Limitations of dermoscopy in detecting distal and lateral subungual onychomycosis among patients with severely dystrophic nail psoriasis

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Background
Onychomycosis among patients with nail psoriasis is being increasingly reported in the literature. When the two conditions coexist in the same nail, it is usually difficult to clinically detect the fungal nail affection.
Objective
To study the value of dermoscopy in detecting distal and lateral subungual onychomycosis among patients with nail psoriasis.
Patients and methods
Fifty psoriasis patients with nail changes were subjected to full history and clinical examination, including targeted Nail Psoriasis Severity Index calculation, dermoscopic examination and nail scrapping for fungal culture on Sabouraud dextrose agar, and dermatophyte (DM) test medium.
Results
Twelve (24%) of the 50 patients recruited showed a positive mycological growth on culture. Nondermatophyte molds and DM were isolated from 16 and 8% of patients, respectively. Nail psoriasis severity was not affected by fungal growth on culture and no significant relation could be detected between culture results and nail dermoscopic findings.
Conclusion
Specific dermoscopic signs of distal and lateral subungual onychomycosis do not appear to be evident in severely dystrophic psoriatic nails even when culture results show growth for DM and/or nondermatophyte molds.

Keywords:
dermoscopy, onychomycosis, psoriasis

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Introduction

Dermoscopy is a noninvasive and inexpensive method providing in vivo magnification of the skin and nails. Onychoscopy, dermoscopy of the nails, is an easily available diagnostic aid for various nail conditions, including psoriasis and onychomycosis [1–3].

Nail psoriasis can be detected in up to 78% of patients with skin and/or joint psoriasis [4]. Oncholysis, pitting, splinter hemorrhage, and subungual hyperkeratosis are the most frequent signs of nail psoriasis reported, among others [5–8]. Although the signs of nail psoriasis are well documented, such findings may be found in other nail disorders, including onychomycosis [5].

Onychomycosis accounts for 50% of all nail-disease cases and is commonly caused by dermatophytes (DM) [9]. Distal and lateral subungual onychomycosis (DLSO) is the most common form of fungal nail affection [10]. The reported incidence of onychomycosis among patients with nail psoriasis may reach up to 62% [11].

Several psoriatic nail features, such as hyperkeratosis and onycholysis, may resemble onychomycosis, making the clinical differentiation between the two entities difficult, especially in the toenails, where both diseases may produce onycholysis and subungual hyperkeratosis as the only manifestations [12–14]. Similarly, differentiation between fingernail psoriasis and onychomycosis can be difficult when one or a few nails are involved, and the main sign is nail-plate crumbling and whitening [15].

The aim of this work was to study the value of onychoscopy in the diagnosis of DSLO-positive culture among psoriasis patients with nail dystrophy.

Patients and methods

This study was conducted between April and November 2019. Fifty psoriasis patients were recruited from the outpatient clinic of the Dermatology Departments of Helwan University Hospital and Kasr Al-Ainy Psoriasis Unit (KAPU), Faculty of Medicine, Cairo University. The study was approved by the Faculty of Medicine Helwan University Ethics Committee on March 2019 'serial 7-2019.'

Selection criteria: patients of both sexes above the age of 18 years, clinically diagnosed with nail psoriasis of either finger or toenails, were included in this study. Nail changes suggestive of psoriasis included any of the reported nail bed/matrix signs of psoriasis as reported by Dogra and Arora [16], including pitting, leukonychia, crumbling, and red spots in the lunula, salmon patches or oil spots, subungual hyperkeratosis, onycholysis, and splinter hemorrhages. Patients diagnosed with concomitant dermatological disorders known to have nail involvement, as well as patients on systemic or topical treatment for onychomycosis in the past 6 months were excluded from the study. An informed consent was obtained from all the patients prior to enrollment.

All psoriasis patients with nail changes were subjected to full history taking, including nail-disease onset, duration, symptoms, and previous treatments. Psoriasis area and severity index (PASI) scores were calculated, and thorough dermatological examination of the nails was performed. For each patient, we selected the most clinically dystrophic nail for targeted Nail Psoriasis Severity Index (tNAPSI) calculation, dermoscopic examination (3 Gen Dermlite DL4, assembled in the USA by 3 Gen Inc., San Juan Capistrano, CA, USA), and dry dermoscopy technique was used, where the dermoscope lens is held over the nail plate (noncontact method) and moved over the four quadrants of the plate to visualize each quadrant through the center of the lens. Pigmentboost was not used in this study. Photos were taken using DL connection kit and DL IOS app using IphoneX digital photography and nail scrapping for mycological culture.

Mycological examination: the nails were cleansed with 75% alcohol swab to remove bacteria and debris. Specimens were collected by careful nail scraping of the selected nail using the edge of disposable surgical scalpel blade no. 22. Samples were obtained from the most proximal portion of the undersurface of the nail plate and the nail bed if possible.

All specimens collected were inoculated on Sabouraud dextrose agar and dermatophyte test medium (manufactured by Liofilchem, LOT 040318505, expiry date 4/2022) and incubated at 28°C. Cultures were maintained for 2–4 weeks and checked periodically for any growth. Cultures were considered negative when no growth occurred after 4 weeks. Cultures were considered positive when growth occurred on the plate in the form of color change in the undersurface of the medium, growth of the fungus with variable morphology, texture, and color. Culture mounts using lactophenol cotton blue (manufactured by LOBA Chemie, Batch No. LM09241703, expiry date 2/2022) were used for identification of the organism based on colony morphology and microscopic morphology.

Statistical analysis

Data were collected, revised, coded, and entered to the Statistical Package for Social Science (IBM SPSS), version 23. The quantitative data were presented as mean, SDs, and ranges when parametric and median with interquartile range when nonparametric and percentiles were used to assess the distribution of some parameters. Also, qualitative variables were presented as number and percentages.

The comparison between groups regarding qualitative data was done by using χ^2 test and/or Fisher exact test when the expected count in any cell found was less than 5. The comparison between two groups regarding quantitative data with parametric distribution was done by using independent t test, while between more than two groups was done by using one way analysis of variance test. The comparison between two groups regarding quantitative data with nonparametric distribution was done by using Mann–Whitney test, while between more than two groups was done by using Kruskall–Wallis test.

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the P value was considered significant as the following:

P value more than 0.05: nonsignificant.
P value less than 0.05: significant.

Results

This study was conducted on 50 psoriasis patients with nail dystrophy. The demographic data and clinical characteristics of the study participants are shown in Table 1.

Table 1 Demographic data and characteristics of the studied patients

	N=50 [*n* (%)]
Sex	
Female	23 (46.0)
Male	27 (54.0)
Age (years)	
Mean±SD	40.18±15.48
Range	18–70
Residence	
Urban	34 (68.0)
Rural	16 (32.0)
Occupation	
Not working	28 (56.0)
Hand worker	14 (28.0)
Office worker	8 (16.0)
Habits	
No	36 (72.0)
Smoker	14 (28.0)
Family history	
Negative	36 (72.0)
Positive	14 (28.0)
Psoriasis phenotype	
Plaque	38 (76.0)
Isolated nail	4 (8.0)
Palmoplantar	4(8.0)
Guttate	1 (2.0)
Erythrodermic	3 (6.0)
Duration of skin disease (years)	
Mean±SD	7.34±5.35
Range	0.5–20
Duration of nail affection (years)	
Mean±SD	4.19±2.88
Range	1–10
Psoriatic arthritis	
No	35 (70.0)
Yes	15 (30.0)

PASI score of patients studied ranged from 0 to 50.4 with a median of 3.15, while the tNAPSI ranged from 1 to 8 with a median of 4. On clinical examination, 38 (76%) patients were suffering from plaque type of psoriasis, four (8%) patients had isolated nail psoriasis, four (8%) patients had palmoplantar psoriasis, three (6%) patients had erythrodermic psoriasis, and only one (2%) patient had guttate type of psoriasis.

Thirty-nine (78%) patients were on topical medications for their psoriasis either alone or in combination with systemic treatment. Twenty-three (46%) patients were under systemic therapies for psoriasis, including methotrexate (11 patients), cyclosporine (eight patients), or acitretin (four patients). Two (4%) patients were receiving PUVA therapy either alone or combined with other treatment modalities. Only one (2%) patient was receiving monthly intramatricial injection of methotrexate for treatment of nail psoriasis.

Table 2 Clinical and onychoscopic features of the studied patients

Nail signs	Clinical [*n* (%)]	Onychoscopy [*n* (%)]
Pitting	19/50 (38.0)	20/50 (40.0)
Crumbling	28/50 (56.0)	31/50 (62.0)
Splinter hemorrhage	8/50 (16.0)	17/50 (34.0)
Onycholysis	35/50 (70.0)	36/50 (72.0)
Subungual hyperkeratosis	24/50 (48.0)	24/50 (48.0)
Leukonychia	15/50 (30.0)	15/50 (30.0)
Red spots in lunula	0/50	1/50 (2.0)
Oil drop	19/50 (38.0)	26/50 (52.0)
Beau lines	3/50 (6.0)	4/50 (8.0)
Onychorrhexis	9/50 (18.0)	9/50 (18.0)
Acrodermatitis pustulosis	2/50 (4.0)	2/50 (4.0)
Paronychia	2/50 (4.0)	2/50 (4.0)

Table 2 lists the clinical and dermoscopic findings in the studied patients' most affected (dystrophic) fingernail or toenail. The most common clinical and dermoscopic nail sign was distal onycholysis found in 72% of patients, while red spots in the lunula were the least observed in only one (2%) patient and only with the aid of dermoscopy (Fig. 1).

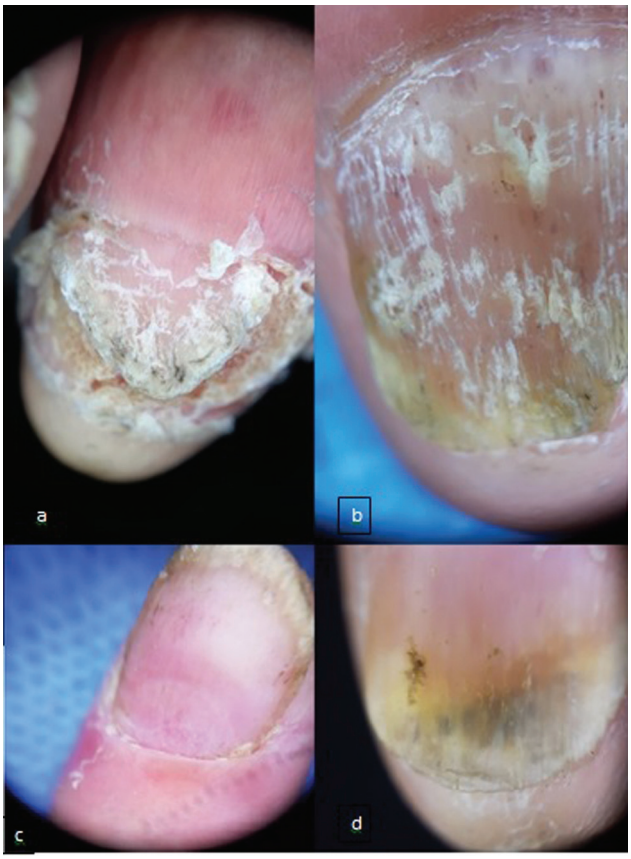
The clinical nail-bed changes detected: oil-drop sign in 19 (38%) patients onycholysis in 35 (70%) patients, splinter hemorrhage in eight (16%) patients, and subungual hyperkeratosis in 24 (48%) patients.

The clinical nail-matrix changes detected: Nail pitting in 19 (38%) patients, nail-plate crumbling in 28 (56%) patients, and leukonychia in 15 (30%) patients. Red spots in lunula were not found clinically in any patients.

Other clinical findings such as Beau's lines were found in three (6%) patients, onychorrhexis in nine (18%) patients, acrodermatitis pustulosis in two (4%) patients, and psoriasis paronychia in two (4%) patients.

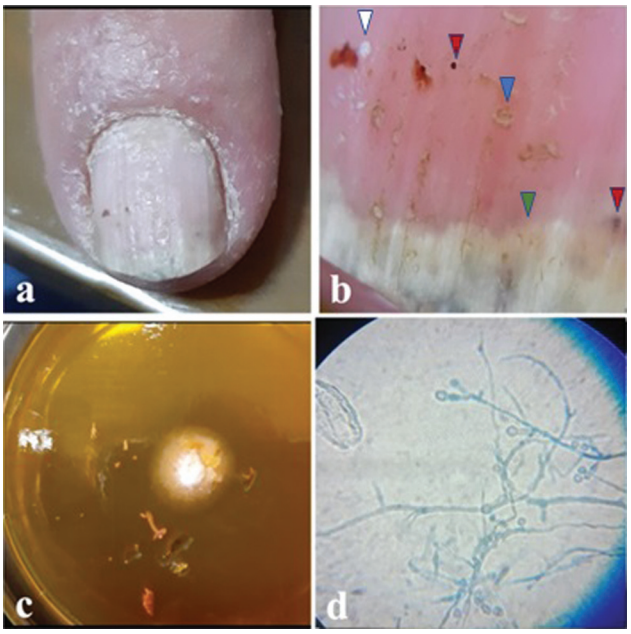
A total of 12 (24%) patients showed growth on culture. Growth on the plate with change in color and texture was observed in five (10%) patients on Sabouraud dextrose agar and seven (14%) patients on dermatophyte test medium, which was further identified by microscopy. *Geotrichium* and *Pencillium* species were the most identified nondermatophytic molds (NDM), while *Trichophyton rubrum* was the most isolated DM (Fig. 2 and Table 3). All patients with positive fungal growth on culture had plaque psoriasis, except one case with erythrodermic

Figure 1



Dermoscopic findings of some of dystrophic nail-psoriasis cases showing acrodermatitis pustulosis with subungual hyperkeratosis and crumbling of nail plate (a), onychorrhexis, onycholysis, oil spots, elkonyxis, pitting, and splinter hemorrhage (b), red spot in lunula and splinter hemorrhage, (c) distal onycholysis with red-border subungual hemorrhage, oil spots, and xanthonychia (d).

Figure 2



Psoriatic nail clinically showing pitting, longitudinal ridging, and onycholysis (a), dermoscopic view of pitting (blue arrowhead), punctate leukonychia (white arrowhead), subungual hemorrhage (red arrowhead), and smooth-bordered onycholysis (green arrowhead) (b), culture on Sabouraud dextrose agar shows Trichophyton mentagrophytes with white to cream in color colonies, with velvety texture powder to granular surface with a yellow reverse color (c), culture mounts show hyaline, septate, and branched hyphae in addition to spherical and semi-spherical microconidia (d).

Table 3 Culture results of the studied patients

	N=50 [*n* (%)]
Culture results	
Negative culture	38 (76.0)
Nondermatophyte	8 (16.0)
Fusarium species	1 (2.0)
Mucor species	1 (2.0)
Geotrichium species	2 (4.0)
Pencillium species	2 (4.0)
Scopulariopsis species	1 (2.0)
Trichosporon species	1 (2.0)
Dermatophyte	4 (8.0)
Epidermophyton floccosum	1 (2.0)
Trichophyton rubrum	2 (4.0)
Trichophyton mentagrophytes	1 (2.0)
DTM	
Negative	43 (86.0)
Positive	7 (14.0)
SDA	
Negative	45 (90.0)
Positive	5 (10.0)

DTM, dermatophyte test medium; SDA, Sabouraud dextrose agar.

psoriasis whose culture revealed infection with *T. rubrum*. Pitting, onycholysis, and oil drop were the most common morphological signs in psoriatic patients with positive fungal growth on culture (Table 4).

There was a significant relation between growth on culture and both psoriasis duration and nail-dystrophy duration (P=0.006 and 0.046, respectively) (Table 5). PASI score correlated positively with both psoriasis duration and nail-dystrophy duration (r=0.534, P=0.000 and r=0.423, P=0.002, respectively). We could not calculate a significant relation between neither PASI nor tNAPSI scores and fungal growth on culture (Table 6). No significant relation could be found between culture results and neither nail dermoscopic finding nor current line of treatment for psoriasis (Table 7).

Discussion

Approximately 10–78% of patients with psoriasis have nail involvement and nail psoriasis can be the sole manifestation in 5–10% of patients [17]. Many psoriatic nail features, like onycholysis and subungual hyperkeratosis, may resemble onychomycosis, and a clinical differentiation between

the two entities can be challenging [14]. More challengingly, onychomycosis and psoriasis may coexist simultaneously [17]. Mycological tests are required for differentiation between psoriasis and onychomycosis [18], while onychoscopy is thought to be of value in differentiation.

An increased prevalence of onychomycosis among patients with psoriasis had been previously reported with varying frequencies [19,20]. In the present study, positive fungal growth on culture was detected in 24% of patients. Méndez-Tovar *et al.* [21] found that 28% of their studied patients had onychomycosis, while a Tunisian study recorded an onychomycosis prevalence of 53% among psoriatic patients [8]. The highest percentage was reported by Zisova *et al.* [11], in which positive mycological cultures were obtained from 62% of patients with nail psoriasis.

The interplay between onychomycosis and nail psoriasis is still unclear. In agreement with previous studies [7,8], tNAPSI scores were not significantly different among patients with negative culture in comparison to those with positive culture. Alternatively, a positive fungal culture was significantly related to a longer duration of cutaneous and nail psoriasis. This may signify a higher risk of developing onychomycosis with long-standing psoriatic nail dystrophy and may need further studies to identify such temporal relation.

Dermoscopically, as well as clinically, the most prevalent sign we observed in our patients' cohort was onycholysis. Several authors reported pitting and splinter hemorrhage as the most prevalent features both clinically and dermoscopically among patients with nail psoriasis [22–24]. The most frequent dermoscopic nail sign we detected among psoriasis patients with a positive DM fungal culture was nail crumbling in 4/4 (100%) patients followed by onycholysis in 3/4 (75%) patients. On the other hand, in patients with a NDM growth on culture, the most prevalent dermoscopic nail sign was onycholysis in 6/8 (75%) patients followed by pitting in 5/8 (62.5%) patients. However, such dermoscopic findings were not significantly associated with onychomycosis in this patient's cohort. The classic dermoscopic characteristics of DLSO onychomycosis, such as jagged edge of the proximal margin of the onycholytic area [24,25], distal irregular termination, or ruin appearance [26] and linear edge [27], could not be detected in our psoriatic patients with positive fungal cultures. As these latter features were described in nails with no other

Table 4 Morphological manifestations in patients with onychomycosis

Culture results	Morphological type
Fusarium species	Oil drop, pitting, onycholysis, splinter hemorrhage, acrodermatitis pustulosis
Mucor species	Pitting, crumbling
Geotrichium species	Onycholysis, crumbling, leukonychia, onychorrhexis pitting, oil drop, splinter hemorrhage
Pencillium species	Onycholysis, oil drop
Scopulariopsis species	Splinter hemorrhage, onycholysis, onychorrhexis, crumbling, bed hyperkeratosis
Trichosporon species	Pitting, onycholysis, oil drop
Epidermophyton floccosum	Oil drop, splinter he, onycholysis, pitting, nail bed crumbling, leukonychia, bed hyperkeratosis
Trichophyton rubrum	Onychorrhexis, crumbling, leukonychia, oil drop, onycholysis, splinterhge, subungual hyperkeratosis, pitting
Trichophyton mentagrophytes	Onycholysis, pitting, crumbling, oil drop

Table 5 Correlation between psoriasis area and severity index and Nail Psoriasis Severity Index score with demographic data

	PASI		Targeted NAPSI	
	r	*P* value	*r*	*P* value
PASI				
Targeted NAPSI	–0.093	0.520	–0.093	0.520
Age	0.301	0.034*	0.250	0.079
Duration of psoriasis	0.534	0.000*	0.156	0.280
Duration of nail disease	0.423	0.002*	0.247	0.083

NAPSI, Nail Psoriasis Severity Index; PASI, psoriasis area and severity index. *P value <0.05 is considered statistically significant.

Table 6 Relation between culture results, psoriasis area and severity index and targeted Nail Psoriasis Severity Index

	Negative culture [*n* (%)]	Dermatophyte [*n* (%)]	Nondermatophyte [*n* (%)]	Test value#	*P* value
PASI					
Median (IQR)	2 (0.6–14)	25.5 (7.9–46.7)	8.95 (0.85–15.0)	3.818	0.148
Range	0–48.4	7.8–50.4	0–50		
Target NAPSI					
Median (IQR)	4 (3–6)	6.5 (6–7.5)	4 (3.5–6.0)	5.769	0.056
Range	1–8	6–8	2–8		

IQR, interquartile range; NAPSI, Nail Psoriasis Severity Index; PASI, psoriasis area and severity index. Kruskal–Wallis test. #Kruskall-Wallis test P value >0.05 is considered statistically non significant.

Table 7 Association between culture results and onychoscopy finding

Dermoscopic nail findings	Negative culture [*n* (%)]	Dermatophyte [*n* (%)]	Nondermatophyte [*n* (%)]	Test value*	*P* value
Pitting					
No	26 (68.4)	1 (25.0)	3 (37.5)	4.852	0.088
Yes	12 (31.6)	3 (75.0)	5 (62.5)		
Crumbling					
No	15 (39.5)	0	4 (50.0)	2.976	0.226
Yes	23 (60.5)	4 (100.0)	4 (50.0)		
Splinter hemorrhage					
No	27 (71.1)	2 (50.0)	4 (50.0)	1.801	0.406
Yes	11 (28.9)	2 (50.0)	4 (50.0)		
Onycholysis					
No	11 (28.9)	1 (25.0)	2 (25.0)	0.070	0.965
Yes	27 (71.1)	3 (75.0)	6 (75.0)		
Subungual hyperkeratosis					
No	19 (50.0)	1 (25.0)	6 (75.0)	2.925	0.232
Yes	19 (50.0)	3 (75.0)	2 (25.0)		
Leukonychia					
No	28 (73.7)	1 (25.0)	6 (75.0)	4.198	0.123
Yes	10 (26.3)	3 (75.0)	2 (25.0)		
Red spots in lunula					
No	37 (97.4)	4 (100.0)	8 (100.0)	0.322	0.851
Yes	1 (2.6)	0	0		
Oil drop					
No	20 (52.6)	0	4 (50.0)	4.032	0.133
Yes	18 (47.4)	4 (100.0)	4 (50.0)		
Beau lines					
No	34 (89.5)	4 (100.0)	8 (100.0)	1.373	0.503
Yes	4 (10.5)	0	0		
Onychorrhexis					
No	33 (86.8)	2 (50.0)	6 (75.0)	3.644	0.162
Yes	5 (13.2)	2 (50.0)	2 (25.0)		
Acrodermatitis pustulosis					
No	36 (94.7)	4 (100.0)	8 (100.0)	0.658	0.720
Yes	2 (5.3)	0	0		
Paronychia					
No	36 (94.7)	4 (100.0)	8 (100.0)	0.658	0.720
Yes	2 (5.3)	0	0		

*χ^2 test. *P* value >0.05 is considered statistically non significant.

pathology than onychomycosis, nail psoriasis may mask or modify these dermoscopic features of onychomycosis.The type of fungi isolated from patients with nail psoriasis seems to vary widely between studies. Gallo *et al*. [28] reported a much lower prevalence of yeast isolation (13.18%) in comparison with DM and NDM (43.27 and 43.55%) from psoriatic nails, while others reported yeasts as the most isolated organisms [7,29,30]. In the current study, NDMs were isolated from eight (16%) patients, whereas DM was isolated from four (8%) patients. This was in concordance with the study of Natarajan *et al*. [12], who reported that NDMs represent 18.75% of the positive-cultured psoriatic patients. Other investigators failed to isolate any DM from the nails of their psoriatic patients and showed a high incidence of NDM-positive cultures [17,31]. Contrastingly, Jendoubi *et al*. [8] as well as Zisova *et al*. [11] reported a high incidence of DM nail affection among psoriasis patients.

In concordance with previous investigators, *T. rubrum* was the most isolated dermatophytic fungi [6,32]. Alternatively, other researchers reported *Trichophyton mentagrophyte* as the most common isolated dermatophytic fungi among patients with nail psoriasis [25,33–36].

These former reports reveal a wide variation in the types and species of fungi isolated from psoriatic nails. These discrepancies may be attributed to the different geographic areas and different climatic conditions of

the above-mentioned studies. Culture techniques may also be partly responsible for these discrepancies. Interestingly, none of our patient's cultures grew candida. This may be due to the former-mentioned factors or because most nail-apparatus yeasts are commensal organisms that may be removed by proper specimen-collection techniques.

It is important to consider the findings of our study with some limitations in mind. As a cross-sectional study, reverse causation can be concerning. Also, we were only able to assemble a small sample size that might affect statistical evaluation and conclusions. We did not perform a KOH mount from our patients, which may have added further insight into our results.

In conclusion, specific dermoscopic signs of DLSO do not appear to be evident in psoriatic nails even when culture results show growth for DM and/or NDM. Associated onychomycosis does not seem to affect nail-psoriasis severity as measured by tNAPSI. Nail crumbling and onycholysis seen both clinically and dermoscopically can be signs of an associated dermatophytic onychomycosis in psoriatic nails and deserves further investigation.

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Conflicts of interest
There are no conflicts of interest.

References

1 Errichetti E, Stinco G. The practical usefulness of dermoscopy in general dermatology. G Ital Dermatol Venereol 2015; 150:533–546.

2 Piraccini BM, Balestri R, Starace M, Rech G. Nail digital dermoscopy (onychoscopy) in the diagnosis of onychomycosis. J Eur Acad Dermatol Venereol 2013; 27:509–513.

3 Kayarkatte MN, Singal A, Pandhi D, Das S, Sharma S. Nail dermoscopy (onychoscopy) findings in the diagnosis of primary onychomycosis: a cross-sectional study. Indian J Dermatol Venereol Leprol 2020; 86:341–349

4 Salomon J, Szepietowski JC, Proniewicz A. Psoriatic nails: a prospective clinical study. J Cutan Med Surg 2003; 7:317–321.

5 Kaul S, Singal A, Grover C, Sharma S. Clinical and histological spectrum of nail psoriasis: a cross-sectional study. J Cutan Pathol 2018; 45:824–830.

6 Rigopoulos D, Baran R, Chiheb S, Daniel IIICR, Di Chiacchio N, Gregoriou S, *et al.* Recommendations for the definition, evaluation, and treatment of nail psoriasis in adult patients with no or mild skin psoriasis: a dermatologist and nail expert group consensus. J Am Acad Dermatol 2019; 81:228–240.

7 Tsentemeidou A, Vyzantiadis TA, Kyriakou A, Sotiriadis D, Patsatsi A. Prevalence of onychomycosis among patients with nail psoriasis who are not receiving immunosuppressive agents: results of a pilot study. Mycoses 2017; 60:830–835.

8 Jendoubi F, Lagha IB, Rabhi F, Doss N, Mrabet A, Jaber K, Dhaoui MR. Nail involvement in psoriatic patients and association with onychomycosis: results from a cross-sectional study performed in a military hospital in Tunisia. Skin Appendage Disord 2019; 5:299–303.

9 Gupta AK, Versteeg SG, Shear NH. Onychomycosis in the 21st century: an update on diagnosis, epidemiology, and treatment. J Cutan Med Surg 2017; 21:525–539.

10 Ghannoum MA, Hajjeh RA, Scher R, Konnikov N, Gupta AK, Summerbell R, *et al.* A large-scale North American study of fungal isolates from nails: the frequency of onychomycosis, fungal distribution, and antifungal susceptibility patterns. J Am Acad Dermatol 2000; 43:641–648.

11 Zisova L, Valtchev V, Sotiriou E, Gospodinov D, Mateev G. Onychomycosis in patients with psoriasis – a multicentre study. Mycoses 2012; 55:143–147.

12 Natarajan V, Nath AK, Thappa DM, Singh R, Verma SK. Coexistence of onychomycosis in psoriatic nails: a descriptive study. Indian J Dermatol Venereol Leprol 2010; 76:723.

13 Klaassen KM, Van De Kerkhof PC, Pasch MC. Nail psoriasis: a questionnaire-based survey. Br J Dermatol 2013; 169:314–319.

14 Rigopoulos D, Papanagiotou V, Daniel IIIR, Piraccini BM. Onychomycosis in patients with nail psoriasis: a point to point discussion. Mycoses 2017; 60:6–10.

15 Piraccini BM. Nail anatomy and physiology for the clinician nail disorders. A practical guide to diagnosis and management. Milan: Springer Verlag Italia; 2014. 1–6

16 Dogra A, Arora AK. Nail psoriasis: the journey so far. Indian J Dermatol 2014; 59:319–333.

17 Sangeetha K, Sridharan KS, Murugan S, Kennedy P. Prevalence of onychomycosis in the psoriatic patients in a tertiary care hospital, Chennai, Tamil Nadu, India. Natl J Lab Med 2019; 8:8–10.

18 Szepietowski JC. Terbinafine exacerbates psoriasis: case report with a literature review. Acta Dermatovenerol Croat 2003; 11:17–21.

19 Kaçar N, Ergin S, Ergin Ç, Erdogan BS, Kaleli I. The prevalence, aetiological agents and therapy of onychomycosis in patients with psoriasis: a prospective controlled trial. Clin Exp Dermatol 2007; 32:1–5.

20 Leibovici V, Hershko K, Ingber A, Westerman M, Leviatan-Strauss N, Hochberg M. Increased prevalence of onychomycosis among psoriatic patients in Israel. Acta Derm Venereol 2008; 88:31–33.

21 Méndez-Tovar LJ, Arévalo-López A, Domínguez-Aguilar S, Manzano-Gayosso P, Hernández-Hernández F, López Martínez R, *et al.* Onychomycosis frequency in psoriatic patients in a tertiary care hospital. Rev Med Inst Mex Seguro Soc 2015; 53:374–379.

22 Wanniang N, Navya A, Pai V, Ghodge R. Comparative study of clinical and dermoscopic features in nail psoriasis. Indian Dermatol Online J 2020; 11:35–40.

23 Polat A, Kapıcıoğlu Y. Dermoscopic findings of psoriatic nail and their relationship with disease severity. Türk Deri Hastalıkları Frengi Arşivi 2017; 51:119–123.

24 Yorulmaz A, Artuz F. A study of dermoscopic features of nail psoriasis. Postepy Dermatol Alergol 2017; 34:28–35

25 El-Hoshy KH, Hay RM, El-Sherif RH, Eldin MS, Moussa MF. Nail dermoscopy is a helpful tool in the diagnosis of onychomycosis: a case control study. Eur J Dermatol 2015; 25:494–495.

26 Kaynak E, Göktay F, Güneş P, Sayman E, Turan D, Baygül A, Aytekin S. The role of dermoscopy in the diagnosis of distal lateral subungual onychomycosis. Arch Dermatol Res 2018; 310:57–69.

27 Jesús-Silva MA, Fernández-Martínez R, Roldán-Marín R, Arenas R. Dermoscopic patterns in patients with a clinical diagnosis of onychomycosis—results of a prospective study including data of potassium hydroxide (KOH) and culture examination. Dermatol Pract Concept 2015; 5:39–44.

28 Gallo L, Cinelli E, Fabbrocini G, Vastarella M. A 15-year retrospective study on the prevalence of onychomycosis in psoriatic vs non-psoriatic patients: a new European shift from dermatophytes towards yeast. Mycoses 2019; 62:659–664.

29 Larsen GK, Haedersdal M, Svejgaard EL. The prevalence of onychomycosis in patients with psoriasis and other skin diseases. Acta Derm Venereol 2003; 83:206–209.

30 Tabassum S, Rahman A, Awan S, Jabeen K, Farooqi J, Ahmed B, *et al.* Factors associated with onychomycosis in nail psoriasis: a multicenter study in Pakistan. Int J Dermatol 2019; 58:672–678.

31 Chaowattanapanit S, Pattanaprichakul P, Leeyaphan C, Chaiwanon O, Sitthinamsuwan P, Kobwanthanakun W, *et al.* Coexistence of fungal infections in psoriatic nails and their correlation with severity of nail psoriasis. Indian Dermatol Online J 2018; 9:314–317.

32 Hamnerius N, Berglund J, Faergemann J. Pedal dermatophyte infection in psoriasis. Br J Dermatol 2004; 150:1125–1128.

33 Altunay ZT, Ilkit M, Denli Y. Investigation of tinea pedis and toenail onychomycosis prevalence in patients with psoriasis. Mikrobiyol Bul 2009; 43:439–447.

34 Ovcina-Kurtovic N, Kasumagic-Halilovic E. Prevalence of nail abnormalities in patients with psoriasis. Dermatol Online 2013; 4:272–274.

35 Kavaliauskiene S, Povilionyte R, Jakubovskiene J, Jasaitiene D, Valiukeviciene S, Petrauskiene R, *et al.* Relationships between the incidence of onychomycosis and nail psoriasis. Medicina (Kaunas) 2010; 46:180–184.

36 Shemer A, Trau H, Davidovici B, Grunwald MH, Amichai B. Onychomycosis in psoriatic patients – rationalization of systemic treatment. Mycoses 2010; 53:340–343.