Dermatology Practical & Conceptual

Dermoscopy of Onychomycosis: A Systematic Review

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ABSTRACT

Introduction: Onychomycosis represents a global burden accounting for about 50% of nail consultations. Several studies have tried to assess the dermoscopic features of onychomycosis. With the multiplication of papers, several "new" dermoscopic signs keep being added leading to some inconsistency in onychoscopic terminology.

Objective: This study aimed to summarize the existing literature on the dermoscopic features of onychomycosis and propose a unified onychoscopic terminology.

Methods: The literature search was performed using PubMed and Scopus databases up to October 30, 2021 to identify eligible contributions. In total, 33 records (2111 patients) were included.

Results: The main dermoscopic signs of onychomycosis are "ruin appearance", "longitudinal striae" and "spikes" on the proximal margin of onycholytic areas, with a specificity of 99.38%, 83.78%, and 85.64% respectively. The "aurora borealis" sign had the highest sensitivity and specificity.

Conclusions: The current review provides a framework for issues related to the onychoscopic terminology of onychomycosis and is intended to serve as an aid for students, teachers, and researchers. We proposed a unifying terminology to describe dermoscopic signs of onychomycosis. Dermoscopic signs of onychomycosis show good specificity and are useful in distinguishing nail psoriasis, trauma, and onychomycosis. It helps differentiate fungal melanonychia from nail melanoma, nevi, and melanocytic activation.

Introduction

Onychomycosis represents all fungal infections of the nail. It is frequent, accounting for about 50% of nail consultations [1]. Onychomycosis could be due to dermatophytes (tinea unguium) as well as non-dermatophytes. Management of onychomycosis is challenging due to diagnostic difficulties, slow nail regrowth, long treatment periods, resistance to systemic medications, possible related side effects, and frequent recurrences. Direct microscopy and fungal culture are the gold standards for the diagnosis of onychomycosis. However, fungal culture has low sensitivity (35–60%) and may require several weeks [2]. Dermoscopy of the nail unit (onychoscopy) is a quick, inexpensive, and reliable tool used for the diagnosis of cutaneous tumors, inflammatory disorders, and skin infections. Several studies addressed the dermoscopic signs of onychomycosis frequently using metaphorical terminology [3]. With "new signs" being introduced (like the "sulphur nuggets" aspect) and the absence of a widely accepted consensus on the onychoscopic terminology, some degree of discrepancy among the definitions of the dermoscopic signs of onychomycosis exists (Table 1).

Dermoscopy can help differentiate onychomycosis from similar conditions including nail psoriasis and traumatic nail dystrophy [3] and can be used to characterize fungal melanonychia [4–7]. However, the sensitivity and specificity of the dermoscopic signs of onychomycosis are yet to be determined.

The aim of this study was to summarize the existing literature on the dermoscopic features of onychomycosis and its diagnostic value and propose a unified onychoscopic terminology.

Methods

This literature search was performed using PubMed and Scopus databases (from the databases' inception up to October 30, 2021) to identify eligible contributions. The following search strategy was used: ("onychomycosis" OR "Tinea unguium" OR "nail fungal infection") AND ("onychoscopy" OR "dermatoscopy" OR "Dermoscopy" OR "videodermatoscopy" OR "videodermoscopy").

Two dermatologists (N.L. and E.M.) independently screened titles and abstracts for eligibility. Only papers in the English language were considered for inclusion. Editorials, commentary, and review articles were excluded. All contributions reporting one or multiple cases of onychomycosis and describing its dermoscopic features were included. Reference lists of included articles were further screened for additional eligible publications. Any discrepancy between the 2 authors (N.L. and E.M.) was resolved by consensus. Each eligible article was retrieved in full, and the epidemiological, mycological, dermoscopic, and histopathological data were extracted.

Both descriptive and analytical statistics were performed. The dermoscopic features of onychomycosis were first analyzed based on the initial description by the authors of included articles (Table 2). Then the following terms that share the same definition: "jagged edge with spikes", "spiked pattern" and "intermittent spiked pattern" were grouped as "spikes" for analytical statistics.

Chi-squared test, when applicable, or Fischer exact test, were used to examine differences in categorical variables. The sensitivity and specificity of the most frequently reported dermoscopic features of onychomycosis were calculated. A P-value lower than 0.05 was considered significant.

Results

The literature search yielded 180 records. Of the 110 papers examined after duplicate removal, 36 were review articles, and 32 were not relevant. Overall, 5 contributions were not in the English language, and 7 did not include information regarding the frequency of dermoscopic signs of onychomycosis. Consequently, 33 records were included in this review [2,3,12–21,4,22–31,5,32–34,6–11]. The process of selecting relevant articles is illustrated in Figure 1.

In total, 2048 patients with onychomycosis were included. The clinical classification of onychomycosis is divided into 6 patterns based on the point of fungal entry into the nail unit. The clinical classification of onychomycosis was specified in 1885 cases:

- Distal/lateral subungual onychomycosis (DLSO): 1514, 71.7%
- Superficial onychomycosis (SO): 31, 1.6%
- Proximal subungual onychomycosis (PSO): 21, 1.1%
- Total dystrophic onychomycosis (TDO): 266, 14.1%
- Mixed pattern (MO): 51, 2.7%
- Endonyx onychomycosis: 2 cases

Methods to diagnose onychomycosis were described in 27 of the included papers. The diagnosis was based on KOH examination [4,7,11,16,17,23,27–32,35], fungal culture [2,3,5,8,13,16,19,20,24,25,33,34], and/or histologic examination of nail plates [5,8,10,19,20,24].

The dermoscopic features of onychomycosis are summarized in Table 2. The most common onychoscopic signs were:

Ruin Appearance

Ruin appearance refers to the distal part of the thickened nail plate showing ventral indentations caused by dermal

Table 1. Definitions.

Dermoscopic features		Definitions
Ruin appearance		Ventral indentations of the nail plate caused by dermal debris. *Some authors consider that ruin appearance and subungual hyperkeratosis are the same sign*[19,32]*, while others defined ruin appearance as a distal irregular termination at the edge of the nail plate*[30].
Subungual hyperkeratosis		Hyperkeratosis of the subungual area under the distal margin of the nail plate[4]
Sulphur nuggets		Described for the first time by Leeyaphan et al. as yellow clumping sulfur nugget-like debris under the nail plate.[8]
Longitudinal striae		Longitudinal pigmentation of different colors in streaks within the nail plate
onycholysis		Separation of the nail plate from the nail bed
	Jagged edge with spikes/ spiked pattern	A nonlinear border at the proximal edge of an onycholysis area, with a sharp white longitudinal indentation pointing to the proximal nail fold
	Straight onycholytic edge	A linear edge of the proximal margin of an onycholytic area without indentations
Distal irregular termination		Refers to the distal pulverization of the nail plate[17,23,29]
Splinter hemorrhage		Longitudinal brown, black, or purple linear hemorrhages[30]
Chromonychia		multicolored, black, brown, white or yellow pigmentation of the nail plate.
Aurea borealis		Area of various colors associating various degrees of green, bluish-gray, black, white, and yellow in association with onycholysis, striae and streaks.[11] *Some authors consider "jagged edge with spikes" sign to be equivalent to "aurora borealis" pattern.*[29]
Leukonychia	True leukonychia	A white discoloration throughout the entire thickness of the nail plate, responsible for the opaque appearance
	Pseudo leukonychia	Seen in white superficial onychomycosis (SO), where only the superficial surface of the nail plate is invaded.[29]
	Homogeneous leukonychia	Homogenous white opacity of the nail plate, greater than 1 mm in size.[19,20]
	Punctate leukonychia	White globules with dimensions of less than 1 mm on the nail plate[19]
	Longitudinal leukonychia	White parallel lines in the nail plate
	Transverse leukonychia	Horizontal white striae in the nail plate
	Grid pattern	Seen in superficial onychomycosis (SO). The grid pattern is the result of the intersection of longitudinal and transverse leukonychia.[10]
Melanonychia	Longitudinal melanonychia	A longitudinal band extending from the proximal nail fold to the distal free edge of the nail plate
	Non-longitudinal homogenous pattern	Structureless pigmentation of the nail plate
	Reverse triangular pattern	Nail pigmentation that is wider at the distal end compared to the proximal part of the nail plate
	Triangular sign	Nail pigmentation is wider at the proximal area compared to the distal end of the nail plate
Micro Hutchinson		Cuticular pigmentation that is normally invisible to the naked eye
Hutchinson sign		Nailfold or hyponychium pigmentation
Pseudo-Hutchinson sign		Nail matrix pigmentation detected through a relatively translucent cuticle at the proximal nail fold.[4]

Table 2. Summary of the dermoscopic features of onychomycosis.

Dermoscopic features	N, percentage
Ruin appearance	752,68%
Longitudinal striae	1351, 64.9%
onycholysis	252, 65.3%
Jagged edge with spikes/spiked pattern	740, 58% / 516, 57.3%
Straight onycholytic edge	55, 8.2%
Distal irregular termination	340, 36%
Splinter hemorrhage	26, 5.3%
Chromonychia	531, 70.4%
Homogeneous leukonychia	120, 33.4%
Punctate leukonychia	113, 75,8%
Transverse leukonychia	18, 10.4%
Leukonychia (unspecified pattern)	182, 31.8%
Black discoloration	212, 23.9%
Brown discoloration	268, 36.9%
Yellow discoloration	365, 57%
Orange discooration	69, 19.5%
Gray discoloration	29, 11.6%
Green discoloration	92, 40.8%

N: number of reported cases

debris (Figure 2a) [19]. It corresponds to the fungal presence in the nail plate [19,26]. For some authors, "ruin appearance", "distal irregular termination" [30], and "subungual hyperkeratosis" [19,32] can be used interchangeably. The frequency of ruin appearance varied between 13% and 100% (a mean of 68%) [2,7,8,12,19–23,26,29,30,34].

Ruin appearance was significantly associated with DLSO and never described in SO and endonyx onychomycosis (Table 3).

Longitudinal Striae:

Longitudinal striae appear as streaks within the nail plate and are the result of the fungal invasion of the nail plate (Figure 2b) [26]. They were reported in 64.9% of cases.

Longitudinal striae are very frequent in DLSO, TDO, and rarely reported in SO (p=0.001), and PSO (p=0.03).

Onycholysis

Onycholysis is the separation of the nail plate from the nail bed. According to Zaias et al, the main etiology of onycholysis is trauma and onychomycosis is never the initiating factor [36].

Dermoscopy helps differentiate onycholysis of traumatic origin from onychomycosis. A linear edge at the proximal aspect of onycholysis is associated with trauma, while spikes are associated with onychomycosis (Figure 2c) [23]. In onychomycosis, the frequency of onycholysis varies between 5 and 100% (a mean of 65%).

The frequency of linear edge in OM varied between 2% and 22% (a mean of 8%) and it is thought to be secondary to trauma preceding OM [36].

Spikes

"Spiked pattern", "intermittent spiked pattern" and "Jagged edge with spikes" share the same definition. It is characterized as indentations at the proximal edge of the onycholytic area (Figure 2c) [23]. These structures correspond to the distal-to-proximal invasion of the nail bed's longitudinal ridges by dermatophytes [3,11,23]. The frequency of jagged edges with spikes varied between 39% and 100% (a mean of 58%) [3,5–9,12–15,17–21,24,29–34,36]. These structures were significantly associated with DLSO, very frequent in TDO, and never described in SO, PSO and endonyx onychomycosis (Table 3).

Spikes can also be seen in onychorrhexis, but are located in the proximal part of the nail [11,26]. Spikes help differentiate onycholysis related to trauma and onychomycosis. The former is virtually never associated with spikes.

Chromonychia

Chromonychia is defined as a discoloration of the nail plate. It may be secondary to colony formation, flakes, or subungual debris [15,23,26]. The colors ranged from white (leukonychia), green, yellow, brown, gray, and black. The prevalence of chromonychia varies between 22 and 100%

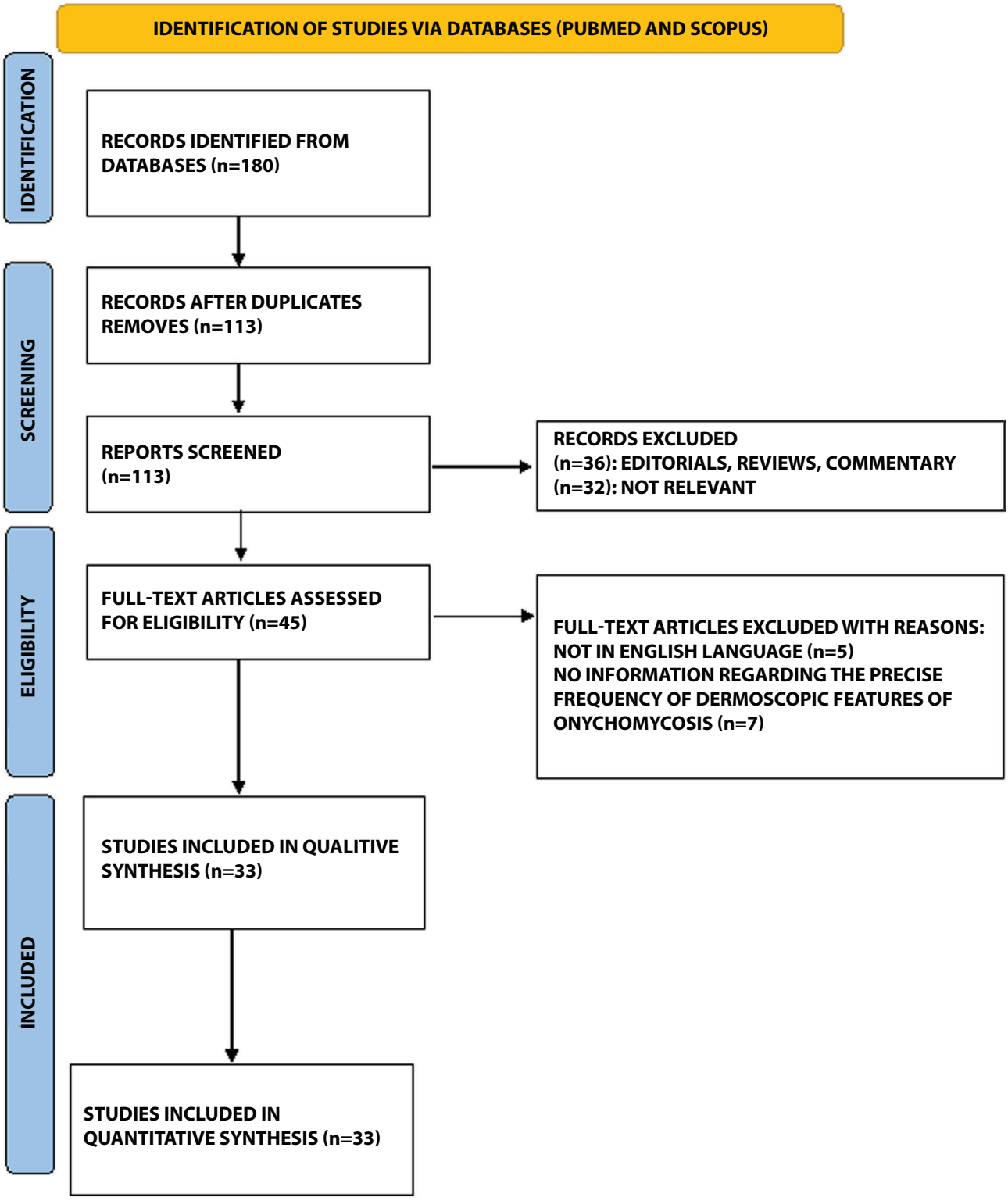

Figure 1. Flow diagram.

(a mean of 70.4%). The most frequent color was yellow (a mean of 57%) [4,8,9,13,14,16,19,20,28–32,34,36,37].

The association of chromonychia of multiple colors with longitudinal striae, spikes, and onycholysis creates a pattern called "aurora borealis" or "aurora sign" (Figure 3) because they resemble waves of northern lights or aurora borealis [30].

Leukonychia:

Leukonychia is a white coloration of the nail. It is explained by the fungal growth in the nail plate, similar to the growth in the culture medium [19]. It can be punctate, transverse (Figure 2d), or homogenous (Table 1). The frequency of leukonychia varies between 2% and 75 % (a mean of 37%) [2,6,19,20,29]. Leukonychia was significantly associated with SO ($p<0.001$).

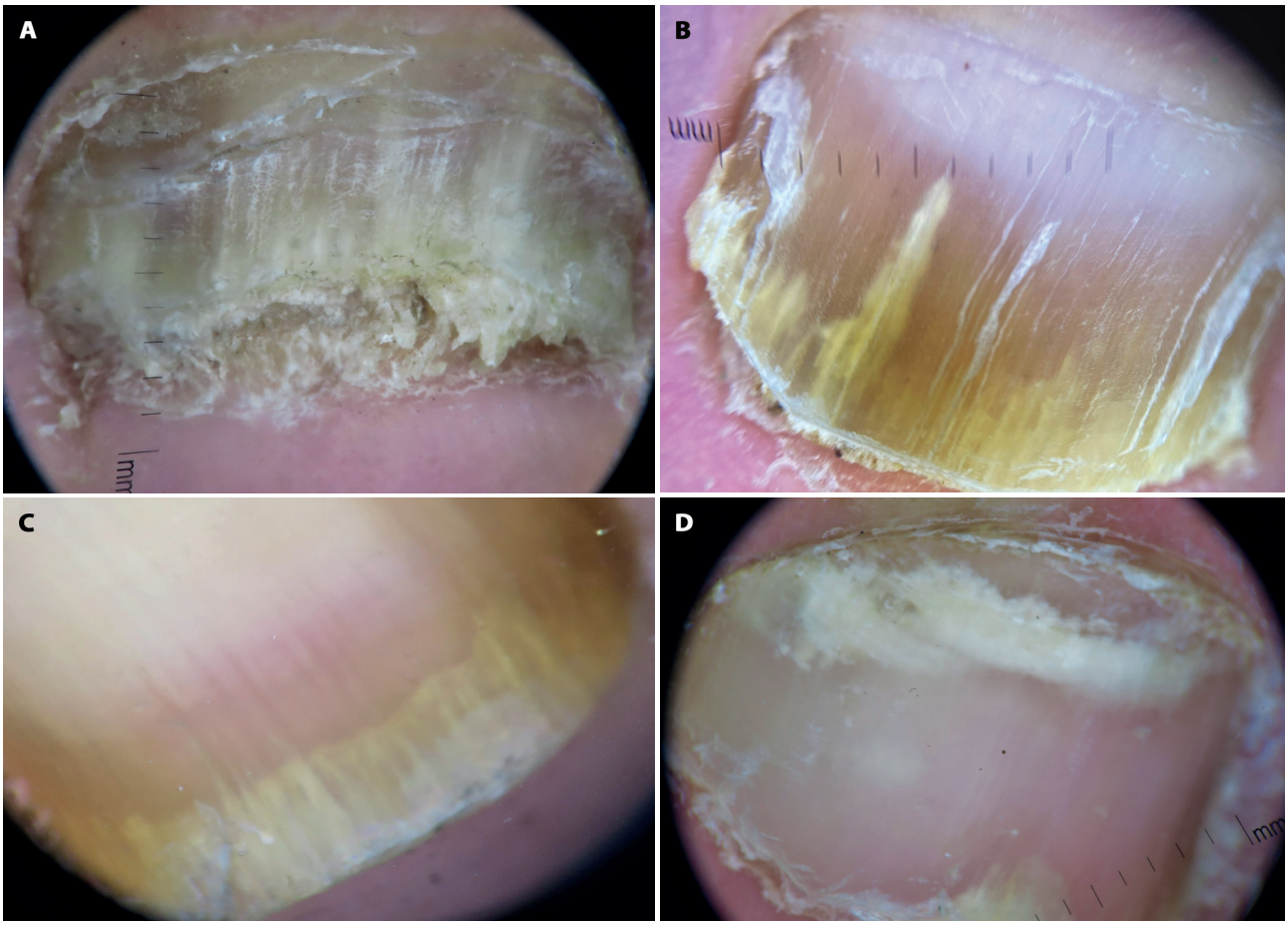

Figure 2. Dermoscopic features of onychomycosis. (A) "ruin appearance". (B) longitudinal striae. (C) spikes on the proximal edge of an onycholytic area. (D) transverse leukonychia.

Fungal Melanonychia

Fungal melanonychia is a dark pigmentation of the nail plate. It is explained by the synthesis of melanin by some fungi. The best-characterized fungal melanin is 1,8-dihydroxynaphthalene (DHN) melanin. Its biosynthetic pathway is called the pentaketide pathway. The name "Pentaketide" derives from the fact that the naphthalene ring structure, that underlies the DHN-melanin pathway is formed by the binding and cyclization of five subunits of a ketone compound derived from five acetate molecules. Fungal melanin protects the fungus from the aggressions of the environment [37].

Dermoscopy helps distinguish fungal melanonychia from nail melanoma, nail matrix nevus, and melanocytic activation [4,5,7,9]. Yellow and red discoloration are significantly associated with fungal melanonychia, while the triangular sign and Hutchinson sign are features of nail melanoma and never described in association with onychomycosis (Table 4). Conversely, distal linear and reverse triangular patterns are signs of fungal melanonychia (Table 4). Indeed, in fungal melanonychia, the pigmentation is wider at the distal portion of the nail due to the distal-to-proximal progression of fungi which is responsible for the reverse triangular pattern (Figure 4). However, in nail melanomas, the pigmentation is wider in the proximal portion, resulting in a triangular melanonychia [30].

Splinter Hemorrhage

Splinter hemorrhages are linear hemorrhages caused by bleeding capillaries[16]. It is a common yet nonspecific sign of onychomycosis. It is reported in association with trauma and psoriasis[25]. The prevalence of splinter hemorrhage in onychomycosis varies between 2% and 25% (a mean of 5%) [11,17,19,21,34,36].

Sensitivity and Specificity of the Dermoscopic Signs of Onychomycosis:

Several studies compared the dermoscopic features of onychomycosis, psoriasis, and traumatic nail dystrophy [3,8,11,12,25]. The sensitivity and specificity of the dermoscopic signs of onychomycosis are summarized in Table 5. Overall the sensitivity of "ruin appearance", "longitudinal striae", and "spikes" are low with good specificity (Table 5). The "Aurora borealis" sign showed the highest sensitivity and specificity. Some dermoscopic signs were only

Table 3. Dermoscopic aspects and their association with clinical subtypes of onychomycosis.

	DLSO		SO		PSO		MO		TDO		Onychomycosis endonyx	
	Frequency	P-Value	Frequency	P-Value	Frequency	P-Value	Frequency	P-Value	Frequency	P-Value	Frequency	P-Value
Ruin appearance	142/206	0.016	0/5	0.001	1/4	NS	-	-	53/55	NS	0	-
Longitudinal striae	326/496	NS	2/13	0.001	3/11	0.03	20/47	-	117/210	NS	2/2	NS
Spikes (Jagged edge with spikes/ Spiked pattern)	403/657	0.002	4/21	NS	2/18	0.029	34/94	NS	95/259	NS	0/2	NS
Distal irregular termination	154/462	NS	1/12	0.017	5/10	NS	14/47	NS	126/186	NS	0/2	NS
Leukonychia	56/256	0.017	7/7	0.0001	1/7	NS	34/47	NS	0/58	NS	2/2	NS

DLSO: Distal/lateral subungual onychomycosis; MO: Mixed pattern; NS: non-significant; PSO: Proximal subungual onychomycosis (PSO); SO: Superficial onychomycosis; TDO: Total dystrophic onychomycosis;

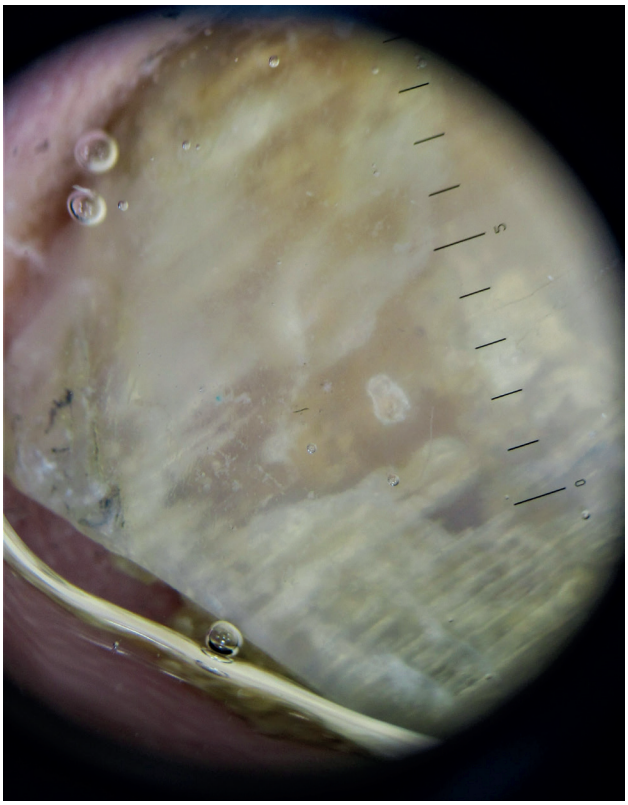

Figure 3. "Aurora borealis" sign. Chromonychia of multiple colors, associated with onycholysis, spikes and longitudinal striae.

reported in association with psoriasis including red dots in the hyponychium and lateral folds, proximal erythematous rim of onycholytic areas, and salmon patches, while plain non-erythematous edges of onycholytic areas are only described in association with trauma.

Discussion

This is the first systematic review addressing the dermoscopic features of onychomycosis. The main dermoscopic signs of onychomycosis are "ruin appearance", "longitudinal striae" and "spikes" on the proximal margin of onycholytic areas, with a specificity of 99.38%, 83.78%, and 85.64% respectively. The "aurora borealis" sign had the highest sensitivity and specificity.

Dermoscopy improves the diagnostic accuracy for cutaneous lesions in comparison with the naked eye examination [38]. Since the first description [3], several studies tried to assess the dermoscopic features of onychomycosis. With the multiplication of papers, and the inexistence of a widely adopted international consensus on onychoscopy similar to those related to cutaneous lesions [38], several "new" dermoscopic signs keep being added [8]. This results in some inconsistency between authors on the terminology to be used to describe dermoscopic features of onychomycosis (Table 1).

Table 4. Characteristics of melanonychia in patients with onychomycosis, nail matrix naevus, melanoma, and melanocytic activation.

		Fungal melanonychia	Nail matrix nevus	Malignant melanoma	Melanocytic activation	P-value
color	black	35/128	12/27	16/25	0/24	0.16
	dark brown	46/128	12/27	17/25	0/24	0.76
	light brown	32/86	16/27	7/25	5/24	1
	yellow	27/86	1/27	3/25	2/24	**0.0001**
	grey	24/148	0/27	7/25	20/24	**0.002**
	red	12/58	0/27	1/25	0/24	**0.0001**
	multicolored	49/100	13/27	22/25	4/24	0.87
	clumped/granular black	23/62	-	-	-	-
pigmentation pattern	longitudinal pattern	57/148	26/27	17/25	24/24	1
	distal diffuse pattern	20/88	-	6/14	-	0.18
	proximal diffuse pattern	7/88	-	2/14	-	0.60
	distal linear pattern	**7/88**	-	0/14	-	0.58
	total diffuse pattern	21/88	-	5/14	-	0.33
	reverse triangular pattern	**19/58**	0/27	1/25	0/24	1
	triangular sign	0/86	3/27	9/25	0/24	-
Hutchinson sign		0/106	1/27	16/25	0/24	-
pseudo Hutchinson sign		3/106	10/27	15/25	2/24	1
superficial transverse striation		18/62	-	-	-	-

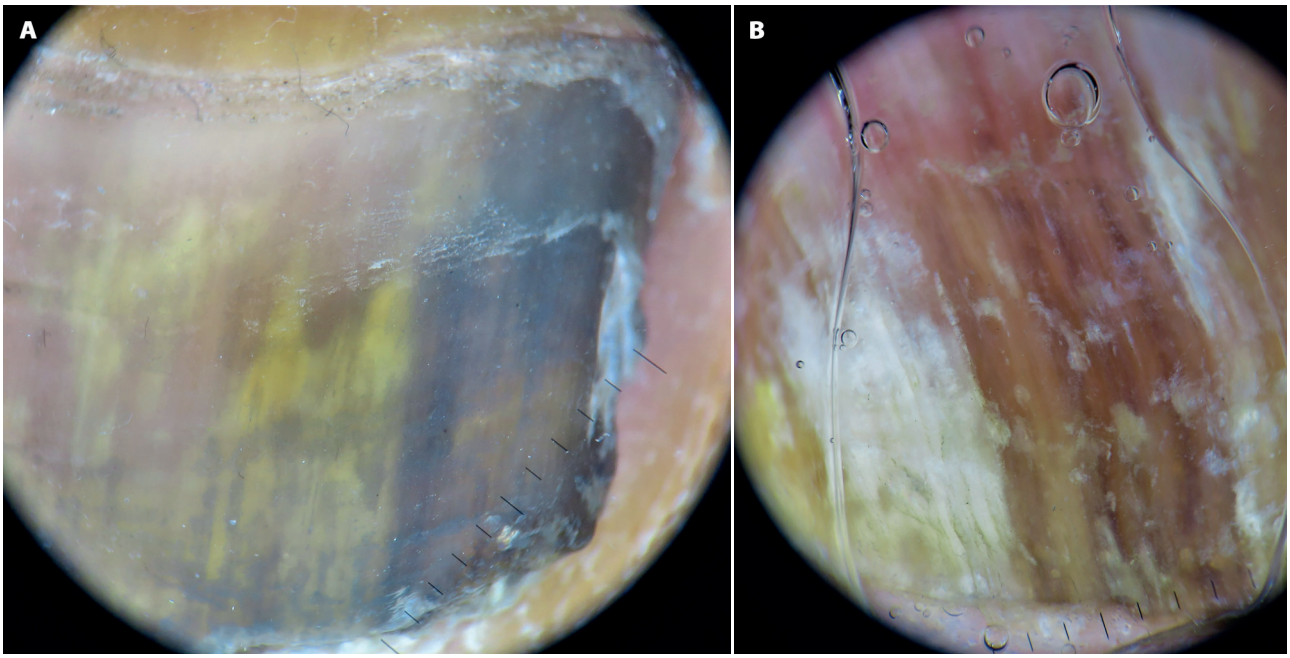

Figure 4. Fungal melanonychia. (A) reverse triangular pattern. (B) distal longitudinal pattern.

Table 5. Sensitivity and specificity of the dermoscopic signs of onychomycosis.

	Onychomycosis	Trauma	Psoriasis	Sensitivity (%)	Specificity (%)
Spikes	141/211	24/147	0/41	66.82	85.64
Longitudinal striae	76/191	24/142	0/6	39.79	83.78
Subungual hemorrhage	17/137	18/120	-	12.41	85
Splinter hemorrhage	6/147	11/96	23/41	4.08	75.18
Onycholysis	31/154	42/129	6/6	20.13	61.9
Ruin appearance	28/157	1/125	0/35	17.83	99.38
Red dots in hyponychium	0/20	0/5	26/35	*	*
Red dots in lateral folds	0/20	0/5	24/35	*	*
Proximal erythematous rim associated with onycholysis	0/37	0/14	26/41	*	*
Plain edges without erythema	0/74	26/27	0/41	**	**
Deep pits and dots	24/74	9/27	14/41	32.43	66.18
Salmon patch	0/20	0/5	9/35	*	*
Subungual hyperkeratosis	5/20	0/5	17/35	25	57.5
Aurora borealis	17/20	0/5	0/35	85	100

*the sign was only described in patients with psoriasis** the sign was only described in association with trauma

Following the third consensus conference of the International Society of Dermoscopy, standardization of terminology in dermoscopy of cutaneous lesions was adopted [38]. Both descriptive and metaphorical terminology was considered acceptable for clinical use and research [38]. Similarly, we believe that both descriptive and analytical terminology can be used to describe dermoscopic signs of onychomycosis. Descriptive (analytical) terminology has the advantage of being comprehensible and suitable for learning, and the disadvantage of possible long descriptive complex structures, while metaphorical terminology is memorable but incomprehensible outside its context [38]. We suggest the following terminology for the most prevalent onychoscopic signs of onychomycosis:

- "ruin appearance" (metaphoric) = subungual hyperkeratosis with distal irregular termination (descriptive)
- "longitudinal striae" (descriptive)
- "spikes" (metaphoric) to replace "spiky pattern", "Jagged edge with spikes" and "spiked pattern"

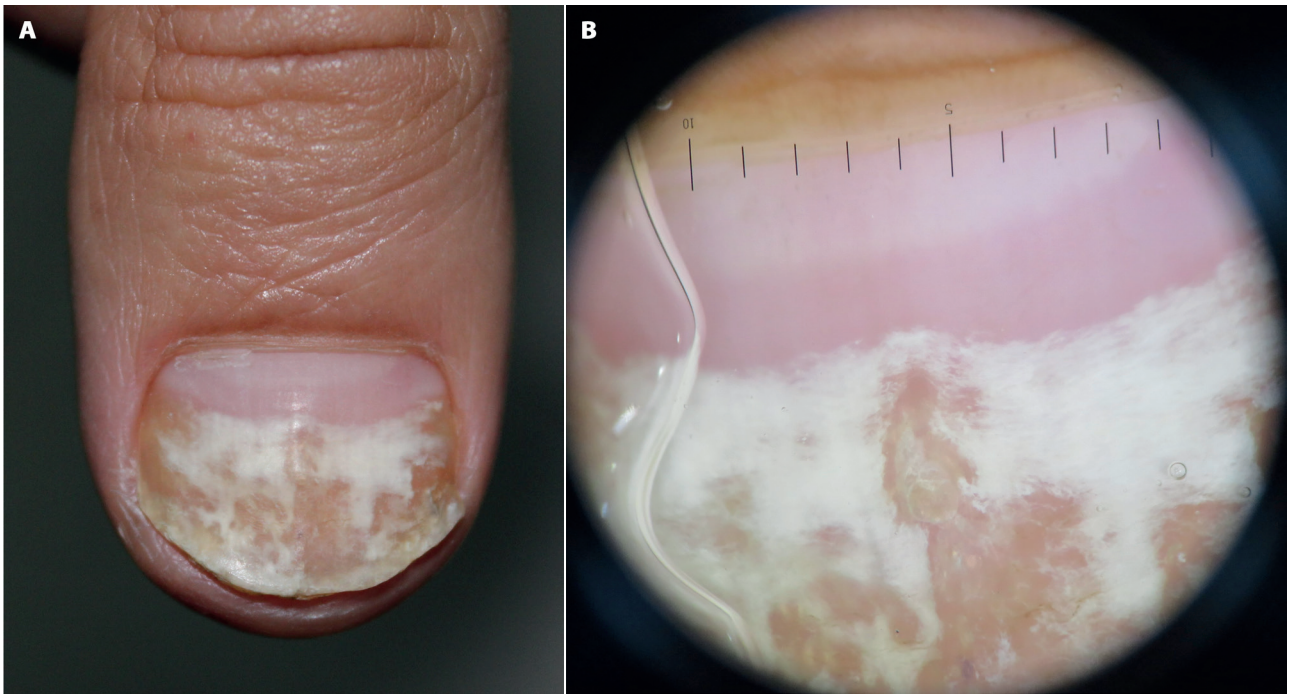

Figure 5. Clinical and Dermoscopic images of the same patient. Response to treatment may be better visualized using Dermoscopy allowing precise measurement of nail regrowth.

- chromonychia (descriptive): nail discoloration
- leukonychia (descriptive): white discoloration of the nail plate

We also suggest that the pigmentation patterns described in Table 4 should be used as-is since these patterns are widely used in onychoscopic terminology and there are no related discrepancies between published articles [3–5,7].

Dermoscopy is very useful in diagnosing pigmented nails. Chromonychia is very frequent in onychomycosis with yellow and red discoloration being significantly associated with fungal melanonychia. Other signs help distinguish fungal melanonychia from nail melanoma including distal linear and reverse triangular patterns. Conversely, the triangular pattern and Hutchinson sign are features of nail melanoma [4–7,9].

In conclusion, dermoscopy is useful in diagnosing onychomycosis. The current review provides a framework for issues related to onychoscopic terminology of onychomycosis and is intended to serve as an aid for students, teachers, and researchers. Dermoscopic signs of onychomycosis show good specificity and are useful in distinguishing nail psoriasis, trauma, and onychomycosis. It helps differentiate fungal melanonychia from nail melanoma, nevi, and melanocytic activation and allows precise monitoring of nail regrowth after systemic antifungal treatment initiation (Figure 5).

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