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Dermoscopic Patterns of Onychomycosis: A Cross-sectional Study in One Institution

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Background: Several dermoscopic findings that could be helpful in diagnosing onychomycosis have been reported in many cases, but they have not been sufficiently utilized in clinical practice.

Objective: To evaluate and identify the dermoscopic findings that may assist in the accurate diagnose of onychomycosis.

Methods: The study included 42 patients with clinical features suggestive of onychomycosis based on the clinical history, physical examination, dermoscopic findings, and mycological investigation. Clinical photographs and nail dermoscopy images were obtained, which were retrospectively reviewed and analyzed according to the onychomycosis classification.

Results: In total, 42 representative nails were reviewed. Common dermoscopic patterns such as yellow/brown discoloration and subungual hyperkeratosis were found in our onychomycosis patients. Key findings observed in specific subtypes were distolateral subungual onychomycosis with "jagged edges with spikes", proximal subungual onychomycosis or white superficial onychomycosis with irregularly bordered homogeneous leukonychia with postinflammatory hyperpigmentation on the proximal nail fold, and fungal melanonychia with nail plate roughness and nail fold hyperkeratosis.

Conclusion: Our study, along with previous studies, demonstrated dermoscopy as a quick and effective tool for diagnosing onychomycosis. In addition, periungual dermoscopic findings can be an important clue in onychomycosis diagnosis, especially in cases of fungal melanonychia and leukonychia.

Key Words: Fungal, Dermoscopy, Onychomycosis

INTRODUCTION

Onychomycosis is a fungal nail infection caused by dermatophytes, nondermatophytic molds, or yeasts. Although its clinical features are relatively obvious, at least one confirmatory test is required to avoid unnecessary treatment. Treatment is often systemic and long-term; consequently, this increases the risk of adverse effects. The most common diagnostic confirmatory tests for onychomycosis include direct microscopy with potassium hydroxide (KOH), fungal culture,

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polymerase chain reaction, and histopathological examination using periodic acid-Schiff staining[1].

Dermoscopy is a widely used, non-invasive, and easily available diagnostic method for many dermatological diseases[1-3]. Recently, several dermoscopic patterns useful in the diagnosis of onychomycosis have been identified. Piraccini et al. described the characteristic dermoscopic patterns in distolateral subungual onychomycosis (DLSO)[4], and Kaynak et al. reported characteristic dermoscopic patterns that may aid in its diagnosis[1]. Meanwhile, Kayarkatte et al. described specific onychoscopic features for different clinical variants of onychomycosis[5].

In this study, we evaluated common onychomycosis dermoscopic findings and patterns helpful in the diagnosis of onychomycosis and analyzed them according to the onychomycosis classifications.

MATERIALS AND METHODS

1. Data collection

1) Study type

This is a cross-sectional observational study conducted at Eunpyeong St. Mary's Hospital from November 2018 to January 2021. The study was exempted from the approval requirement by the Catholic University of Korea Eunpyeong St. Mary's Hospital ethics committee (IRB no. 2021-1689-0001), and informed consent was obtained from the patients for the use of nail photography included in this study. All patients' medical records and clinical photographs were reviewed retrospectively.

2) Study participants

We recruited 42 adult patients with features suggestive of onychomycosis. Patients with non-infectious pre-existing diseases contributing to nail pathology or those who had received topical or systemic antifungal medications within 1~3 months from the first day of visit were excluded.

3) Clinical examination

A picture of the patient's onychomycotic nails was taken and saved in JPEG format.

The clinical onychomycosis subtypes included in this study are DLSO, proximal subungual onychomycosis (PSO), white superficial onychomycosis (WSO), total dystrophic onychomycosis (TDO), and fungal melanonychia (FM).

4) Nail dermoscopy (onychoscopy)

A single representative nail was selected from each patient

Table 1. Definition of dermoscopic patterns[1]

Dermoscopic pattern	Definition
Subungual hyperkeratosis	Accumulation of scales under the distal portion of the nail plate, with nail thickening and uplifting
Jagged edge with spikes	Jagged edges are seen in proximal margin of the onycholytic area, with sharp whitish longitudinal lines extending proximal to the nail plate
Transverse striae	Horizontal lines parallel to the lunula, with colors ranging from white to brown
Distal irregular termination	Irregular ending of the thickened nail plate with crumbly appearance
Yellow discoloration	Color changes ranging from light yellow to orange
Brown discoloration	Color changes ranging from light brown to dark brown
Black discoloration	Black color change except for the bleeding and artificial color changes in the nail plate
Homogeneous leukonychia	White color changes greater than 1 mm on the nail plate
Longitudinal leukonychia	White longitudinal lines parallel to the grooves on the nail plate
Punctate leukonychia	White spots or flecks with dimensions of less than 1 mm on the nail plate
Nail plate destruction (=onychodystrophy)	Partial or complete disruption of the various keratinous layers of the nail plate

for nail dermoscopy. Using a DermLite Cam®dermoscope (3Gen, San Juan Capistrano, CA, USA), each patient's dermoscopic nail image was taken at 10x magnification.

Definitions of the dermoscopic patterns analyzed in our study are described in Table 1[1].

5) Sample collection for direct microscopic examination with 20% KOH

All specimens were collected through subungual debris and nail plate scraping according to the clinical subtypes of onychomycosis.

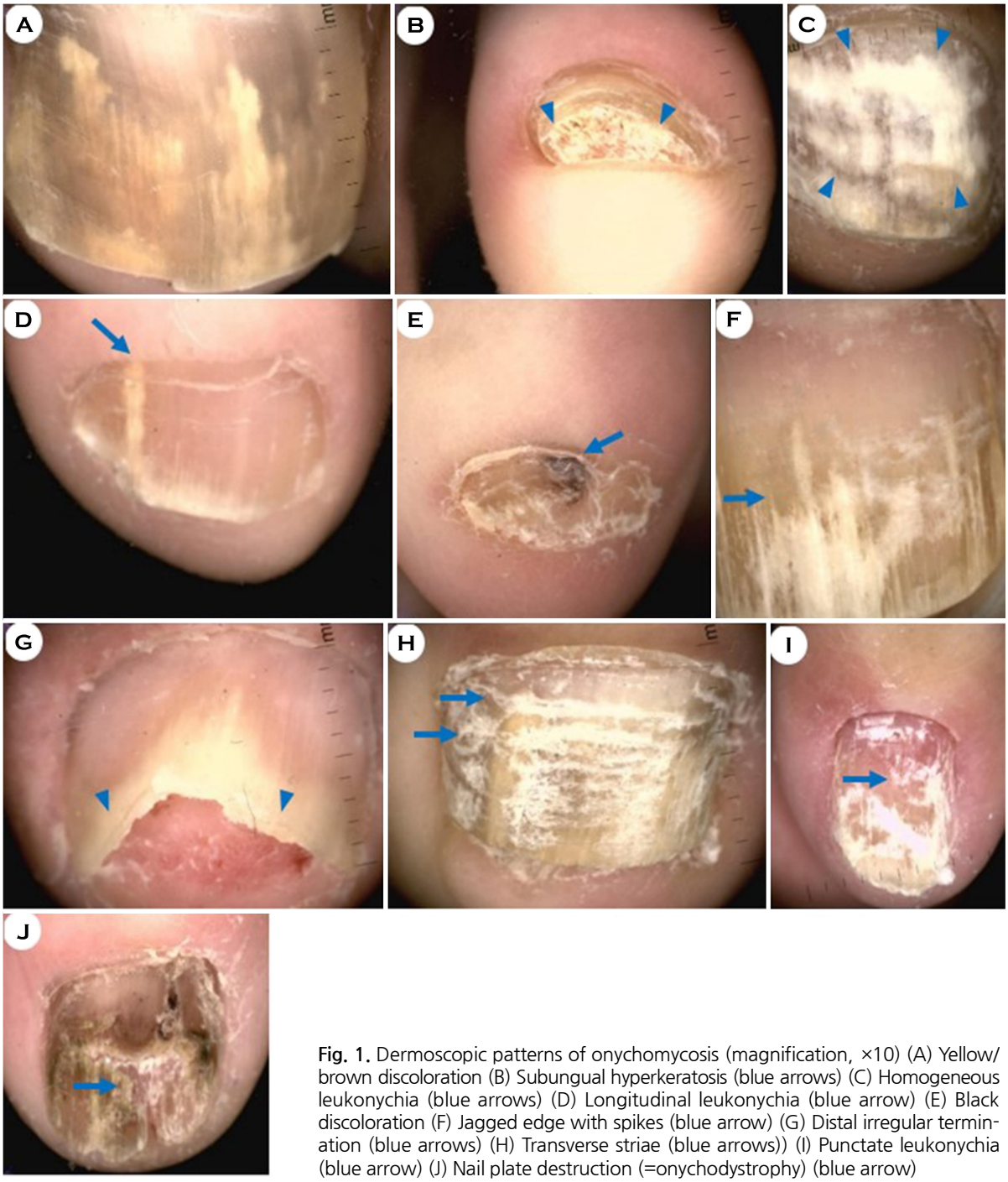

Fig. 1. Dermoscopic patterns of onychomycosis (magnification, ×10) (A) Yellow/brown discoloration (B) Subungual hyperkeratosis (blue arrows) (C) Homogeneous leukonychia (blue arrows) (D) Longitudinal leukonychia (blue arrow) (E) Black discoloration (F) Jagged edge with spikes (blue arrow) (G) Distal irregular termination (blue arrows) (H) Transverse striae (blue arrows)) (I) Punctate leukonychia (blue arrow) (J) Nail plate destruction (=onychodystrophy) (blue arrow)

Table 2. The proportions of specific dermoscopic patterns observed in onychomycosis

Description	Number (N=42)	Percentage (%)
Yellow discoloration	22	52.4
Brown discoloration	21	50.0
Subungual hyperkeratosis	20	47.6
Homogeneous leukonychia	14	33.3
Longitudinal leukonychia	10	23.8
Black discoloration	10	23.8
Jagged edge with spikes	9	21.4
Distal irregular termination	8	19.0
Transverse striae	3	7.1
Punctate leukonychia	3	7.1
Nail plate destruction (=onychodystrophy)	3	7.1

Samples were collected by subungual debris in DLSO and FM, and nail plate scraping in PSO and WSO. To minimize contamination, specimens were collected from the most proximal affected area of the representative nail without causing trauma.

Direct microscopic examination with 20% KOH was not performed in cases wherein the clinical signs were apparent.

2. Statistical analysis

Data were coded and entered into Microsoft Excel. The proportions of each dermoscopic pattern were compared.

RESULTS

A total of 42 suspected onychomycosis patients with dermoscopic nail images were enrolled. Of the 42 patients, 18 had onychomycosis as confirmed through KOH smears. Meanwhile, 24 patients had relatively apparent clinical evidence of onychomycosis at the first visit and showed clean nail growth on the proximal nail plate after topical efinaconazole or amorolfine treatment during outpatient follow-up. In this study, the dermoscopic images of the 42 representative nails were reviewed.

Table 3. The proportions of each clinical subtype of onychomycosis

Subtype	Number (N=42)	Percentage (%)
Distolateral subungual onychomycosis	34	80.9
Fungal melanonychia	3	7.1
White superficial onychomycosis	2	4.8
Total dystrophic onychomycosis	2	4.8
Proximal subungual onychomycosis	1	2.4

1. Common dermoscopic findings in onychomycosis

Dermoscopy images of each representative nail were taken and collected, and the dermoscopic patterns observed in each image were recorded. Thereafter, we analyzed the number and proportion of specific onychomycosis dermoscopic patterns (Fig. 1).

Color change of the nail plate, such as yellow/brown discoloration, was the most frequently observed feature. Yellow and brown discolorations were seen in 52.4% and 50.0% nails, respectively (Fig. 1A). Subungual hyperkeratosis (Fig. 1B), homogeneous leukonychia (Fig. 1C), longitudinal leukonychia (Fig. 1D), black discoloration (Fig. 1E), jagged edge with spikes (Fig. 1F), distal irregular termination (Fig. 1G), transverse striae (Fig. 1H), punctate leukonychia (Fig. 1I), and nail plate destruction (Fig. 1J) were observed in decreasing order (Table 2).

2. Dermoscopic findings according to the clinical subtypes of onychomycosis

The samples in our study were classified according to the clinical subtypes as summarized in Table 3. DLSO was the most frequently observed clinical subtype (34/42; 80.9%), followed by FM (3/42; 7.1%), WSO (2/42; 4.8%), TDO (2/42; 4.8%), and PSO (1/42; 2.4%) (Table 3). The characteristic onychoscopy features of each clinical subtype were observed in this study (Figs. 2-4).

The onychoscopic pattern in DLSO, which accounted for the largest proportion, showed brownish discoloration of the nail plate and a ruined appearance (subungual hyperkeratosis)

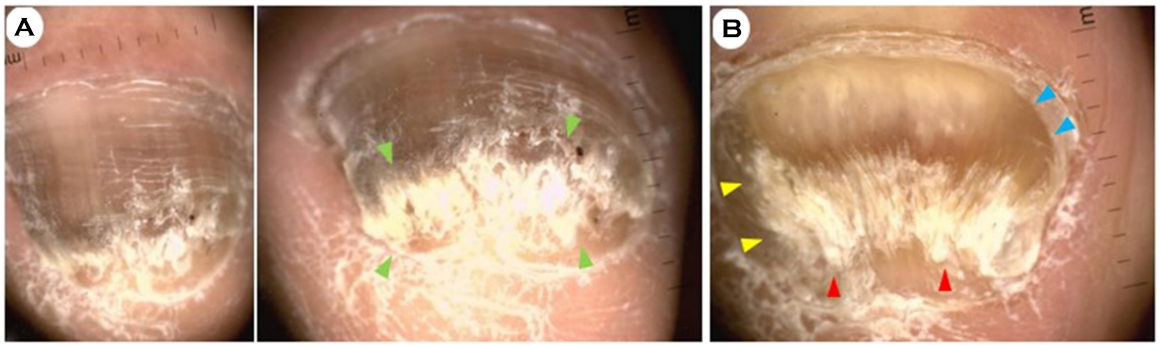

Fig. 2. Dermoscopic findings of DLSO and TDO (A) Distolateral subungual onychomycosis (DLSO), showing brownish discoloration and ruin appearance (green arrow) (magnification, ×10) (B) Total dystrophic onychomycosis (TDO), showing onychodystrophy (yellow arrow), subungual hyperkeratosis (red arrow), and brownish discoloration (blue arrow) (magnification, ×10)

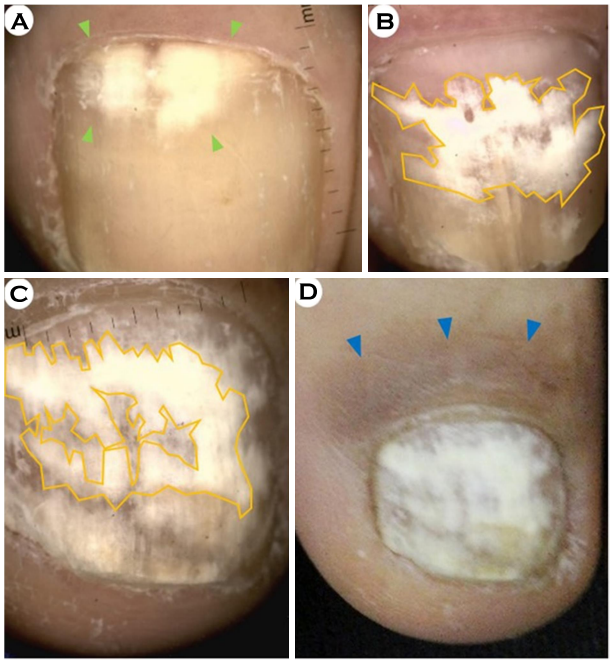

Fig. 3. A specific pattern of fungal leukonychia (A) Proximal subungual onychomycosis (PSO), showing homogeneous leukonychia of the proximal nail plate (green arrow) (magnification, ×10) (B,C) White superficial onychomycosis (WSO), showing homogeneous leukonychia with irregular borders (magnification, ×10) (D) Postinflammatory hyperpigmentation of the proximal nail fold accompanied in WSO (blue arrows) (clinical view)

(Fig. 2A). The onychoscopic pattern of FM showed total melanonychia and mild subungual hyperkeratosis, accompanied by the pseudo-Hutchinson sign (Fig. 4B). Here the pseudo-Hutchinson sign was defined as nail matrix pigmentation detected through a relatively translucent cuticle at the proximal nail fold. The onychoscopic pattern in TDO showed onychodystrophy, subungual hyperkeratosis, and brownish discoloration (Fig. 2B). The onychoscopic pattern in PSO showed homogeneous leukonychia of the proximal nail plate (Fig. 3A). The patients had no previous history of immunocompromizing diseases such as HIV. In WSO, there was homogeneous leukonychia on most of the nail plate (Figs. 3B, 3C).

3. Dermoscopic findings of fungal leukonychia

In our study, the proportion of nails with leukonychia was 64.3% (27/42). We further subdivided the leukonychia samples and classified them according to their morphological type as follows: homogeneous leukonychia (14/42; 33.3%) (Fig. 1C and Fig. 3); longitudinal leukonychia (10/42; 23.8%) (Fig. 1D); and punctate leukonychia (3/42; 7.1%) (Fig. 1I).

The homogeneous leukonychia pattern was commonly observed in PSO and WSO cases (Fig. 3) and was also seen in several DLSO cases (10/31; 32.3%).

In this study, a specific pattern of fungal leukonychia was observed in the WSO subtypes, which was homogeneous leukonychia with irregular borders (Figs. 3B and 3C, magnification, ×10). Severe post-inflammatory hyperpigmentation was observed in the proximal nail fold, which was considered to have resulted from the id reaction to the fungal infection (Fig. 3D, clinical view).

4. Dermoscopic findings related to fungal melanonychia

Three patients with FM were included in this study (Fig. 4),

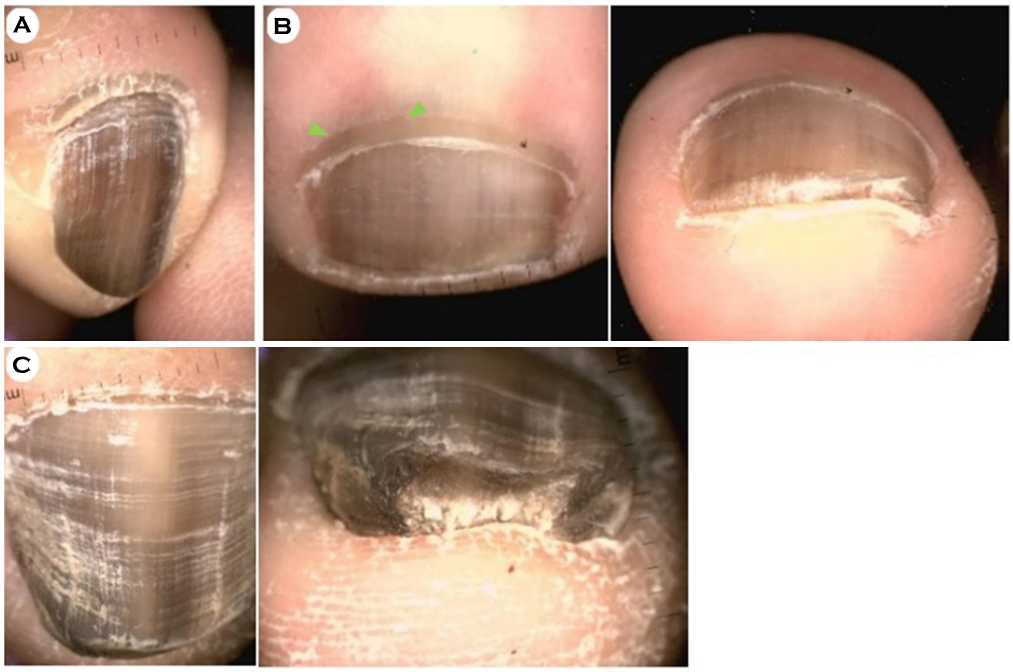

Fig. 4. Three FM cases in our study (A) 63 year-old female patient with FM on right 5th toenail, showing proximal nail plate roughness and proximal nail fold hyperkeratosis (magnification, ×10) (B) 43 year-old female patient with FM on left 2nd toenail, showing pseudo-Hutchinson sign (green arrow) and subungual hyperkeratosis (magnification, ×10) (C) 67 year-old female patient with FM on the right great toenail, showing severe subungual hyperkeratosis and nail plate roughness (magnification, ×10)

and the nails of all three showed dark-brownish, diffuse, and asymmetric pigmentations with a positive KOH test (Fig. 4A-C). In addition, one case showed the pseudo-Hutchinson sign (Fig. 4B), and two cases were accompanied by subungual hyperkeratosis, which was prominently observed in the frontal view during dermoscopy (Fig. 4B-C).

As nail unit melanoma was a differential diagnosis, all patients were followed up while receiving systemic antifungal treatment, and all showed clinical improvement in terms of melanonychia.

DISCUSSION

Five onychomycosis clinical subtypes were observed in this study. DLSO comprised the majority of cases with 80.9%, followed by FM (7.1%), WSO (4.8%), TDO (4.8%), and PSO (2.4%). These findings are consistent with those of a dermoscopic study conducted by De Crignis et al. (DLSO in 66.93%) covering a total of 502 case series[6].

The most frequently observed dermoscopic pattern in our study was nail plate color change. Yellow and brown discolorations were noted in 52.4% and 50% of cases, respectively, which was more than half of all onychomycosis cases, followed by black discoloration (23.8%). A similar pattern of nail color change was also reported by Piraccini et al. (yellow > brown > black: 70% > 51% > 24%)[4]. In their study, 59% of cases showed a whitish color change, which was statistically significant in the diagnosis of onychomycosis. In previous studies, white discoloration of the nail bed or plate was described in various ways such as opacity, white chromonychia, and leukonychia[4,6].

Leukonychia is classified into three subtypes based on its pathologic origin: true leukonychia (pathology originates in the matrix and emerges in the nail plate), apparent leukonychia (pathology is in the nail bed), and pseudoleukonychia (nail plate pathology is exogenous i.e., onychomycosis)[7]. Leukonychia associated with systemic disease tends to be true or apparent, and shows characteristic leukonychia patterns[7]. In our cases, whitish nail color changes were consistent with pseudoleukonychia (Fig. 3).

Kayarkatte et al. reported that the specific morphological types of leukonychia were not statistically significant in the diagnosis of onychomycosis[5]. However, in the present study,

postinflammatory hyperpigmentation of the proximal nail fold along with leukonychia or leukonychia with irregular borders and various chroma was found in the fungal leukonychia cases. Irregular borders of leukonychia may result from fungal invasion and subungual hyperkeratosis. Postinflammatory hyperpigmentation was commonly seen in PSO or WSO cases, which is thought to be due to inflammatory responses to the fungus in the proximal nail fold.

In cases where the clinical features of leukonychia are characteristically expressed, such as fungal balls, the diagnosis of onychomycosis is not difficult. However, in cases where the cause of leukonychia is not clear, the dermoscopic findings can be a decisive clue.

In this study, subungual hyperkeratosis was the most common pattern among the nail changes (47.6%; 20/42). These dermoscopic patterns were observed in 45.2% of DLSO cases (14/31). These findings are consistent with the study by Rathod et al. in which subungual hyperkeratosis was present in 73.9% of all the DLSO cases[8].

A study by Kaynak et al., which was conducted on 205 nail samples from 97 DLSO patients, observed that 92.7% of samples had a ruined appearance pattern, and logistic regression model analysis revealed that this pattern was statistically significant in the diagnosis of DLSO ($p = 0.015$)[1]. However, as described above, the proportion of subungual hyperkeratosis in our study was only 47.6%, which was thought to be due to the differences in infection severity and disease duration.

In the present study, the second most frequently observed nail shape change was the "agged edge with spike" patterns (9/42; 21.4%) (Fig. 1F). All of the "spikes" patterns were observed in DLSO only; in 29.0% (n = 9) of all the DLSO cases. These findings were consistent with a study by Abdallah et al., which reported that "jagged proximal edges" and "intermittent spiked" patterns were more common in DLSO and TDO[9].

Piraccini et al. suggested that "jagged proximal edge with spikes" were exclusive to DLSO[4]. The jagged edge results from the proximal progression of dermatophytes along with the horny layer of the nail bed longitudinal ridges, while the matte discoloration (homogeneous white, yellow, and brown color) reflects the color of the colonies, scales, and subungual debris[4].

The dermoscopic findings of the longitudinal spikes may be found in brittle nail syndrome, also known as onychorrhexis[6]. However, they are not observed on the nail surface and usually start from the proximal region going toward the distal region. This is different from that of onychomycosis longitudinal spikes in DLSO, which are located on the subungual region and start from the distal portion of the nail plate.

FM is a rare cause of nail pigmentation. Diagnosing FM may be very challenging because it can easily be confused clinically with melanocyte related melanonychia[10]. The etiology of melanonychia is multifactorial, with causes that include subungual hematoma, fungal infection, ethnic type pigmentation, drug- or trauma-induced pigmentation, lentigo, nevus, and malignant melanoma[11].

To date, there are very few research studies on the dermoscopic findings of FM. Previous studies described dermoscopic findings of 14, 18, 33, and 20 FM patients[10,12-14]. Kilinc Karaarslan et al. suggested that multicolored pigmentation and reverse triangular patterns (pigmentation that was wider at the distal than the proximal end) are distinctive features of FM; however, their study was limited by its small sample size and the absence of a control group. Ohn et al. compared the dermoscopic findings of FM with those of other causal melanonychias such as nail matrix nevus, melanocytic activation of the nail matrix, and malignant melanoma. Their study reported that several dermoscopic features, such as reverse triangular patterns, subungual hyperkeratosis, and white or yellow streaks, were characteristic of FM. In particular, subungual keratosis increased the likelihood of FM by about 14-fold. Similarly, in our study, 66.7% of the FM cases accompanied subungual hyperkeratosis. Based on our findings, nail plate roughness is an additional FM feature, and it can be more helpful in the diagnosis of FM when accompanied by proximal nail fold hyperkeratosis (Fig. 4A).

Elmas et al. evaluated each of the lesions in combination with the pigmentation color and pattern[12]. The most common presentation was homogeneous brown pigmentation (15/42; 35.7%), and a pseudo-Hutchinson sign was observed in 9.5% (4/42) of lesions. Similarly, in our present study, all 3 FM cases showed dark-brownish homogeneous pigmentations (3/3; 100%), and a pseudo-Hutchinson sign was observed in 33.3% (1/3). However, continuous follow-up is important to differentiate it from a pseudo-Hutchinson sign the true Hutchinson sign.

Our study included some participants who were diagnosed only clinically and not confirmed by mycological examination. Although we used the data of those who only showed clinical improvement after topical antifungal treatment, it is a limitation of our study.

Another limitation of our study is that we did not compare the dermoscopic findings with those of normal controls or controls with non-infectious nail disorders. Our study was also limited by its small sample size, so further large-scale studies are required to validate these findings.

CONCLUSION

We found that dermoscopic patterns such as yellow/brown discoloration and subungual hyperkeratosis were common in our onychomycosis patients. In addition, the characteristic dermoscopic pattern "jagged edge with spikes" was observed in DLSO subtypes.

Our study, along with previous studies, showed that dermoscopy can be a quick and effective tool for diagnosing onychomycosis. In addition, periungual dermoscopic findings can be important clues when diagnosing onychomycosis, especially in cases of FM and leukonychia.

ACKNOWLEDGEMENT

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CONFLICT OF INTEREST

In relation to this article, we declare that there is no conflict of interest.

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ETHICAL APPROVAL STATEMENT

The study was approved by the Institutional Review Board of (IRB No. 2021-1689-0001). This study was conducted in accordance with the principles of the Declaration of Helsinki.

PATIENT CONSENT STATEMENT

The patient provided written informed consent for the publication and the use of images.

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