisions.
Keywords: dermatophytic infections , diagnostic tools, dermoscopy, onychomycosis

Introduction

Onychomycosis is a general term to describe diseases caused by fungal infections of the nails. The etiology of onychomycosis includes dermatophytes, non-dermatophyte molds (NDMs), and non-dermatophyte fungi. Toenails are the most frequent predilection. It is seven to ten times more often than fingernails. This is due to the fact that the growth of fingernails is three times faster compared to toenails [1]. Onychomycosis can cause problems with discomfort, lack of confidence, difficulty using footwear and walking, as well as cosmetic problems[2]. Infected nails have the potential to spread to the feet, hands, and creases of the thighs. Fungal infections, especially caused by dermatophytes, are generally highly contagious and can be transmitted to other family members if left untreated[4]. Onychomycosis can cause impaired skin integrity and become a breeding ground for bacteria that can develop into foot ulcers, osteomyelitis, cellulitis, and gangrene, especially in diabetic patients[3].

Clinicians must be able to establish the diagnosis of onychomycosis to seek ideal management. Some of the conditions of nail dystrophy that resemble onychomycosis include chronic trauma, psoriasis, onycholysis, onychogryphosis, subungual malignant melanoma, and lichen planus[1]. The search for new and optimal diagnostic methods for the diagnosis of onychomycosis continues. Dermoscopy examination has gradually been used as a modern diagnostic method to assess nail abnormalities (onychoscopy)[4]. Nail dermoscopy (onychoscopy) is a non-invasive examination that is easy and inexpensive to perform and is capable of visualizing abnormal microscopic features of the nail. Dermoscopy findings differ in each classification of onychomycosis such as jagged proximal edges from the onycholytic

region with longitudinal striae and spike feature to longitudinal melanonychia with white or yellow bands[5].

Dermoscopy examination to diagnose onychomycosis is still not commonly performed by medical personnel, a literature review is needed that discusses the benefits of nail dermoscopy techniques that can be used to diagnose onychomycosis and explains the observable dermoscopic findings to reduce the misdiagnosis of onychomycosis with its differential diagnosis.

Definition of onychomycosis

Onychomycosis comes from the Greek words "onyx" which means nail and "mykes" which means fungus. Onychomycosis accounts for 40-50% of onychopathy and about 30% of fungal skin infections[6].

Epidemiology of onychomycosis

Onychomycosis is the most common nail disease with a worldwide prevalence of 5.5%. The prevalence in the United States is estimated at 2% to 14%. Onychomycosis is common in the elderly and the prevalence increases with age. The prevalence of onychomycosis in the world reaches 0.44% to 2.6% in children and 20.7% in adults aged >60 years[7]. The majority of onychomycosis is caused by dermatophytes and yeast while 10% of the causes of onychomycosis are NDMs[8]. The report on onychomycosis patient visits at the Mycology Division of the Dermatology and Venereology Polyclinic of Dr. Cipto Mangunkusumo Hospital in 2014 reported that there were 205 new cases out of a total of 1471 new patient visits, of which 90% were caused by candidiasis. The dermatophytes that are widely reported as causes of onychomycosis are Trichophyton rubrum and Trichophyton mentagrophytes[9].

Etiology of onychomycosis

Onychomycosis is more common especially in individuals with old age, wearing closed-toed footwear, sharing shower floor space, recurrent nail trauma, smokers, hyperhidrosis, history of tinea pedis, genetic predisposition, comorbid diseases such as diabetes, poor peripheral circulation, HIV infection, consumption of immunosuppressive drugs and other immunocompromised diseases[4].

Onychomycosis can be inherited in autosomal dominant manner through *Human leukocyte antigene-DR8*[10]. Foot dermatophyte and toenail infections often occur in families who live in the same house. The risk of transmission to other family members when one family member is affected is 44% to 47%.11 Onychomycosis is also more common in psoriasis patients with a 50% probability when compared to the non-psoriasis population[11]. **Table 1** displays the risk factors associated with onychomycosis.

Table 1. Risk factors associated with onychomycosis13

Variables	Descriptions
Dermatological conditions	Tinea pedis, psoriasis, hyperhidrosis
Comorbid	Diabetes, immunocompromised (HIV, patients on chemotherapy, transplant history, dialysis), venous insufficiency, malignancy, peripheral arterial disease (PAD), obesity, and inflammatory bowel disease (IBD)
Exogenous factors	Trauma, poor nail care, sports habit, occupation, smoking, and closed-toed footwear

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Others	Increased age, genetics, hallux valgus, nail gait asymmetry syndrome, history of contact with family members with onychomycosis

Classification of onychomycosis

The general classification of onychomycosis based on the clinical feature consists of distal and lateral subungual onychomycosis (DLSO), white superficial onychomycosis (SO), proximal subungual onychomycosis (PSO), endonyx onychomycosis (EO) and total dystrophic onychomycosis (TDO)[9]. **Table 2** describes the clinical features and infection patterns of each classification.

Establishing of the diagnosis of onychomycosis

Conventional diagnosis of onychomycosis is carried out through evaluation of the cause of onychomycosis in culture media. Based on the Walshe and English criteria, dermatophytes are considered as the cause if dermatophytes are found in culture, if non-dermatophytic molds or yeasts is discovered, it is considered as the cause if at the direct examination, the appropriate fungal elements are found and if non-dermatophytic molds is discovered, it is considered as the cause if at least 5 inoculums out of 20 inoculums are found without the discovery of dermatophytes[9].

The Walshe and English criteria are considered to have weaknesses because NDMs is often a contaminant in the nail and laboratory. Non-dermatophytic molds have a high probability of false negatives in the culture medium, so repeated culture sampling is required to be carried out serially with an interval of one to two weeks and the number of sample repeats is at least two or three times. This repeated sampling is recommended by Gupta et al. in 2001 who report the weakness of calculating the number of inoculums isolated at one time[12].

The diagnosis establishment of onychomycosis can be conducted clinically and confirmed by examination of 10–30% KOH, fungal cultures, Sabouraud dextrose agar (SDA), or potato dextrose agar (PDA) with or without antibiotics and/or nail plate biopsy with Periodic Acid Schiff staining (PAS)[6].

Table 2. Classification of onychomycosis[9,12]

Types of onychomycosis	Clinical Features	Etiology	Infection patterns	Annotation
DLSO	Starting in the distal part of the hyponychium and spreading to the nail plates and beds; debris; hyperkeratosis; onycholysis; thickened, peeling, dystrophic, yellow or blackish-brown nails; infection spreads to the proximal forming linear lines or spikes that can make therapy difficult, may be accompanied by paronychia	*Epidermophyton floccosum, T. mentagraphytes, T. rubrum, Fusarium sp., Scopufariopsis brevicaulis, Neoscytalidium sp., C. albicans, Acremonium sp., Aspergillus sp*	Fungal invasion through the interstices of the nails on the lateral part or under the surface of the nail	The most common forms
EO	Nails appear milky white,	*T. saudanense,*	The fungus	Rare;

	indented, without hyperkeratosis and onycholysis	*T. violoceum*	invades the entire nail thickness directly from under the skin without infecting the nail beds	considered a subtype form of DLSO
PSO	Debris accumulates under the proximal part of the nail, causing onycholysis and whitish color, and spreading to the distal	*T. rubrum, Aspergilus sp., Fusarium sp., C. albicans, Scopulariopsis brevicoulis*	The fungus invades the proximal nail folds and cuticle; can develop from paronychia	Indicates an immunocompromised condition (e.g. HIV infection)
SO	Powder-like patches appear on the transverse line on the surface of the nail	*T. mentagraphytes, T. rubrum, Acremonium sp., Fusarium sp., Neoscytalidium sp., Aspergillus sp*	It can arise in the superficial nail plate or emerge from under the nail crease; or deep penetration of superficial infections	It used to be known as PSO, however some organisms produce black debris
TDO	Total damage to the nail due to chronic infection; thickening of the nails and the structure of the nails disappearing	*Candida sp*	It can come from all types of onychomycosis however the most common is due to severe DLSO	Usually in immunocompromised conditions

a. Anamnesis

Patients with onychomycosis often complain of nail discoloration, nail separation, brittleness, or thickening that frequently deteriorates over time. A history of tinea pedis or foot hyperhidrosis is frequently a comorbidity. Nails affected by onychomycosis can generate local pain, and difficulties in putting on shoes to affect social functions such as work and communication, and harm the quality of life. A thorough examination is required, including specifically asking about previously experienced nail problems. History of treatment (oral or topical medications) should be evaluated including history of prior use of antifungal medications previously started and stopped as they may affect diagnostic and therapeutic testing[11,13].

b. Physical examination

In evaluating patients with nail disease, all hand and toe nail units should be examined. Patients are instructed to remove all nail polish before the examination. Onychomycosis most often involves toenails. Typical physical examination findings include nail base hyperkeratosis which often leads to varying degrees of nail plate

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onycholysis. White or yellow discoloration of the nail plates is frequent as well as the formation of subungual debris. In chronic or severe cases, extensive onychodystrophy can occur with thickening of the nail plate, brittleness, jaggedness, onychocryptosis, and partial or complete loss of the nail. Dermatophytoma or fungal abscess is an elongated white/yellow or orange/brown line on the nail plate and is quite specific to onychomycosis. Onychomycosis can occur at the same time as other nail malignancies so that if a significant nail dystrophy or failure in antifungal administration is found, even if there is laboratory evidence of a fungal infection, a biopsy specimen of the nail must be taken immediately[14].

c. Supporting examinations

Supporting examinations should be conducted before starting treatment for onychomycosis. Supporting examination modalities such as direct microscopy, fungal culture, histopathology, and PCR can be used to identify infectious organisms quickly **(Table 3)**[13,15].

Table 3. Modalities for the examination of onychomycosis[13]

Modalities	Sensitivities	Specificities	Advantage	Shortcomings
KOH	61% (44-100%)	95 (75-100%)	Easy to do, inexpensive, and quick results (15 to 60 minutes)	Diagnostic accuracy depends on the examiner, unable to identify pathogen subtypes
Fungal Culture	56% (29-82%)	99% (83-100%)	Can identify pathogen subtypes	Low sensitivity
Histopathology	84% (61-93%)	89 (44-100%)	The most sensitive conventional mycology tests	Expensive and unable to identify pathogen subtypes
PCR	85%	94%	Can identify pathogen subtypes, high sensitivity, can perform examinations in small sample sizes	Cannot be performed on thick nail beds, assay regimens are still in development and risk false positives
Dermoscopy	Jagged onycholytic edges with spike feature:	Jagged onycholytic edges with spike feature:	Bedside and non-invasive examination, fast results, and	Unable to indicate the occurrence of specific fungi

	86.4% - 100% Longitudinal striae:25%-86.5% Brittle appearance: 59.1% Homogeneous opacity: 34.1%	58.3% - 100% Longitudinal striae:83.3%-100% Brittle appearance: 91.7% Homogeneous opacity: 83.3%	inexpensive examinations

NAIL DERMOSCOPY

a. Dermoscopy Definition

Nail dermoscopy (onychoscopy) is a non-invasive bedside examination that visualizes the microscopic features of abnormal nails[16]. Nail dermoscopy examinations are fast, non-invasive, and inexpensive so they have the potential to help clinicians identify onychomycosis at the bedside and decide to go to mycological evaluation[17].

b. Dermoscopy technique

The technique of examining nail dermoscopy begins with a basic understanding of the anatomy of the nail. The next step is to understand the focus area and use of gel media. Technical problems can occur due to convex nail plates that interfere with the full attachment of the lens to the nail surface, necessitating the use of a large amount of gel media (e.g., ultrasound gel). The operator needs to move the dermatoscope in different positions to see the entire nail unit including the proximal and lateral folds, the hyponychium, and the distal edge of the nail to the nail base visible through the plate. Dermatoscopes allow the observation of many nail abnormalities even at low magnification. The dermatoscope examination may begin with a low magnification and then increase the magnification for better observation with an estimated 15-20 minutes duration for a thorough and complete examination. Dermoscopy examination techniques are recommended to begin with an examination without gel application followed by gel application. Nail epithelial dermoscopy includes proximal and hypotonic nail folds. The use of *ultrasound* gel and a magnification range of 10x to 40x is recommended. Periungual capillaries (in proximal and hypotonic nail folds) can be evaluated with higher magnification (40x, 50x, and 70x) and enhanced with gel application. The nail plate can be observed with 10x or 20x magnification to maintain a non-blurry image. Dry dermoscopy works best for studying the surface of the nail plate. This is because the gel will obscure surface abnormalities. The distal edges of the nail plate can be studied with gel at different magnifications. The base of the nail can be seen through the plate after gel application with magnification ranging from 10x to 40x. Care should be taken not to put too much pressure on the dermatoscope on the nail plate as this can obscure the blood vessels underneath. Nail matrix dermoscopy is not necessary for the diagnosis of onychomycosis and can only be performed during the surgical procedure[18].

c. Dermoscopic pattern

The definition of the dermoscopic pattern is presented in **Table 4** and the dermoscopic pattern is presented below along with the dermoscopic findings that support the feature of onychomycosis in **Figure 1**[19].

Table 4. Dermoscopic pattern[20]

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Dermoscopic pattern	Description
Brittle appearance	Subungual hyperkeratosis
Longitudinal striae	Elongated lines in colors ranging from whitish to brown on the onycholytic nail plates
Jagged onycholytic edges with spike feature	Jagged edges with a spike depiction on the whitish longitudinal line visible on the proximal side of the onycholytic area and extending to the proximal nail plate
Distal irregular termination	The thickened end of the nail plate and is irregular and brittle
Straight onycholytic edges	Linear edges on the proximal side of the onycholytic nail plate
Black discoloration	Black discoloration except bleeding and artificial discoloration of the nail plate
Yellow discoloration	Yellowish discoloration of the nail plate from light yellow to orange
Hematoma	Bleeding points except splinter and punctata hemorrhages
Microhemorrhage in the cuticle	Bleeding points in the cuticle

1. Dermoscopy of distal and lateral subungual onychomycosis (DLSO)

Distal and lateral subungual onychomycosis usually occurs with onycholysis, subungual hyperkeratosis, and nail discoloration. Other clinical presentations include dermatophytoma and pigmented onychomycosis. Several dermoscopic findings have been observed such as the proximal edges of the onycholytic area showing jagged edges with pointed structures called spikes in the proximal fold direction and longitudinal striae of different colors occurring within the onycholytic nail plate.

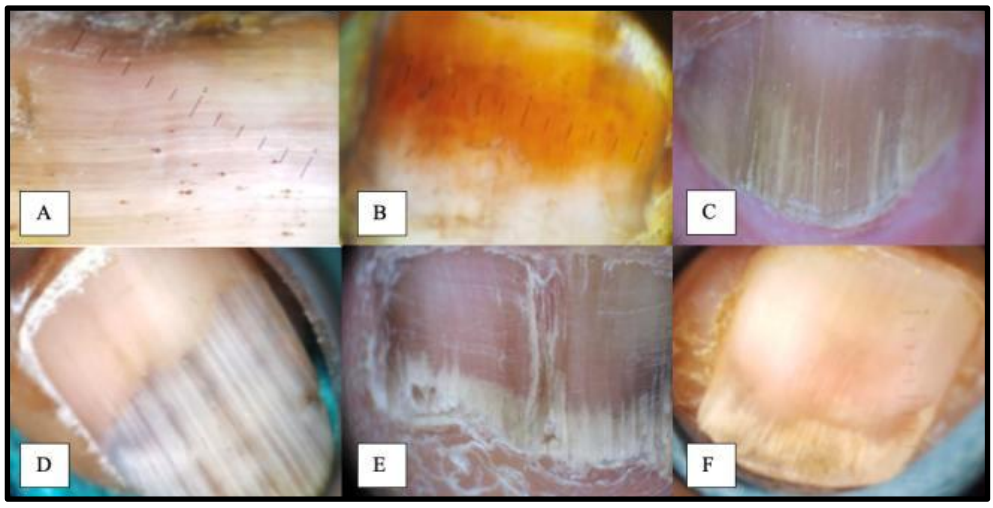

Figure 1. Depiction of dermoscopic findings of onychomycosis. A. Hemorrhagic subungual; B. Yellowish discoloration of the nail plate; C. Longitudinal striae of the onycholytic nail plate; D. Blue and white discoloration; E. Spike feature on the proximal edge in the area with onycholysis; F. Jagged pattern on the proximal edges of the onycholytic area[19]

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Discoloration of the affected nail plate appears in parallel bands with faded color, resembling an aurora borealis **(Figure 2).** Dermoscopy helps to distinguish DLSO from onycholysis generated by other causes, especially trauma and psoriasis. In traumatic onycholysis, the line of the plate separated from the nail bed appears to be gradual, smooth, and surrounded by a pale pink bed area. The subungual space is usually white-yellow with frequent black spots that correspond to subungual hemorrhage. DLSO findings associated with black pigmentation of the nails may appear however they are rare, especially if the infectious pathogen is a melanoid variant of *Trichophyton rubrum* or *Scytalidium dimidiatum*[18].

2. Dermoscopy of White Superficial Onychomycosis

White superficial onychomycosis is exclusively observed on the toenails and is characterized by superficial spots on the nail plates that appear opaque, brittle, and whitish. The clinician can perform a dry dermoscopy to obtain the correct visualization of the affected nail plate. Findings of SO include large, brittle, irregularly spreading white-yellow patches on the surface of the nail **(Figure 3).** The use of gel induces the partial loss of white discoloration due to the presence of intermediate spaces. This technique is useful to distinguish superficial nail fragility due to prolonged nail polish use from leukonychia punctata which is a traumatic nail disorder caused by repeated minor injuries to the nail matrix. In dermoscopy, superficial nail fragility due to prolonged use of nail polish appears as dense, small, opaque white areas, on the nail plate whereas leukonychia punctata appears as single or multiple, small, regular, and opaque white spots, within the nail plate and unchanged with the use of gel[18].

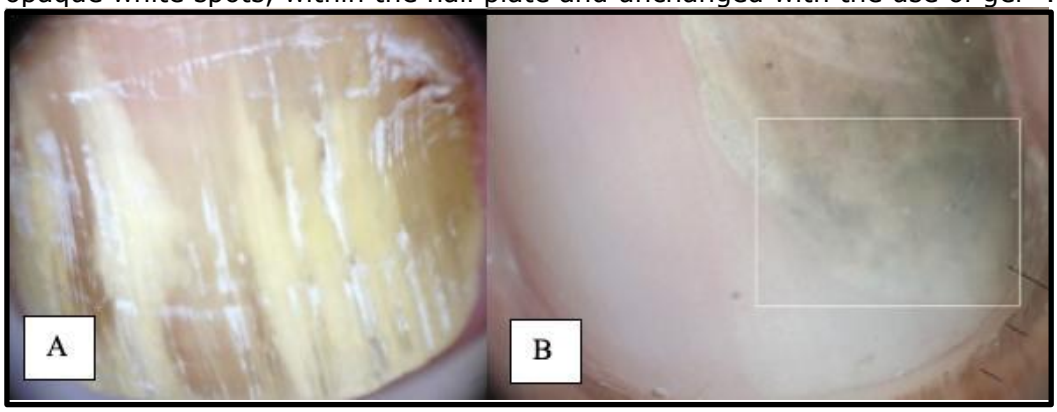

Figure 2. Distal and lateral subungual onychomycosis (DLSO) A. Depiction of elongated spike with white-yellow color in the proximal direction; B. Depiction of aurora borealis[18]

3. Dermoscopy of Proximal Subungual Onychomycosis

Proximal subungual onychomycosis usually appears as a white to yellow area under the proximal nail plate in the lunula area and is easily visible by dermoscopy. In these cases dermoscopy may show one or more transverse white bands observed on the deep nail plate with a normally smooth surface of the nail **plate (Figure 3)**[18].

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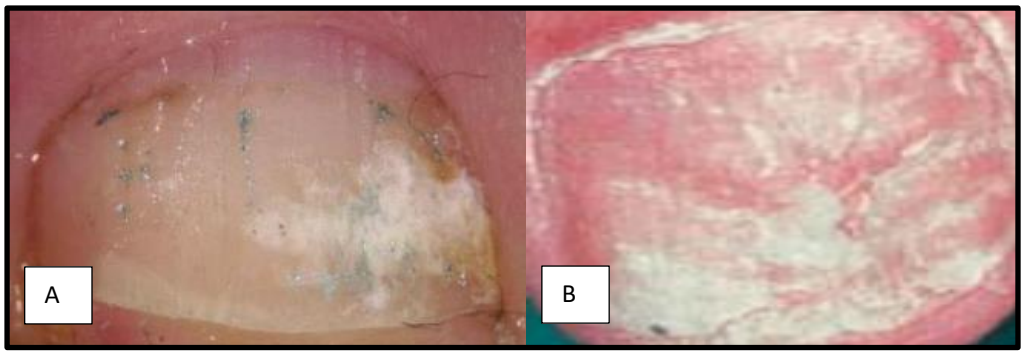

Figure 3. A. White superficial subungual onychomycosis (OS); B. Proximal subungual onychomycosis (OSP))[18]

4. Dermoscopy of Dystrophic Total Onychomycosis

Total dystrophic onychomycosis is a possible outcome of all types of onychomycosis, especially prolonged DLSO. The nail plate thickens diffusely, brittle, and yellowish and may not be distinguishable from nail psoriasis. Nail plate dermoscopy can assist in observing longitudinal striae and spikes as well as distal irregular terminations corresponding to the characteristics of distal destruction from nail thickening in TDO **(Figure 4)**. Observation of the hyponychium at high magnification (40x to 70x) can indicate psoriasis when the capillaries are irregularly distributed, dilated, sinuous, and elongated characteristic of dermoscopic examination of nail psoriasis. The mycological supporting examination will be significant in cases such as OTD[18].

Figure 4. Dystrophic total subungual onychomycosis (TDO) with yellow to white scales and distal irregular termination [18]

CONCLUSION

Nail dermoscopy can improve the quality of dermatology practice and simplify examination through easy clinical application and adequate equipment for the establishment of onychomycosis diagnosis.

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