Retrospective single-center study evaluating clinical and dermoscopic features of longitudinal melanonychia, ABCDEF criteria, and risk of malignancy

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Background: Longitudinal melanonychia (LM) is a common finding in clinical practice; however, it has a broad differential diagnosis, including subungual melanoma (SUM), which can be difficult to distinguish clinically from benign conditions.

Objective: To identify clinical and dermoscopic features that distinguish histopathologically diagnosed SUM from benign LM and to evaluate the validity of the ABCDEF criteria among patients on whom a biopsy was performed.

Methods: Retrospective cohort study of consecutive patients who underwent nail matrix biopsy for LM at a single center from January 2011 to November 2017.

Results: A total of 84 cases in which biopsy was performed (8 cases of SUM and 76 benign) were included in the analysis. The patients with SUM were younger ($P = .011$), had their melanonychia longer ($P = .017$), and presented with a wider band ($P = .002$) and greater width percentage ($P < .001$) than patients with benign LM did. The number of ABCDEF criteria met did not differ between the groups.

Limitations: Retrospective single-center study; patients who did not undergo biopsy could not be studied.

Conclusions: In the cases of LM in which biopsy was performed, SUM usually presented with a wider band and greater width percentage than benign LM did. The number of ABCDEF criteria met was not different between the groups. Because many of the clinical and dermoscopic signs were less consistent, biopsy should be performed in cases with any concerning band, especially in those with width percentage higher than 40%. (J Am Acad Dermatol 2019;80:1272-83.)

Key words: ABCDEF criteria; dermoscopy; longitudinal melanonychia; melanocytic activation; melanotic macule; nail apparatus melanoma; nail unit nevus; subungual melanoma.

Longitudinal melanonychia (LM) is defined as a longitudinally oriented brown-black band that extends from the matrix to the distal portion of the nail plate.[1,2] It has a broad differential diagnosis, including the following: subungual hematoma; exogenous, fungal or bacterial pigment; and melanotic macule (melanocytic activation).[1,3,4] LM may also occur as a result of melanocyte hyperplasia from nevi or malignant melanomas. Subungual melanoma (SUM) is an uncommon variant of

Abbreviations used:

LM: longitudinal melanonychia
SUM: subungual melanoma

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melanoma that arises in the nail unit, accounting for only 0.7% to 3.5% of all malignant melanomas worldwide.[5] SUM is commonly diagnosed in later stages than cutaneous melanomas are, which may account for its relatively poor prognosis.[2,6] The 5- and 10-year survival rates are 30% and 13%, respectively, with the average depth at diagnosis ranging from 3.5 to 4.7 mm.[5,7,8]

One of the key challenges in managing patients with LM is distinguishing SUM from benign conditions.[9] Although tangential matrix excision with histopathologic analysis is the current optimal standard for diagnosing SUM,[10] clinical evaluation has been facilitated with use of the ABCDEF rule proposed by Levit et al in 2000.[11,12] The *A* stands for age (peak incidence in fifth to seventh decade), African Americans, Asians, and Native Americans; the *B* stands for lesion breadth 3 mm or more, brown-to-black coloration, and variegated borders. The *C* stands for change and the *D* stands for digit most commonly involved (thumb > hallux > index finger, single digit > multiple digits). The *E* refers to extension of pigment onto the proximal or lateral nailfold (ie, Hutchinson sign), and the *F* refers to family history of melanoma or dysplastic nevi.[11] It is also important to note that up to one-third of SUMs may be amelanotic.[7]

CAPSULE SUMMARY

- Clinical examination, ABCDEF criteria, and dermoscopy are used to evaluate longitudinal melanonychia.
- Greater width and width percentage may signify subungual melanoma; ABCDEF criteria should be re-examined.

In addition to the clinical features described in the ABCDEF rule, other concerning signs are nonhomogenous pigmentation or triangular shape of the band, nail plate splitting, and blurred lateral borders.[3]

In recent years, use of dermoscopy has refined the evaluation of LM.[13] A brown background with regular brown lines is suggestive of a nail unit nevus, and a gray background with regular gray lines is often seen with a melanotic macule (melanocytic activation). SUMs are more often characterized by a brown background with irregular lines and sometimes by loss of parallelism.[7,13,14]

The most important prognostic factor in SUM is Breslow thickness at diagnosis; early detection, biopsy, and treatment of SUM is crucial to minimize associated morbidity and mortality.[10,15,16] In this study, we sought to identify clinical and dermoscopic criteria that differentiate between histopathologically proven benign LM and SUM and evaluate the validity of the ABCDEF criteria.

METHODS

After approval from the institutional review board at Weill Cornell Medicine, we identified consecutive LM cases in which nail matrix biopsies were performed at Weill Cornell Dermatology from January 2011 to November 2017. Clinical photographs, dermoscopy photographs, clinical records, and histopathology reports were retrospectively reviewed. The electronic medical record data included sex, age at time of biopsy, digit involved, time to presentation, change in the band, associated symptoms (pain, bleeding, drainage), band width, total nail width, band color(s), presence of periungual pigmentation (Hutchinson sign), family or personal history of melanoma, family history of LM, trauma history, hand dominancy, and presence of bands on other nails. When band width and nail plate width were not recorded in the electronic medical record, clinical or dermoscopic photographs were analyzed to measure the band width as a percentage of the nail plate width, which was defined as width percentage. Nail matrix histopathology was utilized to determine malignancy status. Dermoscopic photographs were analyzed and described by 1 of the authors of this article (S.R.L.). The aforementioned variables were statistically analyzed for differences between benign and malignant etiologies of LM. The Fisher exact test was performed for categoric variables and the Wilcoxon rank sum test was performed for continuous variables with a .05 significance level.

Each case was evaluated against the ABCDEF criteria such that a plus sign or minus sign was assigned to each letter in the criteria. A modified version of ABCDEF criteria was used; according to this modified version, race was excluded from criterion A due to sparse data and color and borders were excluded from criterion B on account of their subjectivity. Cases with a complete set of criteria (each letter had a + or − assigned to it) were analyzed with the Wilcoxon rank sum test.

RESULTS

A total of 84 consecutive patients with LM who underwent nail matrix biopsies were included in the analysis (Table I). According to histopathologic analysis, 8 of 84 cases (9.5%) were SUM and 76 of

Table I. Demographic and clinical characteristics by malignancy status

Characteristic	Total (N = 84)	Benign melanonychia (n = 76)	Subungual melanoma (n = 8)	*P* value
Sex				.269
Female	56 (66.7%)	49 (64.5%)	7 (87.5%)	
Male	28 (33.3%)	27 (35.5%)	1 (12.5%)	
Mean age (SD)	51.36 (17.78)	51.96 (17.36)	36.12 (15.04)	.011*
Location				.225
Thumbnail	22 (26.2%)	20 (26.3%)	2 (25.0%)	
Nail of the hallux	17 (20.2%)	15 (19.7%)	2 (25.0%)	
Nail of the index finger	13 (15.5%)	13 (17.1%)	0 (0.0%)	
Second toenail	5 (6.0%)	5 (6.6%)	0 (0.0%)	
Nail of the long finger	5 (6.0%)	5 (6.6%)	0 (0.0%)	
Third toenail	1 (1.2%)	1 (1.3%)	0 (0.0%)	
Nail of the ring finger	6 (7.1%)	4 (5.3%)	2 (25.0%)	
Fourth toenail	6 (7.1%)	6 (7.9%)	0 (0.0%)	
Nail of the small finger	5 (6.0%)	3 (3.9%)	2 (25.0%)	
Fifth toenail	4 (4.8%)	4 (5.4%)	0 (0.0%)	
Mean band width, mm (SD)	3.34 (1.81)†	3.11 (1.68)‡	5.31 (1.77)§	.002*
Mean width percentage (SD)	27.18 (17.96)	24.84 (16.69)	49.48 (14.57)	<.001*
Pigment involving nailfold				.187
Yes	9 (18.4%)	6 (14.3%)	3 (42.9%)	
No	35 (71.4%)	31 (73.8%)	4 (57.1%)	
Pigment seen through transparent nailfold	5 (10.2%)	5 (11.9%)	0 (0.0%)	
Missing	29	27	2	
Mean duration, mo (SD)	49.5 (71.7)‖	39.1 (57.2)¶	128.9 (117.4)#	.017*
Family history of LM				.532
Yes	7 (16.7%)	6 (15.8%)	1 (25.0%)	
No	35 (83.3%)	32 (84.2%)	3 (75.0%)	
Missing	42	38	4	
Family history of melanoma				.357
Yes	4 (5.1)	3 (4.3)	1 (12.5)	
No	74 (94.9)	67 (95.7)	7 (87.5)	
Missing	6	6	0	
Personal history of melanoma				1.000
Yes	2 (2.6%)	2 (2.9%)	0 (0.0%)	
No	76 (97.4%)	68 (97.1%)	8 (100.0%)	
Missing	6	6	0	
Trauma				.165
Yes	14 (25.5%)	11 (22.4%)	3 (50.0%)	
No	41 (74.5%)	38 (77.6%)	3 (50.0%)	
Missing	29	27	2	
Pain				1.000
Yes	6 (9.8%)	6 (10.7%)	0 (0.0%)	
No	55 (90.2%)	50 (89.3%)	5 (100.0%)	
Missing	23	20	3	
Change				1.000
Yes	30 (71.4%)	25 (71.4%)	5 (71.4%)	
Wider	16 (38.1%)	12 (34.3%)	4 (57.1%)	
Darker	9 (21.4%)	9 (25.7%)	0 (0.0%)	
Ridging	2 (4.8%)	2 (5.7%)	0 (0.0%)	
Wider and darker	3 (7.1%)	2 (5.7%)	1 (14.3%)	
No	12 (28.6%)	10 (28.6%)	2 (28.7%)	
Missing	42	41	1	
Color				.493
Black-brown	2 (2.7%)	2 (3.1%)	0 (0.0%)	
Brown	40 (54.8%)	34 (52.3%)	6 (75.0%)	
Dark brown	11 (15.1%)	11 (16.9%)	0 (0.0%)	

Continued

Table I. Cont'd

Characteristic	Total (N = 84)	Benign melanonychia (n = 76)	Subungual melanoma (n = 8)	*P* value
Gray-black	1 (1.4%)	1 (1.5%)	0 (0.0%)	
Gray-brown	10 (13.7%)	10 (15.4%)	0 (0.0%)	
Light brown	8 (11.0%)	6 (9.2%)	2 (25.0%)	
Red-brown	1 (1.4%)	1 (1.5%)	0 (0.0%)	
Missing	11	11	0	
Hand dominancy				.090
Dominant	8 (66.7%)	8 (80.0%)	0 (0.0%)	
Nondominant	4 (33.3%)	2 (20.0%)	2 (100.0%)	
Missing	72	66	6	
Bands on other nails				.100
Isolated band	7 (33.3%)	5 (26.3%)	2 (100.0%)	
Bands on other nails	14 (66.7%)	14 (73.7%)	0 (0.0%)	
Missing	63	57	6	

The results shown in this table do not include the category missing as a level in the Fisher exact test. The test with categories having exact meaning is applied to each categoric variable.
LM, Longitudinal melanonychia; *SD*, standard deviation.
**P* values less than .05 are significant.
[†]n = 77.
[‡]n = 69.
[§]n = 8.
[‖]n = 62.
[¶]n = 55.
[#]n = 7.

the 84 (90.5%) were due to benign causes of LM (Figs 1-3 and Table II). Melanotic macule was the most common benign diagnosis (in 71 of 76 cases [93.4%]); in 2 of 76 cases (2.6%) the diagnosis was nevus, 1 of the 76 cases (2.6%) was nonmelanocytic, and 1 of the 76 (1.3%) was a hematoma (Table III). Of the 84 patients, 56 (66.7%) were female and 28 (33.3%) were males; 7 of the 8 patients with SUM (87.5%) were female (vs with benign LM, $P = .269$). Overall, the patients' average age was 51 years (range, 14-81). The average age of patients with benign melanonychia was 52 versus 36.1 in the case of those patients with SUM ($P = .011$). SUM was similarly prevalent in the nails of the thumb, ring finger, and small finger and nail of the hallux, with SUM in each location affecting 2 patients. The thumbnail and nail of the hallux were most commonly involved in the benign group. None of the patients with SUM had a personal history of melanoma versus 2 of the 76 in the benign group ($P = .99$); 1 of the 8 patients with SUM had a family history of melanoma versus 3 of the 76 in the benign group ($P = .36$).

Overall, the average LM band width was 3.3 mm (range 1 to 10), with a smaller width found in the benign group (3.1 vs 5.3 mm [$P = .002$]). The average width percentage in the benign group was 24.8% versus 49.5% in the group with SUM ($P < .001$). Periungual pigmentation was recorded in 3 of the 8 patients with SUM (37.5%) and in 6 of the 76 with benign LM (7.9%), with an additional 5 patients with benign LM having pigmentation visible through the transparent nailfold.

Patients with SUM had their band for a longer time (mean duration, 128.9 months) than did patients in the benign group (mean duration, 38.3 months) ($P = .017$). A history of trauma was reported in 3 of the 8 patients with SUM (37.5%) versus in 11 of the 76 with benign LM (14.5%) ($P = .165$). There was no associated pain in 5 patients with SUM (no data reported for 3 patients). In the SUM group, 4 of the 8 patients (50%) reported widening of the band and an additional 1 of 8 (12.5%) reported widening and darkening. Five of 19 patients with benign LM (26.3%) had an isolated band versus 2 of 2 (100%) patients with SUM ($P = .100$).

Dermoscopy photographs were available for 25 of the 84 patients (20 with benign disease and 5 with SUM) (Table IV). All 5 patients with SUM showed a brown background and brown lines. In the benign group, 8 of 20 patients (40%) showed a brown

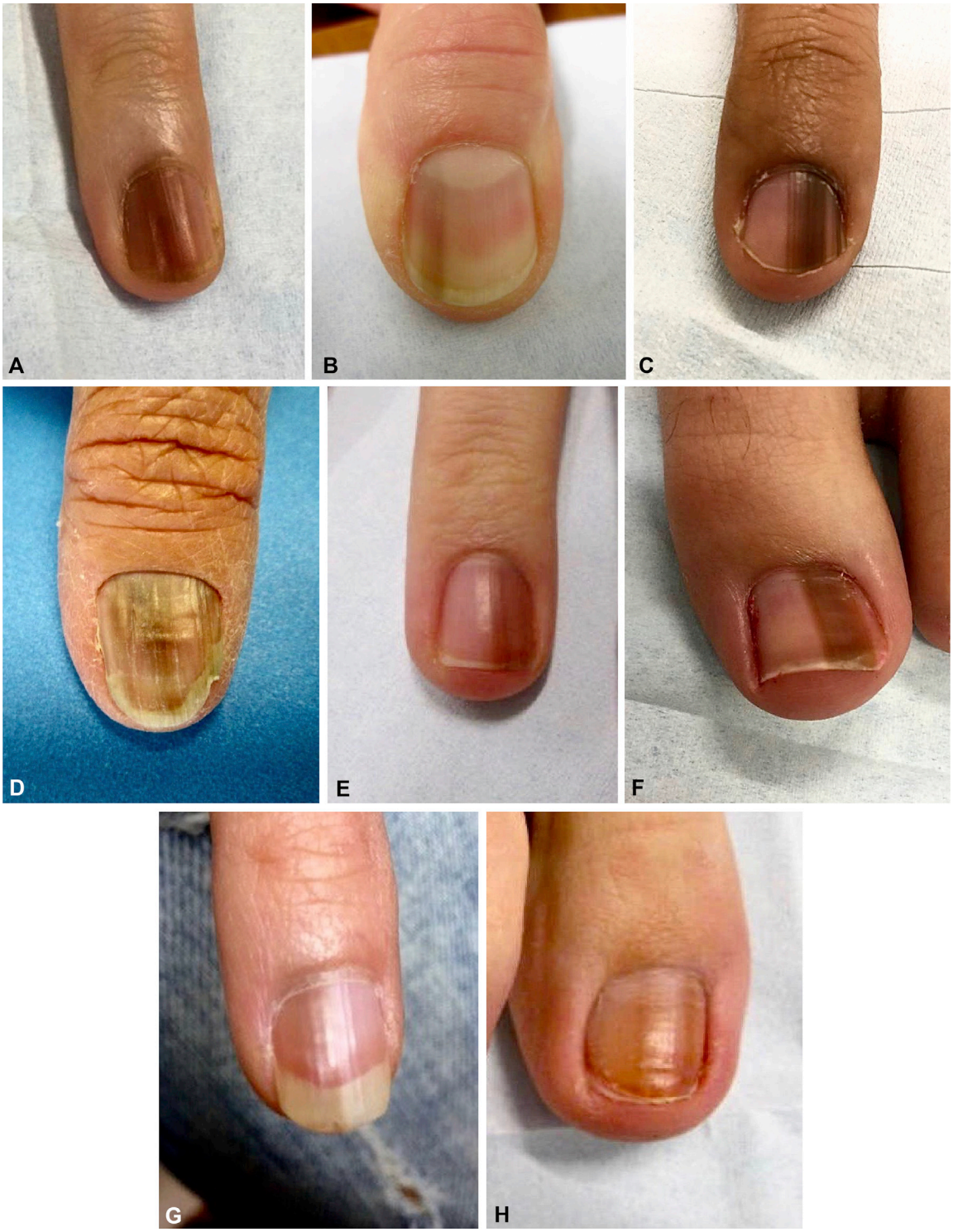

Fig 1. Clinical appearance of subungual melanoma cases. **A**, Case 1. The patient is a 26-year-old woman with a 5-mm brown band (68.0% width percentage) on the nail of the right ring finger. **B**, Case 2. The patient is a 63-year-old woman with a 2.5-mm brown band (18.6%) on the right thumbnail. **C**, Case 3. A 42-year-old man with a 6-mm brown band (54.5%) on the nail of the left small finger. **D**, Case 4. A 52-year-old woman with a 7.5-mm brown band (60.0%) on the left thumbnail. **E**, Case 5. A 31-year-old woman with 6-mm light brown band (45.7%) on the nail of the right ring finger. **F**, Case 6. An 18-year-old woman with a 5.5-mm dark brown band (46.4%) on the nail of the left hallux. **G**, Case 7. A 28-year-old woman with a 3-mm brown band (48.2%) on the nail of the left small finger. **H**, Case 8. A 29-year-old woman with a 7-mm light brown band (54.4%) on the nail of the right hallux.

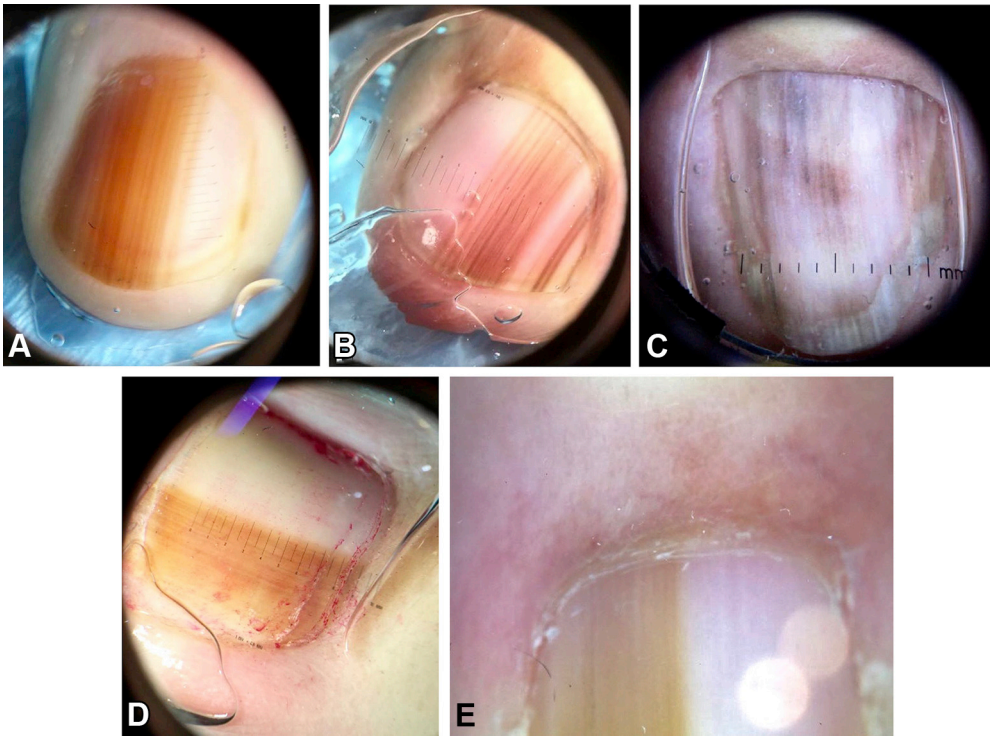

Fig 2. Dermoscopic appearance of 5 subungual melanomas (cases 1, 3, 4, 6, and 7). **A**, Case 1. Brown lines on a brown background, regular color and spacing, irregular thickness with no loss of parallelism. **B**, Case 3. Brown lines on a brown background, irregular color, thickness, and spacing with no loss of parallelism. **C**, Case 4. Brown lines on a brown background, irregular color, thickness, and spacing with loss of parallelism. **D**, Case 6. Brown lines on a brown background with regular color, thickness, and spacing with no loss of parallelism. **E**, Case 7. Brown lines on a brown background, regular color, thickness, and spacing with no loss of parallelism.

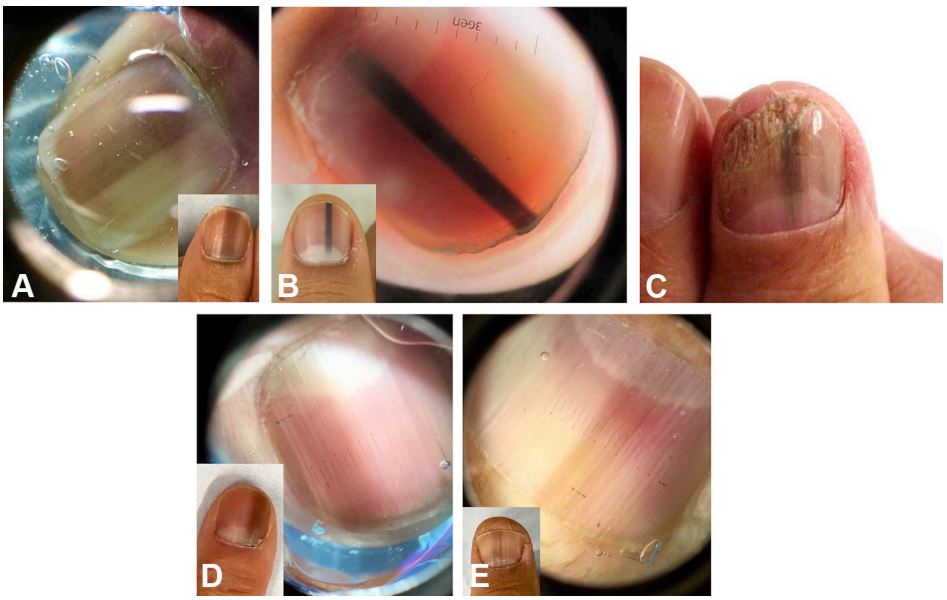

Fig 3. Clinical and dermoscopic appearance of cases of benign melanonychia. **A**, Ethnic-type pigmentation in a 29-year-old woman with a 4.5-mm brown band of the left thumbnail. **B**, Junctional nevus in a 17-year-old boy with a 4-mm black-brown band of the right thumbnail. **C**, Melanocytic activation secondary to onychomycosis in a 78-year-old man with a 2-mm dark brown band of the right thumbnail. **D**, Melanotic macule in a 68-year-old woman with a 5-mm brown band of the nail of the left index finger. **E**, Melanotic macule in a 57-year-old man with a 3-mm brown band of the right thumbnail.

Table II. Clinical features in 8 cases of subungual melanoma

Case	Sex	Age, y	Location	Band width, mm	Width %	Color	Hutchinson sign	Duration	Change	Dermoscopy characteristics
1	F	26	Nail of the right ring finger	5	68.0	Brown	+	10 y	Wider	Brown background, brown lines, regular color, irregular thickness, regular spacing, parallel
2	F	63	Right thumbnail	2.5	18.6	Brown	−	8 mo	No change	Dermoscopy not available
3	M	42	Nail of the left small finger	6	54.5	Brown	+	27 y	Wider	Brown background, brown lines, irregular color, irregular thickness, irregular spacing, parallel
4	F	52	Left thumbnail	7.5	60.0	Brown	−	1.5 y	Wider	Brown background, brown lines, irregular color, irregular thickness, irregular spacing, loss of parallelism
5	F	31	Nail of the right ring finger	6	45.7	Light brown	−	5 y	No change	Dermoscopy not available
6	F	18	Nail of the left hallux	5.5	46.4	Dark brown	−	Unknown	Wider and darker	Brown background, brown lines, regular color, regular thickness, regular spacing, parallel
7	F	28	Nail of the left small finger	3	48.2	Brown	+	12 y	Wider	Brown background, brown lines, regular color, regular thickness, regular spacing, parallel
8	F	29	Nail of the right hallux	7	54.4	Light brown	−	Unknown	Unknown	Dermoscopy not available

F, Female; *M*, male.

Table III. Frequency of benign diagnoses of longitudinal melanonychia

Benign diagnosis	Cases, n (%) (N = 76)
Melanotic macule	71 (93.4)
Nevus	2 (2.6)
Nonmelanocytic	2 (2.6)
Hematoma	1 (1.3)

background and 7 of 20 (35%) showed brown lines. In terms of regularity, 2 of 5 patients with SUM (20%) showed irregularity in color, 3 of 5 (60%) showed irregularity in thickness, and 2 of 5 (60%) showed irregularity in spacing. Only 1 of 5 (20%) showed loss of parallelism versus none in the benign group.

A complete set of data on the ABCDEF criteria was available for 27 subjects (20 in the benign group and 7 with SUM). The average number of criteria met in the benign group was 2.45 versus 2.86 in the SUM group (a difference that was not statistically significant [$P = .361$]) (Tables V-VII). The 2 most common ABCDEF criteria for which patients in the SUM group were positive were B (7 of 8 patients [87.5%] were positive for it) and C (5 of 7 patients [71.4%] were positive for it) (no data were available for 1 patient with SUM). These 2 criteria were also the most common in the benign group, with 40 of 69 patients (58.0%) positive for B ($P = .140$) and 26 of 36 patients (72.2%) positive for C ($P = .99$). Of the patients with SUM, only 3 were positive for criterion A, 4 were positive for D, 3 were positive for E, and 1 was positive for F.

DISCUSSION

SUM is definitively diagnosed via nail matrix biopsy with histopathologic examination; however, the procedure is invasive and even with tangential matrix excision, there is risk of permanent nail dystrophy. Ideally, biopsy and treatment would be performed only for patients with SUM while sparing those patients with benign LM. Therefore, it is paramount to develop clinical guidelines to better determine when a nail matrix biopsy is necessary to rule out malignancy. Concerning clinical examination findings, the ABCDEF rule, and dermoscopy findings have been purported to help distinguish benign from malignant etiologies of LM.

In the present study, the patients with benign melanonychia on whom biopsy had been performed were older than the patients with SUM, with mean ages of 36.1 and 52 years, respectively. Our results contrast with those of prior studies

Table IV. Dermoscopy characteristics between benign melanonychia and subungual melanoma

Characteristic		Benign melanonychia, n (%) (n = 20)	Subungual melanoma, n (%) (n = 5)
Background	Gray background	12 (60)	0 (0)
	Brown background	8 (40)	5 (100)
Band color	Gray line	6 (30)	0 (0)
	Brown line	7 (35)	5 (100)
	Gray-brown line	7 (35)	0 (0)
Regularity of color	Regular color	18 (90)	3 (60)
	Irregular color	2 (10)	2 (40)
Regularity of thickness	Regular thickness	11 (55)	2 (40)
	Irregular thickness	9 (45)	3 (60)
Regularity of spacing	Regular spacing	11 (55)	3 (60)
	Irregular spacing	9 (45)	2 (40)
Parallelism	Parallel	20 (100)	4 (80)
	Loss of parallelism	0 (0)	1 (20)

Table V. Evaluation of the ABCDEF criteria in 8 cases of subungual melanoma

Case	Age (fifth to seventh decade)	Band ≥3 mm	Change	Digits (commonly affected)	Extension of pigment (Hutchinson sign)	Family history of melanoma	Total criteria met, n
1	−	+	+	−	+	−	3
2	+	−	−	+	−	−	2
3	+	+	+	−	+	−	4
4	+	+	+	+	−	−	4
5	−	+	−	−	−	−	1
6	−	+	+	+	−	−	3
7	−	+	+	−	+	−	3
8	−	+	?	+	−	+	?
							2.86*

A, + if patient is in the fifth to seventh decade at the time of biopsy, otherwise −; *B*, + if LM band is 3 mm or larger, − if band is less than 3 mm; *C*, + if patient reported change in the band, − if no change, and ? if unknown; *D*, + if digit affected is thumbnail or nail of the hallux, − if any other location; *E*, (+) if there is extension of pigment on nailfold (Hutchinson sign), (−) if there is not; and *F*, (+) if there is family or personal history of melanoma, (−) if there is not.

*Mean of the total number of criteria met only in cases with a complete data set, cases 1 to 7.

showing that SUM occurs most often in the fifth to seventh decades of life.[2,5,16-19] Therefore, we advocate that younger adults also be screened for SUM. There was a female predominance in the SUM group, which is consistent with previous literature.[1,6,8] This pattern was also true in the benign group, which may suggest that females are more likely to undergo biopsy, have a genuine sex predominance of LM, or seek earlier medical attention. Unlike the authors of other reports,[11,12,18,20,21] we did not find a predisposition toward SUM for the thumbnail and nail of the hallux, though the small sample size may explain this discrepancy. SUM affected the thumbnail, nails of the ring finger and small finger, and nail of the hallux equally. Trauma is implicated as a risk factor for SUM[11,22]; however, 3 of 6 patients with SUM in this study reported trauma to the affected nail versus 11 of 49 patients with benign LM (P = .165), which does not support this association.

Compared with patients with benign LM who underwent biopsy, patients in the SUM group had a longer duration of the band before presentation. Interestingly, those patients with SUM and a band duration of 10 years or more (the patients in cases 1, 3, and 7) all experienced changes (specifically, widening of their band).

The band width was wider in the SUM group than in the benign group, which is consistent with previous reports.[12,18,21,23] The ABCDEF criteria propose that a band width of 3 mm or more is suggestive of malignancy.[11] Seven of the 8 patients

Table VI. Evaluation of the ABCDEF criteria in benign cases of LM

Case	Age (fifth to seventh decade)	Band ≥3 mm	Change	Digit (most commonly affected)	Extension of pigment	Family history of melanoma	Total no. of criteria met
1	+	+	+	−	−	−	3
2	+	+	+	−	−	−	3
3	+	−	−	−	−	−	1
4	+	+	+	−	−	−	3
5	+	−	+	+	−	+	4
6	−	−	+	−	−	−	1
7	+	+	+	−	−	−	3
8	−	+	+	+	−	−	3
9	+	+	−	−	−	−	2
10	−	+	+	−	−	−	2
11	+	+	+	−	−	−	3
12	+	+	+	+	−	−	4
13	+	+	+	+	−	−	4
14	−	+	−	−	+	−	2
15	−	+	+	−	−	−	2
16	−	+	+	−	+	−	3
17	+	−	−	+	+	−	3
18	−	−	+	−	−	−	1
19	−	+	−	−	−	−	1
20	−	−	+	−	−	−	1
							2.45

A, + if patient is in their fifth to seventh decade at time of biopsy, otherwise −; B, + if LM band ≥ 3 mm, − if band < 3 mm; C, + if patient reported change in the band, − if no change; D, + if digit affected is thumbnail or nail of the hallux, − if any other location; E, + if there is extension of pigment on nailfold (Hutchinson sign), − if there is not; and F, + if there is family or personal history of melanoma, − if there is not.

LM, longitudinal melanonychia.

with SUM in this study indeed presented with band widths of 3 mm or more, whereas 1 patient (the patient in case 2) presented with a 2.5-mm-wide band. The width percentage was also greater in the SUM group than in the benign group. In a previous study, SUM typically involved more than two-thirds of the nail plate whereas benign LM involved less than one-third of the nail plate.[23] In our study, post hoc analyses showed statistical significance with a dichotomizing band width percentage at 40% (P = .047). Thus, we propose a band width percentage cutoff of 40% to suggest SUM over benign LM, which is a hypothesis that should be independently tested in future studies. We suggest that band width percentage is a more specific predictor of SUM than band width is (Fig 4). Both band width and width percentage cutoffs correctly identified 7 of the 8 patients with SUM, but 58.6% of patients with benign LM had band widths of 3 mm or more versus 17.1% with width percentages greater than 40%, demonstrating that our proposed cutoff of width percentage of more than 40% rules out more patients with benign LM than does a band width of 3 mm or more. We speculate that this is due to the varying sizes of all nails within and among patients.

On dermoscopy, patients 6 and 7 showed regularity in every aspect on dermoscopic examination (color, thickness, spacing, and parallelism). However, even with these dermoscopy findings, which suggest a benign etiology, patients 6 and 7 had band widths of 5.5 mm and 3 mm and width percentages of 46.4% and 48.2%, respectively, raising the suspicion for malignancy. Our study reinforces previous data showing the limitations of dermoscopy in the evaluation of LM.[6,18,20,24]

Evaluation of the ABCDEF criteria in the groups with SUM and benign LM (Tables V-VII) showed that none of the patients with SUM met all the criteria and only 2 criteria (B and C) were met by the majority of patients with SUM. The other 4 criteria (A, D, E, and F) were met by half or less than half of patients with SUM, which suggests that the ABCDEF criteria should be reconsidered. However, all 8 patients with SUM met at least 1 of the 6 ABCDEF criteria, with an average of 2.86 criteria met compared with 2.45 met

Table VII. Analysis of ABCDEF criteria in benign longitudinal melanonychia and subungual melanoma

Criterion	Total (N = 27)	Benign melanonychia (n = 20)	Subungual melanoma (n = 7)	*P* value
A-F, mean no. of criteria met (SD)	2.52 (1.01)	2.45 (1.03)	2.86 (1.07)	.361
A				.573
Yes	42 (50.0%)	39 (51.3%)	3 (37.5%)	
No	42 (50.0%)	37 (48.7%)	5 (62.5%)	
Missing	0	0	0	
B				.140
Yes	47 (61.0%)	40 (58.0%)	7 (87.5%)	
No	30 (39.0%)	29 (42.0%)	1 (12.5%)	
Missing	7	7	0	
C				1
Yes	31 (72.1%)	26 (72.2%)	5 (71.4%)	
No	12 (27.9%)	10 (27.8)	2 (28.6%)	
Missing	41	40	1	
D				1
Yes	39 (46.4%)	35 (46.1%)	4 (50.0%)	
No	45 (53.6%)	41 (53.9%)	4 (50.0%)	
Missing	0	0	0	
E				.144
Yes	9 (18.0%)	6 (14.3%)	3 (37.5%)	
No	41 (82.0%)	36 (85.7%)	5 (62.5%)	
Missing	34	34	0	
F				.357
Yes	4 (5.1%)	3 (4.3%)	1 (12.5%)	
No	74 (94.9%)	67 (95.7%)	7 (87.5%)	
Missing	6	6	0	

Analyses for each single criterion through A to F are based on the completed cases for each single criterion, respectively, instead of completed cases for all criteria.
SD, Standard deviation.

by patients in the benign group (a non–statistically significant difference). Therefore, on the basis of this study cohort, the ABCDEF criteria for diagnosing SUM may not be sensitive enough to use in clinical practice. A previous study also found no difference in age, affected digit, family history, and trauma history in the ABCDEF criteria and thus proposed a new dermoscopic scoring model based on width of pigmentation, asymmetry, Hutchinson sign, multicolor pigmentation, and border fading.[21] Because the differences analyzed in our study were between malignant and benign cases of patients with LM who underwent biopsy, these differences may not hold true for all benign cases of LM and SUM. However, because there is no difference in the number of criteria met between the cases of benign and malignant LM in which biopsy was performed, we suggest that less emphasis be placed on the ABCDEF criteria and more importance be given to band width and band width percentage.

The limitations of this study are its retrospective design and the fact that it was limited to a single institution over a 7-year period with different biopsy techniques used. There was also missing information in the data, including information on dermoscopy. This study elucidates the frequency of SUM in patients with LM who underwent nail matrix biopsies but not on the incidence of SUM in the general population or among everyone with LM. A larger-scale prospective multi-institution study evaluating all patients with LM should be conducted to answer these questions.

CONCLUSION

This study supports the finding that SUM typically presents with a wider band width and width percentage and is present for a longer time than in benign cases of LM with histopathology. This study also suggests that given enough clinical suspicion to warrant a biopsy for LM, the ABCDEF criteria are not fully reliable to distinguish SUM from benign LM. In other words, among these high-risk patients, the number of criteria met may not directly correlate with a higher chance of malignancy. In addition, our study also supports the finding that width percentage is a more specific predictor of SUM than band width

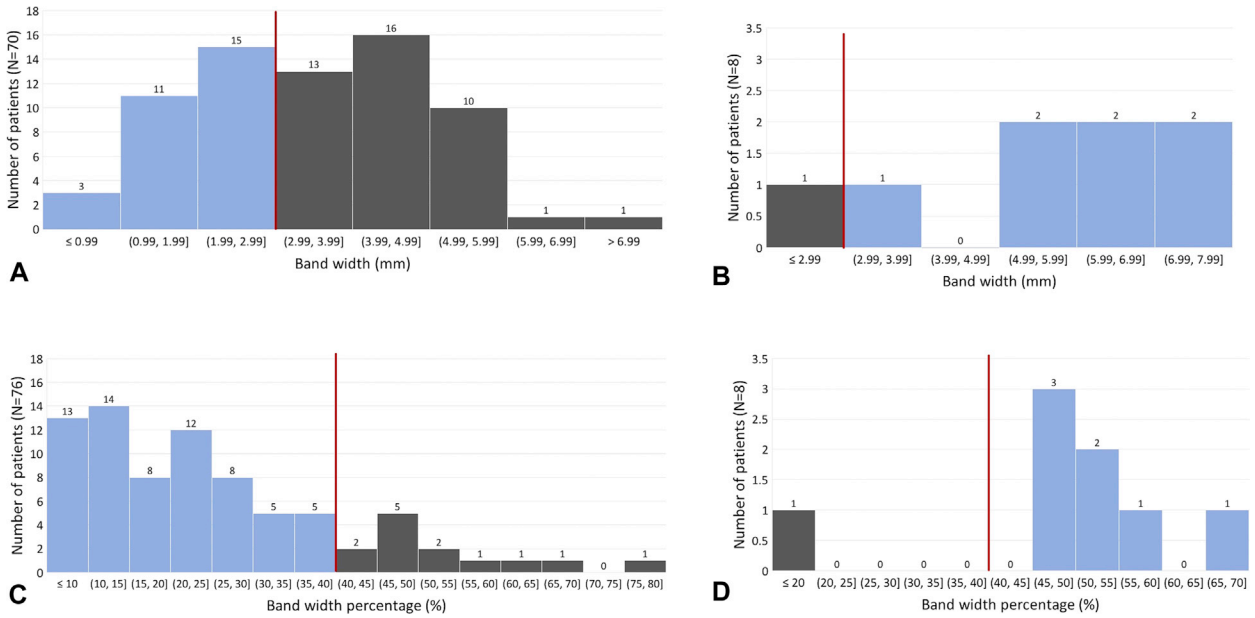

Fig 4. Width percentage is a more specific predictor of subungual melanoma (SUM) than band width; both correctly identify the same number of SUM cases, whereas width percentage correctly rules out more benign cases. The red line indicates band width equal to or greater than the 3-mm cutoff or the proposed width percentage cutoff of 40%. **A**, Distribution of band width (in millimeters) in patients with longitudinal melanonychia with a benign biopsy result. Of the 70 patients with benign disease, 41 (58.6%) had band widths of 3 mm or more and thus were falsely identified. **B**, Distribution of band width percentage (%) in patients with longitudinal melanonychia with a benign biopsy result. Of the 76 benign cases, 13 (17.1%) had width percentages greater than 40% and were thus falsely identified. **C**, Distribution of band width (in millimeters) in SUM cases. Of the patients in the 8 SUM cases, 7 (87.5%) had band widths of 3 mm or more and thus were correctly identified. **D**, Distribution of band width percentage (%) in SUM cases. Of the patients in the 8 SUM cases, 7 (87.5%) had width percentages greater than 40% and thus were correctly identified.

is. To compensate for the low sensitivity of the ABCDEF criteria, we recommend that patients with LM undergo biopsy if there is any doubt regarding the results of their clinical or dermoscopic evaluation, especially with a width percentage greater than 40%.

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