

Significance of Dermoscopic Patterns in Detecting Malignant Melanoma on Acral Volar Skin

Results of a Multicenter Study in Japan

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Objective: To determine diagnostic variables such as sensitivity and specificity of the major dermoscopic patterns observed in melanocytic lesions on acral volar skin, with particular attention to the significance of the parallel ridge pattern and irregular diffuse pigmentation in detecting acral melanoma.

Design: Multicenter, retrospective study.

Setting: University hospitals in Japan.

Patients: Patients with melanocytic lesions on acral volar skin. A total of 712 melanocytic lesions (103 malignant melanomas, including 36 in situ lesions, and 609 melanocytic nevi) were consecutively collected from the files of 3 hospitals. Diagnoses of all the lesions had been determined histopathologically.

Interventions: Dermoscopic examination.

Main Outcome Measures: The sensitivity, specificity, positive predictive value, negative predictive value,

and diagnostic accuracy of the major dermoscopic patterns seen in benign and malignant melanocytic lesions on acral volar skin.

Results: The parallel ridge pattern and irregular diffuse pigmentation showed extremely high specificity (99.0% and 96.6%, respectively) and very high negative predictive value (97.7% and 97.5%, respectively) in malignant melanoma. For melanoma in situ, the positive predictive value and diagnostic accuracy of the parallel ridge pattern were significantly higher than those of irregular diffuse pigmentation ($P=.009$ and $P=.006$, respectively). In melanocytic nevi, the specificity and positive predictive value of the parallel furrow pattern and/or the latticelike pattern were found to be very high (93.2% and 98.3%, respectively).

Conclusions: Dermoscopy is immensely helpful in differentiating malignant melanomas from melanocytic nevi on acral volar skin. Moreover, the parallel ridge pattern aids in detecting acral melanomas in early, curable stages.

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IN NONWHITE POPULATIONS, malignant melanoma is most frequently seen on acral skin. In Japanese, about one half of all cutaneous melanomas affect acral skin, and nearly 30% of them are detected on the sole of the foot.¹ In addition, approximately 10% of melanomas involve the nail apparatus of fingers and toes. Most melanomas affecting acral skin are of the acral lentiginous type, which accompanies a macular component within the lesions.¹ The prognosis of acral lentiginous melanoma is generally poor, since most of them are found in advanced stages. Detection of this type of melanoma in early, curable stages is essential to improve the prognosis. On acral skin, however, benign melanocytic nevi are also frequently encountered. In a recent study by Saida,² approximately 7% of the Japanese population had melanocytic nevi on the soles.

Clinical differentiation between early melanomas and melanocytic nevi on acral volar skin is often not easy. Moreover, biopsy of lesions on the sole and of the nail apparatus can be difficult to perform.

Our group investigated clinical and histopathologic characteristics of early melanoma affecting acral skin and proposed guidelines for the early detection of malignant melanoma on the sole and of the nail apparatus.³⁻⁶ More recently, we found characteristic dermoscopic features of malignant melanoma and those of benign melanocytic nevus affecting acral volar skin. Dermoscopic examinations by our group have demonstrated that the parallel ridge pattern showing prominent pigmentation on the ridges of the skin markings is a characteristic dermoscopic feature often detected in macular portions of malignant melanoma and melanoma in situ on acral volar skin.⁷⁻¹¹ In addition, studies by our

Author affiliations are listed at the end of this article. The authors have no relevant financial interest in this article.

Table 1. Number of Melanocytic Lesions on Acral Volar Skin Evaluated by Dermoscopy

Institution (Period)	Malignant Melanoma, No.			Melanocytic Nevus, No.			Total, No.
	Invasive	In Situ	Total	Acquired	Congenital	Total	
Shinshu University Hospital (November 1990-September 2000)	48	18	66	189	20	209	275
Saitama Medical School Hospital (March 1994-October 2000)	15	8	23	157	130	287	310
University of Tokyo Hospital (April 1995-September 2000)	4	10	14	107	6	113	127
Total	67	36	103	453	156	609	712

Table 2. Definition of Dermoscopic Patterns Observed in Melanocytic Lesions on Acral Volar Skin

Pattern	Definition
Parallel ridge pattern*	Bandlike pigmentation on ridges of skin markings
Irregular diffuse pigmentation*	Diffuse pigmentation with variable shades from tan to black, occasionally even with grayish tone
Parallel furrow pattern	Parallel linear pigmentation along sulci of skin markings
Latticelike pattern	Linear pigmentation following and crossing sulci of skin markings
Fibrillar pattern	Numerous fine fibrillar or filamentous pigmentation running in slanting direction to skin markings

*See also Figure 1.

group have found that irregular diffuse pigmentation (previously called *diffuse multicomponent pigmentation*⁸ or *diffuse pigmentation with variable shades*⁹) is also frequently detected in malignant melanoma on acral volar skin.⁹⁻¹² In contrast, the parallel furrow pattern showing pigmentation along the sulci of the skin markings and its variant, the latticelike pattern, are the most prevalent dermoscopic features observed in benign melanocytic nevi on acral volar skin.⁷⁻¹² Such distinctive dermoscopic findings surely help us to correctly diagnose acral melanocytic nevi and, most important, to detect early melanomas on acral volar skin. Ronger et al¹³ recently reported dermoscopic characteristics of pigmented lesions affecting the nail apparatus. Malvehy and Puig^{14,15} described dermoscopic patterns seen in melanocytic nevi on glabrous skin of white subjects. The patterns are essentially the same as those we described, although they added a few new minor patterns.

In the present multicenter study, we investigated dermoscopically a total of 712 melanocytic lesions on acral volar skin and, on the basis of the data obtained, we estimated diagnostic variables such as the sensitivity and specificity of these dermoscopic patterns in detecting malignant melanoma and melanocytic nevus of this anatomic site.

METHODS

MELANOCYTIC LESIONS INCLUDED

Cases of malignant melanoma (including melanoma in situ) and melanocytic nevus, acquired or congenital, affecting acral volar skin were collected from the files of 3 university hospitals in Ja-

pan: Shinshu University Hospital in Matsumoto, Saitama Medical School Hospital in Moroyama, and the University of Tokyo Hospital. In this study, acral volar skin included the sole of the foot, the volar aspect of the toe, the palm of the hand, and the volar aspect of the finger. Nail apparatus lesions involving hyponychial volar skin were also included. These cases were consecutively seen at each hospital. The numbers of lesions examined in each hospital are given in **Table 1**. A total of 712 melanocytic lesions were entered in this study: 103 lesions of malignant melanoma, including 36 lesions of melanoma in situ, and 609 lesions of melanocytic nevus (453 acquired melanocytic nevi and 156 congenital melanocytic nevi). All of the lesions came from Japanese patients. Written informed consent was obtained from each patient. Diagnoses of all the lesions were established histopathologically by means of standard criteria.¹⁶⁻¹⁸ Congenital nevi were differentiated from acquired nevi by clinical information and histopathologic findings.¹⁸ Lesions of melanocytic nevi were excluded from this study if they were not definitely determined to be acquired or congenital. Tissue slides of a few cases with difficult histopathologic features were sent to an experienced dermatopathologist (T.S.), who examined the slides and determined the final diagnosis.

DEVICES FOR DERMOSCOPY AND EVALUATION OF PATTERNS

Dermoscopic findings, magnified 10 to 50 times, were obtained by using a videomicroscope (Hirox Inc, Tokyo, or Keyence Inc, Osaka, Japan), dermoscope (DG-2; Scalar Inc, Tokyo), or Dermatoscope/Dermaphot (Heine Inc, Herrsching, Germany), and recorded and stored in personal computers or in the form of 35-mm transparencies. Experts in dermoscopy at the 3 institutions evaluated dermoscopic findings of the lesions. For invasive melanomas, macular portions of the lesions were evaluated dermoscopically in this study. For nail apparatus lesions, pigmented lesions on hyponychial volar skin were examined dermoscopically. Dermoscopic patterns of the lesions were classified according to the classification proposed by our group^{7-12,19} (**Table 2**). The parallel ridge pattern and irregular diffuse pigmentation are illustrated in **Figure 1**. As our classification of dermoscopic patterns of acral melanocytic lesions is very simple, dermoscopic images of all the cases in this series were easily interpreted.

CALCULATION OF DIAGNOSTIC SIGNIFICANCE OF DERMOSCPIC PATTERNS

In the present study, particular attention was paid to the diagnostic significance of the parallel ridge pattern and irregular diffuse pigmentation in dermoscopic detection of malignant melanoma on acral volar skin. In calculating diagnostic variables of a particular dermoscopic pattern in malignant melanoma, definitions of lesions were as follows: true-positive (TP) lesions were malignant melanomas showing the dermoscopic pattern, true-negative (TN) lesions were melanocytic nevi where

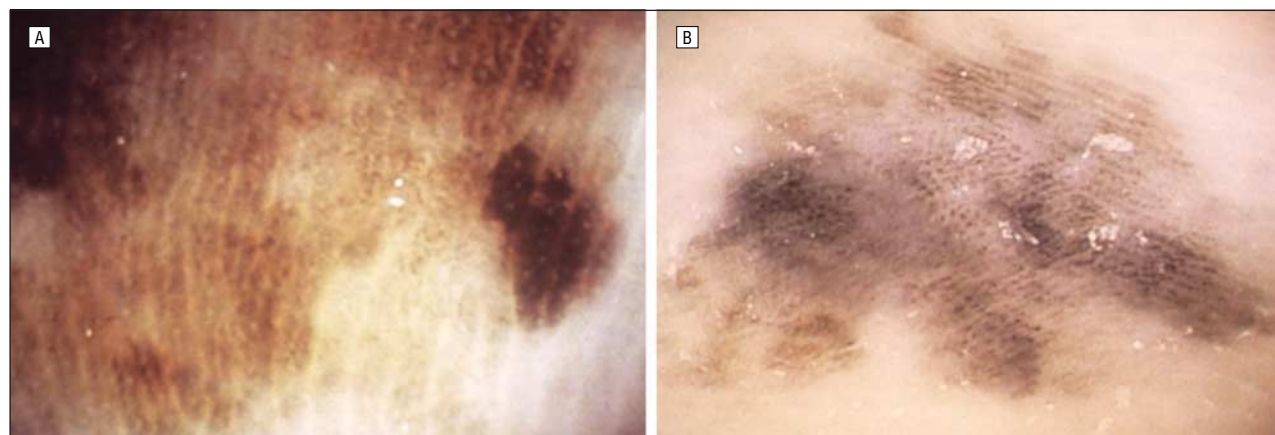


Figure 1. Characteristic dermoscopic patterns detected in macular portions of invasive melanoma and melanoma in situ on acral volar skin. A, The parallel ridge pattern, which shows bandlike pigmentation on the ridges of the skin markings. Note that eccrine openings seen as whitish dots are regularly distributed within the bandlike pigmentation. B, Irregular diffuse pigmentation, showing randomly distributed brownish or grayish black pigmentation with highly variable shades. In this lesion, many brownish black dots or globules are also observed.

Table 3. Prevalence of Dermoscopic Patterns Detected in Each Melanocytic Category

Dermoscopic Pattern	Malignant Melanoma, No. (%)			Melanocytic Nevus, No. (%)		
	Invasive (n = 67)	In Situ (n = 36)	Total (N = 103)	Acquired (n = 453)	Congenital (n = 156)	Total (N = 609)
Parallel ridge pattern	58 (87)	31 (86)	89 (86)	4 (0.9)	2 (1.3)	6 (1.0)
Irregular diffuse pigmentation	63 (94)	25 (69)	88 (85)	12 (2.6)	9 (5.8)	21 (3.4)
Parallel furrow pattern	2 (3)	0	2 (2)	202 (44.6)	90 (57.7)	292 (47.9)
Latticelike pattern	3 (4)	2 (6)	5 (5)	97 (21.4)	20 (12.8)	117 (19.2)
Fibrillar pattern	16 (24)	7 (19)	23 (22)	115 (25.4)	32 (20.5)	147 (24.1)

the dermoscopic pattern was not detected, false-negative (FN) lesions were malignant melanomas not showing the dermoscopic pattern, and false-positive (FP) lesions were melanocytic nevi showing the dermoscopic pattern. Sensitivity was the fraction of melanoma lesions showing the dermoscopic pattern among all lesions of malignant melanoma and was calculated as $TP/(TP+FN)$. Specificity was the fraction of melanocytic nevi not showing the dermoscopic pattern among all melanocytic nevi and was calculated as $TN/(TN+FP)$. The positive predictive value was the fraction of melanoma lesions showing the dermoscopic pattern among all melanocytic lesions showing the dermoscopic pattern and was calculated as $TP/(TP+FP)$. The negative predictive value was the fraction of melanocytic nevi not showing the dermoscopic pattern among all melanocytic lesions not showing the dermoscopic pattern and was calculated as $TN/(TN+FN)$. Diagnostic accuracy was the fraction of melanoma lesions showing the dermoscopic pattern among all melanoma lesions and melanocytic nevi showing the dermoscopic pattern and was calculated as $TP/(TP+FN+FP)$. The diagnostic variables of the dermoscopic patterns seen in acral melanocytic nevi were calculated in the same manner.

STATISTICAL ANALYSIS

We used the χ^2 test to assess for statistical differences of the diagnostic variables between the melanocytic categories (malignant melanoma vs melanocytic nevus) and developmental stages of melanoma (melanoma in situ vs invasive melanoma). We considered $P < .05$ to be significant.

RESULTS

The prevalence of each dermoscopic pattern in each melanocytic category on acral volar skin is shown in **Table 3**. On the basis of the results, diagnostic variables of the parallel ridge pattern and those of irregular diffuse pigmentation in malignant melanoma on acral volar skin were calculated as shown in **Table 4**. With regard to all melanomas (invasive and in situ), the positive predictive value of the parallel ridge pattern was significantly higher than that of irregular diffuse pigmentation (93.7% vs 80.7%; $P = .01$), although sensitivity, specificity, and negative predictive value were not significantly different between the 2 patterns. The diagnostic accuracy of the parallel ridge pattern was higher than that of irregular diffuse pigmentation (81.7% vs 71.0%), although statistically not significant ($P = .51$). Regarding only melanoma in situ, the positive predictive value (83.8% vs 54.3%; $P = .009$), and the diagnostic accuracy (73.8% vs 43.9%; $P = .006$) of the parallel ridge pattern were significantly higher than those of irregular diffuse pigmentation. In melanoma in situ, the sensitivity of the parallel ridge pattern was also higher than that of irregular diffuse pigmentation (86.1% vs 69.4%), although not statistically significant ($P = .16$). In contrast, in invasive melanoma, the positive predictive

Table 4. Diagnostic Significance of Dermoscopic Patterns Detected in Melanocytic Lesions on Acral Volar Skin*

Pattern	Lesions	Sensitivity, %	Specificity, %	Positive PV, %	Negative PV, %	Diagnostic Accuracy, %
Parallel ridge pattern	All melanomas	86.4	99.0	93.7 ^d	97.7	81.7 ^j
	Invasive melanoma	86.5	99.0	90.6 ^e	98.5	79.5
	Melanoma in situ	86.1 ^a	99.0	83.8 ^f	99.2	73.8 ^k
Irregular diffuse pigmentation	All melanomas	85.4	96.6	80.7 ^g	97.5	71.0 ^l
	Invasive melanoma	94.0 ^b	96.6	75.0 ^h	99.3	71.6 ^m
	Melanoma in situ	69.4 ^c	96.6	54.3 ⁱ	98.2	43.9 ⁿ
Parallel furrow pattern or latticelike pattern	All melanocytic nevi	67.2	93.2	98.3	32.4	66.4
	Acquired nevi	66.0	93.2	97.7	61.6	65.0
	Congenital nevi	70.5	93.2	94.0	32.4	67.5

Abbreviation: PV, predictive value.

*Superscript letters refer to comparisons for *P* values: a vs c, *P* = .16; b vs c, *P* = .002; d vs g, *P* = .01; e vs h, *P* = .03; f vs i, *P* = .009; h vs i, *P* = .03; j vs l, *P* = .51; k vs n, *P* = .006; m vs n, *P* = .002.

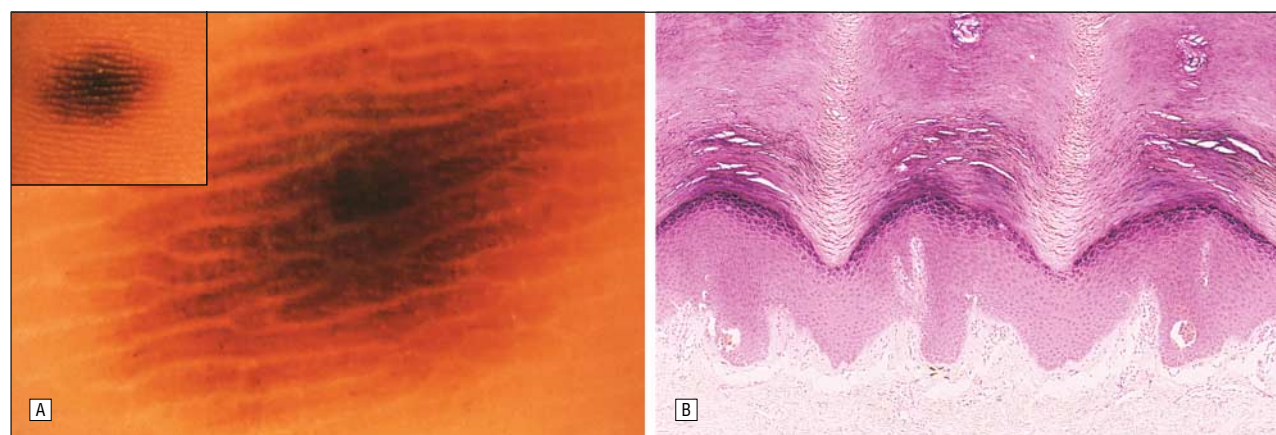


Figure 2. An exceptional case of melanocytic nevus on the sole that showed the parallel ridge pattern on dermoscopy (patient 1 in Table 5). A, Dermoscopic features showing bandlike pigmentation on the ridges of the skin markings. Inset, Clinical features. B, On histopathologic examination, well-demarcated nests of melanocytes are located in the crista profunda intermedia, ie, epidermal rete ridges situated under the surface ridges of the skin markings. The melanocytes in the nests are small and round with typical oval nuclei (hematoxylin-eosin, original magnification $\times 18$).

Table 5. Clinical and Histopathologic Information on Acral Melanocytic Nevi on the Sole Showing the Parallel Ridge Pattern on Dermoscopy

Patient No./Sex/Age, y	Size of Lesion, mm	Histopathologic Diagnosis
1/F/21	10 \times 7	Acquired nevus, junctional type
2/F/52	4 \times 3	Congenital nevus, compound type
3/F/27	3 \times 2	Acquired nevus, junctional type
4/M/50	2 \times 2	Acquired nevus, compound type
5/F/51	4 \times 3	Congenital nevus, compound type
6/F/56	5 \times 2	Acquired nevus, junctional type

value of the parallel ridge pattern was significantly higher than that of irregular diffuse pigmentation (90.6% vs 75.0%; *P* = .03). The sensitivity of irregular diffuse pigmentation in invasive melanoma was higher than that of the parallel ridge pattern (94.0% vs 86.5%), although not statistically significant (*P* = .24). In the present series, 6 (1.0%; 4 acquired and 2 congenital nevi) of 609 melanocytic nevi exhibited the parallel ridge pattern. A representative case of acquired melanocytic nevus showing the parallel ridge pattern is illustrated in **Figure 2**, and

information on the 6 cases is given in **Table 5**. With regard to irregular diffuse pigmentation, invasive melanoma showed significantly higher sensitivity (*P* = .002), positive predictive value (*P* = .03), and diagnostic accuracy (*P* = .002) than melanoma in situ.

The parallel furrow pattern and the latticelike pattern are representative dermoscopic patterns mainly detected in melanocytic nevi on acral volar skin. The diagnostic variables of these 2 patterns in melanocytic nevi are given in Table 4. The specificity and positive predictive value of the parallel furrow patterns and/or the latticelike pattern were very high in melanocytic nevi, around 95%, although the sensitivity and diagnostic accuracy were not as high (67.2% and 66.4%, respectively). The negative predictive value of these dermoscopic patterns was low in all melanocytic nevi and in congenital nevi (32.4%). In addition, the fibrillar pattern was detected in 20% to 25% in all the categories of melanocytic lesions on acral volar skin.

COMMENT

The present multicenter study has confirmed that the 2 dermoscopic patterns, the parallel ridge pattern and irregular diffuse pigmentation, are highly valuable in de-

tecting malignant melanoma on acral volar skin. In all melanomas, including invasive and in situ melanomas, the positive predictive value of the parallel ridge pattern was significantly higher than that of irregular diffuse pigmentation. When only melanoma in situ was considered, the differences were much more prominent. In melanoma in situ, the diagnostic accuracy of the parallel ridge pattern was also significantly higher than that of irregular diffuse pigmentation. In contrast, in invasive melanomas, the sensitivity of the parallel ridge pattern was a little lower than that of irregular diffuse pigmentation, although the positive predictive value of the parallel ridge pattern was still significantly higher than that of irregular diffuse pigmentation. These data indicate that the parallel ridge pattern is a superior dermoscopic finding to irregular diffuse pigmentation in detecting malignant melanoma on acral volar skin, particularly in the early in situ stage.^{9,10} Conversely, the positive predictive value and diagnostic accuracy of irregular diffuse pigmentation were significantly higher in invasive melanoma than in melanoma in situ. However, the sensitivity, positive predictive value, and diagnostic accuracy of the parallel ridge pattern were not significantly different between melanoma in situ and invasive melanoma. These results suggest that irregular diffuse pigmentation becomes more prominent after melanoma lesions develop to the invasive stage from melanoma in situ. On the basis of these data, we suspect that, in malignant melanoma on acral volar skin, neoplastic melanocytes initially proliferate mainly in the crista profunda intermedia, epidermal rete ridges situated under the surface ridges, and then spread across the entire epidermis.⁹

The parallel ridge pattern is a highly specific dermoscopic pattern to malignant melanoma, including melanoma in situ, on acral volar skin. However, in the present series, 6 (1.0%) of 609 melanocytic nevi exhibited this dermoscopic pattern, indicating that the parallel ridge pattern is not an absolute hallmark of malignant melanoma on acral volar skin. Nonetheless, the great advantage of this dermoscopic pattern in detecting malignant melanoma on acral volar skin is still maintained because of the extremely low frequency in melanocytic nevi.

The parallel furrow pattern, where linear pigmentation is observed along the sulci of the skin markings, is the most prevalent dermoscopic pattern in melanocytic nevi on acral volar skin. We consider the latticelike pattern to be a variant of the parallel furrow pattern.⁹ In the present series, more than two thirds of melanocytic nevi showed the parallel furrow pattern or the latticelike pattern. These dermoscopic patterns showed very high values of specificity (93.2%) and positive predictive value (98.3%) in melanocytic nevi (congenital or acquired) in the present series. The diagnostic variables of the parallel furrow pattern and/or the latticelike pattern were mostly comparable between acquired and congenital melanocytic nevi, although the negative predictive value was lower in congenital nevi (Table 4). In malignant melanoma, these 2 dermoscopic patterns are detected only rarely. They were found in 7 of 103 malignant melanomas in the present series. When these patterns were seen in a melanoma lesion, they were detected just focally within the lesion. This is in contrast to melanocytic nevi, where these dermo-

scopic patterns were consistently observed throughout the entire lesion. In any case, if a pigmented lesion on acral volar skin shows the typical parallel furrow pattern or the latticelike pattern on dermoscopy, it is certainly diagnosed as benign melanocytic nevus, which helps us to prevent unnecessary biopsy.

The fibrillar pattern was detected in 20% to 25% in all categories of melanocytic lesions on acral volar skin. In malignant melanoma, this pattern is also only focally detected. In contrast, in most melanocytic nevi, this pattern is evenly distributed throughout the lesion. In our view, the fibrillar pattern does not reflect any particular distribution of proliferating melanocytes within the epidermis. We suspect that the histopathologic background of the fibrillar pattern is a slanting arrangement of the epidermal structures, particularly of the cornified layer.⁹ Melanin granules distributed along this slanting direction could produce linear pigmentation on dermoscopy. This slanting may be caused by mechanical pressure from body weight (A.M., T.S., S.O., T. Suzuki, MD, PhD, and T.T., unpublished data, 2002).

Fortunately, other common pigmented lesions such as seborrheic keratosis and basal cell carcinoma, which often cause problems in clinical and dermoscopic diagnosis of malignant melanoma, are not found on acral volar skin. So-called black heel (subcorneal hematoma), ethnic-type volar pigmentation, and pigmented macules of Peutz-Jeghers syndrome could show similar dermoscopic patterns to the parallel ridge pattern^{9,11}; however, these conditions could be rather easily diagnosed by their characteristic clinical and/or dermoscopic presentation. Therefore, differentiation between malignant melanoma and melanocytic nevus is the major practical concern on this anatomic site. The present study of melanocytic lesions on acral volar skin has confirmed the value of dermoscopy not only in differentiating malignant melanoma from melanocytic nevus but also in detecting malignant melanoma in early, curable stages.

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