STUDY

Epiluminescence Microscopy for the Diagnosis of Doubtful Melanocytic Skin Lesions

Comparison of the ABCD Rule of Dermatoscopy and a New 7-Point Checklist Based on Pattern Analysis

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Objective: To compare the reliability of a new 7-point checklist based on simplified epiluminescence microscopy (ELM) pattern analysis with the ABCD rule of dermatoscopy and standard pattern analysis for the diagnosis of clinically doubtful melanocytic skin lesions.

Design: In a blind study, ELM images of 342 histologically proven melanocytic skin lesions were evaluated for the presence of 7 standard criteria that we called the "ELM 7-point checklist." For each lesion, "overall" and "ABCD scored" diagnoses were recorded. From a training set of 57 melanomas and 139 atypical nonmelanomas, odds ratios were calculated to create a simple diagnostic model based on identification of major and minor criteria for the "7-point scored" diagnosis. A test set of 60 melanomas and 86 atypical nonmelanomas was used for model validation and was then presented to 2 less experienced ELM observers, who recorded the ABCD and 7-point scored diagnoses.

Settings: University medical centers.

Patients: A sample of patients with excised melanocytic lesions.

Main Outcome Measures: Sensitivity, specificity, and accuracy of the models for diagnosing melanoma.

Results: From the total combined sets, the 7-point checklist gave a sensitivity of 95% and a specificity of 75% compared with 85% sensitivity and 66% specificity using the ABCD rule and 91% sensitivity and 90% specificity using standard pattern analysis (overall ELM diagnosis). Compared with the ABCD rule, the 7-point method allowed less experienced observers to obtain higher diagnostic accuracy values.

Conclusions: The ELM 7-point checklist provides a simplification of standard pattern analysis because of the low number of features to identify and the scoring diagnostic system. As with the ABCD rule, it can be easily learned and easily applied and has proven to be reliable in diagnosing melanoma.

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EPILUMINESCENCE microscopy (ELM; in vivo cutaneous surface microscopy, dermoscopy, dermatoscopy, and magnified oil immersion diascopy) is an in vivo, noninvasive technique that has disclosed a new dimension of the clinical morphologic features of pigmented skin lesions using different incident light magnification systems with an oil immersion technique.[1]

Results of previous studies demonstrate that ELM improves accuracy in diagnosing pigmented skin lesions. Results of reports[2,3] assessing diagnostic accuracy by clinical examination show that dermatologists are able to detect melanoma in 65% to 80% of lesions, depending on their expertise. In a recent systematic review of ELM accuracy in diagnosing melanoma,[4] dermatoscopy had 10% to 27% higher sensitivity than clinical diagnosis by the naked eye.

Austrian research groups[5-8] performed a systematic analysis of the new morphologic features that become apparent with ELM and proposed a qualitative pattern analysis model for distinguishing between different types of pigmented skin lesions and, in particular, between benign and malignant growth patterns. In 1989, a consensus meeting held by the Committee on Analytical Morphology of the Arbeitsgemeinschaft Dermatologische Forschung in Hamburg, Germany, provided a new standardized terminology of ELM patterns and variables to better communicate this method to clinical dermatologists.[9] It was later pointed out that a high rate of diagnostic accuracy in pigmented skin lesions could only be obtained by experienced ELM

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MATERIALS AND METHODS

MATERIALS

In a blind study, we evaluated ELM images of 342 melanocytic skin lesions. All lesions were photographed in vivo at a fixed magnification of ×10 with special photography equipment (Dermaphot, Heine Optotechnik, Herrsching, Germany) after being covered by immersion oil (to render the stratum corneum translucent). Each 35-mm color slide was studied on a viewer (Kodak Ektapro 5000 Slide Projector, Kodak Aktiengesellschaft, Stuttgart, Germany).

All lesions were excised and reviewed for histological diagnosis. The study included 117 cutaneous melanomas (CMs) and 225 clinically atypical melanocytic nevi (MN). All MN were considered atypical by the clinician, thus leading to the decision to perform a biopsy examination. The group of CMs included 18 in situ CMs, 50 CMs with a Breslow index less than 0.76 mm, and 49 CMs with a Breslow index greater than 0.75 mm (mean tumor thickness, 0.9 mm); the group of MN comprised 114 histologically atypical nevi[15] and 111 "common" nevi.

ELM CRITERIA

Epiluminescence microscopic images were studied to evaluate the incidence of 7 standard ELM criteria (and 11 variables of them) that we called the "ELM 7-point checklist" (**Table 1**). These features were selected for their frequent association with melanoma (as previously reported)[8,9,16] and for their histopathologic substrate[17-19] (**Table 2**). Most of these features were listed in the guidelines of the consensus meeting in Hamburg.[9] In addition, the following were selected: irregular diffuse pigmentation (blotches),[7] "peppering" (multiple gray-blue dots),[19-22] and atypical vascular pattern.[14,19,21,23] The latter was defined as shown in Table 2 (**Figure 1** through **Figure 6**).

In contrast to the terminology used in the consensus paper, we used the term "atypical" pigment network to describe all the features of the network frequently associated with melanoma. We chose the term "prominent" to describe the hyperpigmentation and the thickness (broadness) of the network grid lines because these characteristics may not be easily differentiated at low magnification (×10). Furthermore, we did not include the evaluation of the diameter (width) of the network meshes because of the scarce significance of the feature, as previously reported.[16,22] Radial streaming and pseudopods (irregular extensions and streaks) are morphologically dissimilar, but both are histopathologically correlated to confluent radial junctional nests of melanocytes[9,24]; they were, therefore, evaluated as a single criterion. Dots and globules were also considered as a single criterion because they are distinguished by their size (a globule being a large dot), but both may have multiple colors (black, brown, or blue)[22] and may not be easily differentiated on a 10-fold magnification ELM image.[19] On the basis of their similar histopathologic significance, we included white (scarlike) areas, hypopigmented areas, and peppering in a single criterion termed "regression pattern." We used the term "peppering" (instead of gray-blue areas) because it better defines the typical ELM appearance of the dermal melanophages that can be observed in small clumps within regression areas. Furthermore, the term "gray-blue areas" was used for defining the irregular, con-

investigators because of a series of subtle features and special criteria that had to be qualitatively assessed by pattern analysis.[10,11]

More recently, a new ABCD rule of dermatoscopy has been developed on the basis of a semiquantitative scoring system to obtain a high rate of diagnostic accuracy also for inexperienced ELM investigators. This method can be easily learned and easily applied and has proven to be reliable.[12-14]

The purpose of our study was to compare the reliability of a new 7-point checklist based on a simplified ELM pattern analysis with the ABCD rule of dermatoscopy and standard pattern analysis for the diagnosis of clinically doubtful melanocytic skin lesions.

RESULTS

In the training set, 8 variables of the 7 ELM criteria showed significant differences between CMs and MN (Table 1). A formula (not shown) created by multivariate analysis for the best differentiation of melanocytic skin lesions produced (by means of the receiver operator characteristic technique), at a threshold of 0.15, a sensitivity of 93%, and a specificity of 75% (area under the curve ± SD value, 0.98 ± 0.01). However, because of the complexity of this model, it was not suitable for clinical use. Rather, a simple diagnostic model was developed to produce a sensitivity and specificity approaching that of the aforementioned formula. Using the odds ratios calculated with multivariate analysis, a score of 2 was given to the 3 criteria with odds ratios greater than 5, which we called "major" criteria, and a score of 1 was given to the 4 criteria with odds ratios lower than 5, which we called "minor" criteria (**Table 3**). By simple addition of the individual criteria scores, a total score of 3 or more allowed classification in the training set with a sensitivity of 93%, a specificity of 78%, and diagnostic accuracy of 60%. Reliability of the ELM 7-point checklist was verified on the test set, revealing a sensitivity of 97%, a specificity of 71%, and diagnostic accuracy for melanoma of 68%. The total combined sets gave a sensitivity of 95%, a specificity of 75%, and diagnostic accuracy for melanoma of 64% (**Table 4** and **Figure 7**). In total, 280 (81.9%) of 342 melanocytic skin lesions were correctly diagnosed by this method compared with 247 correct ABCD scored dermoscopic diagnoses (72.2%) and 309 correct overall ELM diagnoses (90.4%). Compared with the ABCD rule, the 7-point checklist allowed greater sensitivity (95% vs 85%), specificity (75% vs 66%), and diagnostic accuracy (64% vs 51%), whereas with respect to the overall ELM diagnosis it gave an increase in sensitivity (95% vs 91%) but a decrease in specificity (75% vs 90%) and diagnostic accuracy (64% vs 76%) (Table 4). With the 7-point checklist, the less experienced observers also obtained higher

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fluent, gray-blue to whitish blue diffuse pigmentation histopathologically correlated to pigmented melanophages or melanocytes of midreticular dermis location.[18] We did not include the evaluation of whitish veil (milky way) because clinicians often use the terms "milky way" and "gray-blue veil" synonymously because of the presence of blue pigment in a whitish veil.[22,25]

The evaluation of the presence or absence of ELM criteria was carried out with the consensus of at least 2 of 3 different ELM-experienced investigators (G.A., P.C., and V.D.G.). For each lesion, the same observers (using the same procedure) recorded the overall dermoscopic impression for the overall ELM diagnosis, and the final dermatoscopy score for the ABCD scored dermoscopic diagnosis was calculated using the ABCD scoring criteria established by Stolz et al.[12] Lesions with scores of 4.75 or less were classified as benign, and those with scores higher than 4.75 were classified as melanomas. In contrast with the original report by Stolz et al, we included the range of suspicious lesions (scores, 4.76-5.45) in the group of melanomas to obtain a lower number of false-negative results, thereby increasing the sensitivity of the model.

STATISTICAL ANALYSIS

Three hundred forty-two lesions were randomly divided into a training set of 57 CMs and 139 MN and a test set of 60 CMs and 86 MN. In the training set, absolute and relative frequencies of each ELM variable in both groups of CMs and MN were calculated. In a univariate approach, significant differences between CMs and MN were evaluated using the χ^2 test of independence. The significant variables ($P<.01$) were used for stepwise logistic regression analysis (BioMedical Data Package [BMDP] Dynamic, version 1993, Statistical Software Inc, Cork, Ireland) to determine their different diagnostic weights in the diagnosis of melanoma, as expressed by odds ratios.

Two models for diagnosing melanoma were developed with the training set. For the first model, multivariate analysis was used to create a formula for calculating the probability of each lesion belonging to the group of melanomas, and the receiver operator characteristic analysis (Labroc program, authored by C. E. Metz, Department of Radiology, University of Chicago, Chicago, Ill) was performed for diagnostic validation. The receiver operator characteristic curve shows the relation between true-positive results (on the y-axis) and false-positive results (on the x-axis); the more a curve arches into the upper left-hand corner, the greater the area beneath the curve and the better the test. For the second model, the individual criteria were scored according to the odds ratios calculated by the multivariate analysis. This allowed the creation of a simple diagnostic method (suitable for clinical use) based on identification of major and minor ELM criteria for the 7-point scored ELM diagnosis.

The ELM images from the test set were then scored by the experienced observers using the latter method and were evaluated by 2 ELM less experienced dermatologists (G.F. and E.S.), after short formal ELM training of 9 hours, who recorded the ABCD and 7-point scored diagnoses. Finally, sensitivity, specificity, and diagnostic accuracy for melanoma were calculated for the overall ELM diagnosis of the experienced investigators and for the ABCD and 7-point scored ELM diagnoses of experienced and less experienced dermatologists.

diagnostic accuracy and specificity values compared with the ABCD rule (49%-52% vs 46% and 45%-48% vs 27%-35%, respectively), whereas the sensitivity values ranged from 85% to 93% for the 7-point checklist and from 88% to 95% for the ABCD rule. Independent of the method used, the ELM nonexperts were able to classify a high percentage of melanomas (85%-95%) as well as the experienced observers, but the specificity and, therefore, the accuracy values were lower (Table 4).

Of the 117 CMs, 111 had a 7-point score of 3 or more and were, therefore, correctly predicted as CMs by the experts with the 7-point checklist. Six lesions were not identified (score, <3) with this method (5% false-negative rate). Five lesions had ABCD scores less than 4.76 and were recorded as benign lesions for the overall ELM diagnosis; 3 CMs showed black, intense, diffuse pigmentation that entirely obscured the lesions; 1 lesion showed the typical pattern of the Spitz nevus (regular, large, brown globules on the lesion's periphery)[26]; and 2 lesions were featureless. With the ABCD rule, 18 of 117 CMs had scores lower than 4.76 and were, therefore, not identified with this method (15% false-negative rate). Most of these lesions showed no more than 1-axis asymmetry[12] and few colors and structures. Of the 99 CMs with scores higher than 4.75, 84 (71.8% of all CMs) had scores higher than 5.45, and 15 (12.8% of all CMs) had scores in the range of the suspicious lesions (scores, 4.76-5.45). With overall ELM diagnosis, 11 CMs were classified as benign lesions, giving a false-negative rate of 9%. **Table 5** shows the number of correctly diagnosed CMs (by means of the 3 methods being evaluated), which were divided into subgroups of less than 0.76- and more than 0.75-mm histological thickness.

Melanocytic nevi were correctly assessed (score, <3) with the 7-point checklist in 169 of 225 lesions. Most of the 56 MN not identified (score, ≥3) with this method (25% false-positive rate) showed histological features of dysplastic nevi (35 of 56 lesions); in the remaining lesions, histological examination revealed MN of a junctional or compound type (17 lesions), Spitz nevi (3 lesions), and a blue nevus (1 lesion). Of the 77 incorrectly assessed MN with the ABCD rule (34% false-positive rate), 48 (21.3% of all MN) were classified as malignant lesions (score, >5.45) and 29 (12.9% of all MN) were classified as suspicious lesions (score, 4.76-5.45). Only a 10% false-positive rate was registered with the overall ELM diagnosis (22 MN were recorded as melanoma).

COMMENT

Early detection of CM is one of the greatest challenges of dermatologic practice today. Epiluminescence microscopy has recently proven to be a valuable method for improving the clinical diagnosis of melanoma.[6,7] However,

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Table 1. Frequencies of ELM Variables in Melanocytic Skin Lesions (N = 196) and Their Statistical Significance for the Univariate Classification of the Training Set*

ELM Criterion	Variable	Frequency (%)		χ^2	*P*
		CM (n = 57)	MN (n = 139)		
Atypical pigment network	Irregular	13 (22.8)	47 (33.8)	2.31	.13
	Prominent	0	8 (5.8)	3.42	.06
	Irregular and prominent	30 (52.6)	24 (17.3)	25.33	<.001
Gray-blue areas	Present	27 (47.4)	6 (4.3)	53.51	<.001
Atypical vascular pattern	Present	22 (38.6)	7 (5.0)	36.12	<.001
Radial streaming (streaks)	Present	34 (59.6)	14 (10.1)	53.73	<.001
Irregular diffuse pigmentation (blotches)	Present	44 (77.2)	42 (30.2)	36.23	<.001
Irregular dots and globules	Present	42 (73.7)	25 (18.0)	55.74	<.001
Regression pattern	White areas	15 (26.3)	10 (7.2)	13.28	<.001
	Hypopigmented areas	19 (33.3)	30 (21.6)	2.98	.08
	"Peppering"	21 (36.8)	12 (8.6)	22.97	<.001

*ELM indicates epiluminescence microscopy; CM, cutaneous melanoma; and MN, melanocytic nevi.

Table 2. Definitions and Histological Correlates of ELM Criteria Significantly Associated With Melanoma*

ELM Criterion	Definition	Histological Correlates[14,15]
Atypical pigment network	Prominent (hyperpigmented or broad) and irregular network	Hyperpigmented or broadened rete ridges with irregular shape or distribution
Gray-blue areas	Irregular, confluent, gray-blue to whitish blue diffuse pigmentation not associated with red-blue lacunes or maple leaf pigmentation[18]	Pigmented melanophages or melanocytes of midreticular dermis location
Atypical vascular pattern	Linear, dotted, or globular red structures irregularly distributed outside areas of regression and associated with other melanocytic pigment patterns	Neovascularization or vascularized nests of amelanotic cells[11]
Radial streaming (streaks)	Radially and asymmetrically arranged linear or bulbous extensions at the edge of the lesion	Confluent radial junctional nests of melanocytes[20]
Irregular diffuse pigmentation (blotches)	Brown, gray, and black areas of diffuse pigmentation with irregular shape or distribution and abrupt end	Hyperpigmentation throughout all levels of the epidermis or upper dermis (in melanocytes or melanophages)
Irregular dots and globules	Black, brown, or blue round structures irregularly distributed within the lesion	Aggregates of pigment of stratum corneum, junctional, or dermis location
Regression pattern	White scarlike depigmentation or "peppering" (speckled multiple blue-gray dots within a hypodepigmented area)[19] irregularly distributed within the lesion	Areas of loss of pigmentation and fibroplasia, with scattered dermal melanophages

*ELM indicates epiluminescence microscopy.

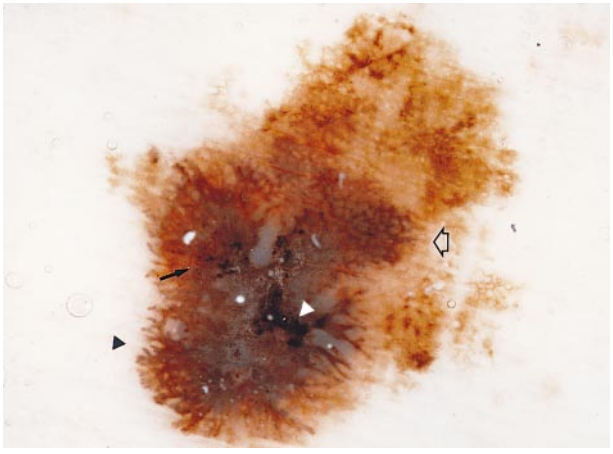

Figure 1. *Cutaneous melanoma (0.45 mm thick) with an irregular and prominent (atypical) pigment network (white arrow) (7-point score: 2), streaks (black arrowhead) (score: 1), blotches (white arrowhead) (score: 1), and irregular dots and globules (black arrow) (score: 1). Seven-point total score: 5 (original magnification ×10).*

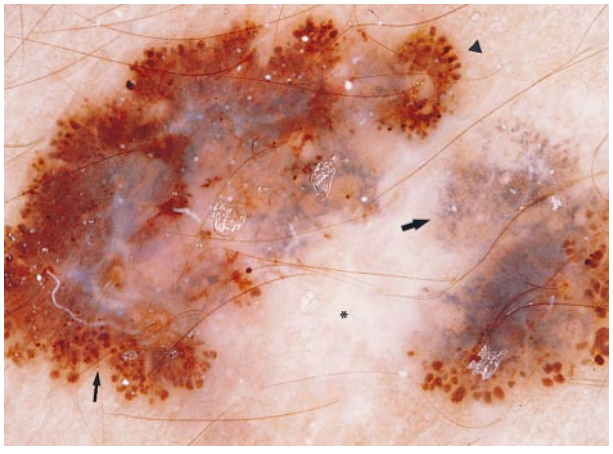

Figure 2. *Cutaneous melanoma (0.6 mm thick) with irregular dots and globules (thin black arrow), streaks (black arrowhead), and regression pattern. The latter consists of white areas (asterisk) and peppering (thick black arrow) (score: 1). Total score: 3 (original magnification ×10).*

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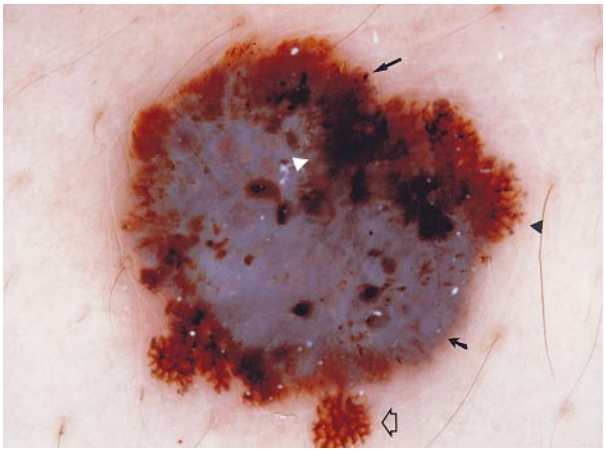

Figure 3. *Cutaneous melanoma (1 mm thick) with a prevalence of gray-blue areas (curved black arrow) (score: 2). An atypical pigment network (white arrow), streaks (black arrowhead), blotches (white arrowhead), and irregular dots and globules (black arrow) are also observed. Total score: 7 (original magnification ×10).*

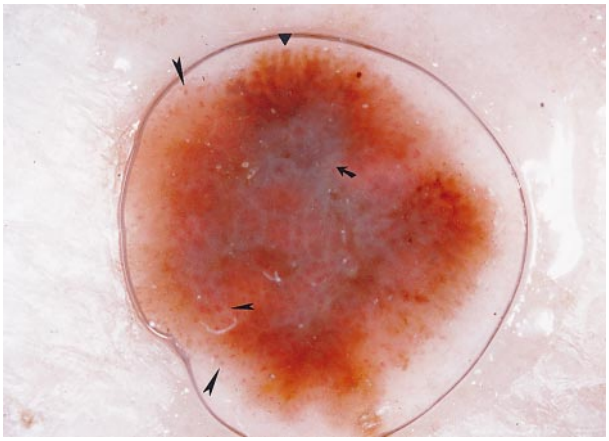

Figure 4. *Cutaneous melanoma (0.8 mm thick) with an atypical (dotted and globular) vascular pattern (long black arrowheads) (score: 2), gray-blue areas (curved black arrow), and streaks (short black arrowhead). Total score: 5 (original magnification ×10).*

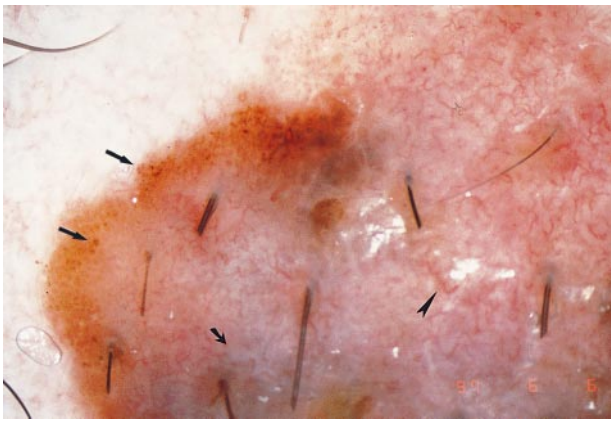

Figure 5. *Cutaneous melanoma (1.8 mm thick) with an atypical (linear) vascular pattern (black arrowhead). Irregular dots and globules (black arrows) and gray-blue areas (curved black arrow) can also be detected. Total score: 5 (original magnification ×10).*

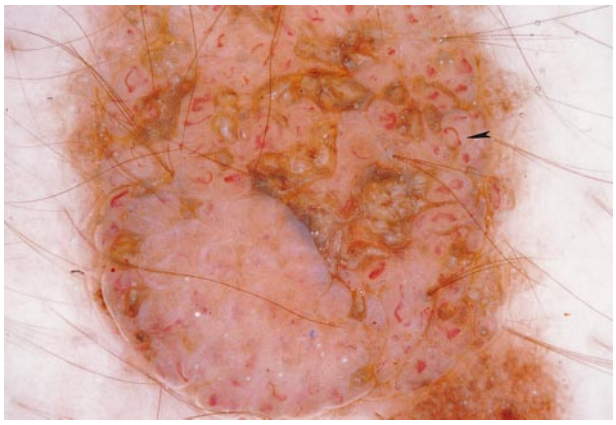

Figure 6. *Compound melanocytic nevus with commalike vessels (black arrowhead) (score: 0) that are commonly associated with dermal papillae in compound and dermal nevi (original magnification ×10).*

Table 3. Method of Melanoma Diagnosis by the ELM 7-Point Checklist*

ELM Criterion	Odds Ratio†	*P*‡	7-Point Score§	Figures
Major criteria				
Atypical pigment network‖	5.19	<.001	2	1, 3, 10
Gray-blue areas	11.10	<.001	2	3-5, 11
Atypical vascular pattern	7.42	.001	2	4, 5
Minor criteria				
Streaks	3.01	<.001	1	1-4, 10, 12 (bottom)
Blotches	4.90	<.001	1	1, 3, 10-12 (top)
Irregular dots and globules	2.93	.04	1	1-3, 5, 11, 12
Regression pattern¶	3.89	.004	1	2, 8, 9, 12 (bottom)

**ELM indicates epiluminescence microscopy.*
†Odds ratios measure the capacity of each criterion of increasing the probability of the melanoma diagnosis.
‡Improvement χ^2 significance.
§The score for the criterion presence is determined on the basis of the odds ratio: >5 (score, 2) and <5 (score, 1). By simple addition of the criteria scores, a minimum total score of 3 is required for the diagnosis of melanoma.
‖Criterion is defined as the presence of an irregular and prominent pigment network.
¶Criterion is defined as the presence of white areas or peppering (χ^2, P<.001).

the ELM criteria for distinguishing benign from malignant melanocytic skin lesions are not yet completely standardized. Two diagnostic models with similar reliability have become more widely accepted by clinicians: (1) pattern analysis, which is based on the "expert" qualitative assessment of numerous individual ELM criteria, and (2) the ABCD rule of dermatoscopy, which is based on a semiquantitative analysis of the lesion's asymmetry, border, color, and different dermatoscopic structures. The ABCD rule was believed to be helpful also for clinicians not fully experienced in ELM observation because of its lower complexity vs pattern analysis.

In earlier reports on the ABCD rule of dermatoscopy,[12,13] the most important finding was that more than 90% of melanocytic skin lesions were correctly identified when the method was used by experienced investigators. More recently, Rao et al[27] compared the

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Table 4. Sensitivity, Specificity, and Diagnostic Accuracy of the Methods for ELM Diagnosis of Melanoma*

Method	Sensitivity, %	True-Positive/ Total CM	Specificity, %	True-Negative/ Total MN	Diagnostic Accuracy, %†
Overall ELM diagnosis (EO)	91	106/117	90	203/225	76
7-Point scored diagnosis (EO)	95	111/117	75	169/225	64
ABCD scored diagnosis (EO)	85	99/117	66	148/225	51
7-Point scored diagnosis (LO-1)	93	56/60	45	39/86	52
ABCD scored diagnosis (LO-1)	88	53/60	35	30/86	46
7-Point scored diagnosis (LO-2)	85	51/60	48	41/86	49
ABCD scored diagnosis (LO-2)	95	57/60	27	23/86	46

**ELM indicates epiluminescence microscopy; CM, cutaneous melanoma; MN, melanocytic nevi; EO, experienced observers; and LO-1 and LO-2, the 2 less experienced observers.*

†Diagnostic accuracy for melanoma is calculated as (true-positive/[true-positive + false-positive + false-negative]).

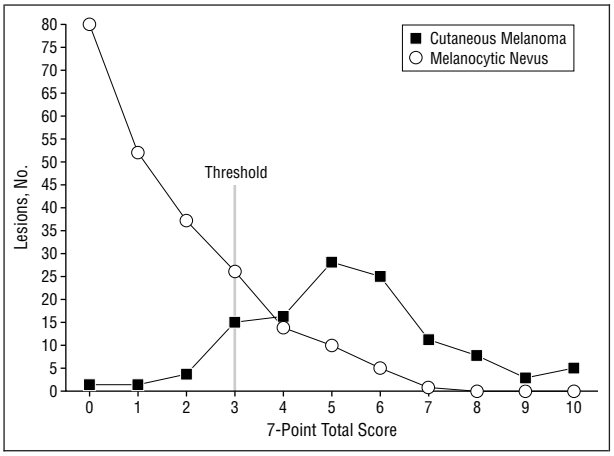

Figure 7. *Classification of lesions according to 7-point scores of epiluminescence microscopy.*

Figure 8. *Atypical melanocytic nevus with an irregular, but discrete (not prominent), pigment network (score: 0) and regression pattern (peppering within depigmented areas) (asterisk). Total score: 1. The lesion is asymmetrical, with 4 colors and 3 dermoscopic structures (original magnification ×10).*

Table 5. Number of Correctly Diagnosed Melanomas by Different Histological Thicknesses*

Melanoma Thickness	Correctly Diagnosed Melanomas, No. (%)		
	ELM 7-Point Checklist	ABCD Rule of Dermatoscopy	Standard Pattern Analysis
<0.76 mm, including in situ melanomas (n = 68)	63 (93)	57 (84)	58 (85)
>0.75 mm (n = 49)	48 (98)	42 (86)	48 (98)

**ELM indicates epiluminescence microscopy.*

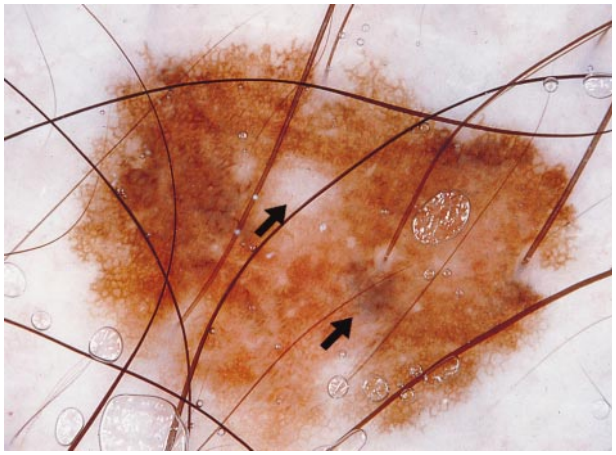

Figure 9. *Atypical melanocytic nevus with an irregular, discrete pigment network and regression pattern (black arrows) (total score: 1). The lesion is asymmetrical, with abrupt cutoff of pigment pattern, 4 colors, and 3 dermoscopic structures (original magnification ×10).*

diagnostic performance of experienced and less experienced observers in differentiating early melanomas from atypical MN by means of clinical, ABCD scored and overall dermatoscopic diagnoses. Regarding the clinical diagnosis, they reported an increase in sensitivity with dermatoscopic diagnosis (either overall or ABCD scored) but a decrease in specificity with the ABCD rule. In contrast, the specificity increased with overall ELM diagnosis for all observers except for 1 of the experienced observers. On the whole, the diagnostic accuracy with the ABCD rule was lower than that previously reported (range, 38%-64% for experienced observers and 39%-44% for less experienced observers), whereas overall ELM diagnosis gave higher diagnostic accuracy values for experienced (41%-64%) and less experienced (43%-54%) observers.

Our principal findings are close to the results of the above-mentioned study.

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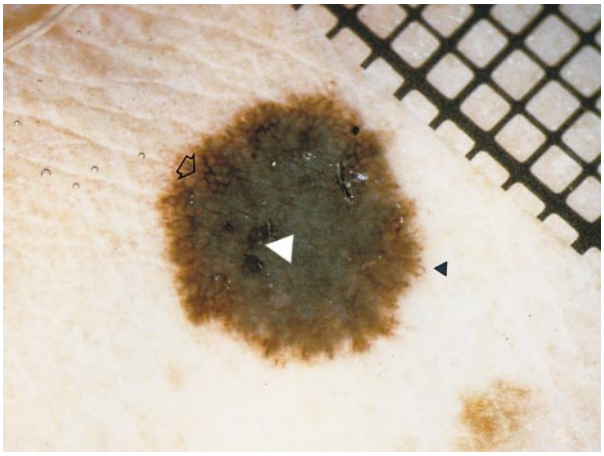

Figure 10. *Cutaneous melanoma (0.3 mm thick). Relatively symmetrical lesion with abrupt cutoff of pigment pattern, 3 colors, and 4 structures. Presence of atypical pigment network (white arrow), streaks (black arrowhead), and blotches (white arrowhead). Total score: 4 (original magnification ×10).*

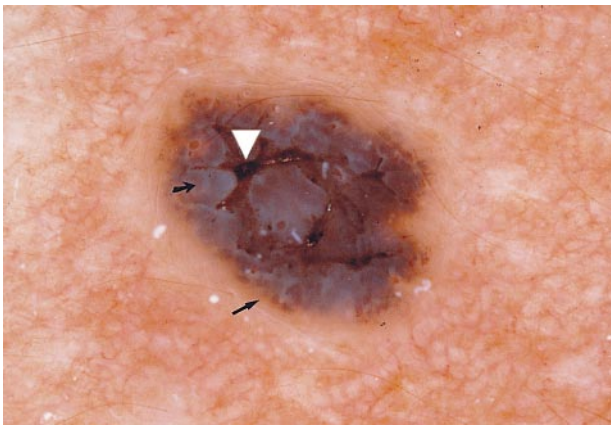

Figure 11. *Cutaneous melanoma (0.6 mm thick). Relatively symmetrical lesion with abrupt cutoff of pigment pattern, 2 colors, and 3 structures. Presence of gray-blue areas (curved black arrow), blotches (white arrowhead), and irregular dots and globules (black arrow). Total score: 4 (original magnification ×10).*

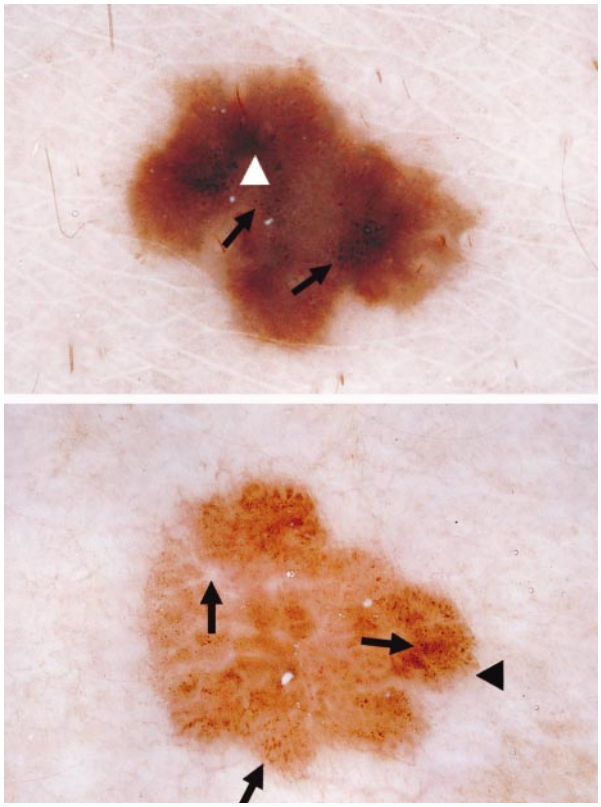

Figure 12. *Two lesions with similar silhouettes and distribution of colors and structures. Top, Compound melanocytic nevus with irregular dots and globules (black arrows) and blotches (white arrowhead). Total score: 2. Bottom, Cutaneous melanoma (0.45 mm thick) with irregular dots and globules (thin black arrows), streaks (black arrowhead), and regression pattern (white areas) (thick black arrow). Total score: 3 (original magnification ×10).*

1. Standard ELM pattern analysis (overall diagnosis), when used by experienced observers, is the most reliable method for differentiating melanocytic skin lesions. It gave the highest diagnostic accuracy value (76%) and the highest number of correct diagnoses (90%) compared with the other diagnostic methods (the ABCD rule and the 7-point checklist). These values are comparable to those previously reported,[6,7,16] confirming the validity of the pattern analysis model.

2. The ELM 7-point checklist, in the hands of experienced observers, gave the greatest sensitivity value (95%), especially in the subgroup of early CM (Table 5). Compared with overall ELM diagnosis, the specificity was lower (75% vs 90%) because of the tendency to overclassify MN (especially the atypical types) as melanomas with the scoring diagnostic systems. Nevertheless, to increase the sensitivity, one may have to forfeit specificity and diagnostic accuracy. A decrease in specificity may result in some increase in biopsy examinations of benign lesions, but the increase in sensitivity would decrease the chances of missing melanomas. We designed a model that requires the identification of only 7 standard ELM criteria (detailed in the "Materials and Methods" section and in Table 2), thus enabling even the less experienced clinician to use the method. In fact, this simplified scored pattern analysis was shown to be reproducible not only with a test set performed by experts but also by less experienced dermatologists, who were able to classify a high percentage of melanomas (85%-93%). The lower specificity values (45%-48%) obtained by the less experienced observers could be explained by the fact that most of the nonmelanomas used to determine specificity were clinically atypical (leading to the decision to perform a biopsy); thus, their correct assessment needs more experience. However, use of the model would have avoided the excision of almost half of those lesions. Clearly, the true specificity of the method in clinical practice should be much greater. For a CM to be diagnosed, identification of at least 1 major and 1 minor ELM criterion (or 3 minor criteria) is required. This confirms the previously reported rule that a single criterion usually does not suffice to make a diagnosis.[7]

3. The ABCD rule of dermatoscopy was confirmed in our study as a reliable method for detecting CM (sensitivity range, 85%-95%). In the hands of experienced observers, 13% of all CMs had ABCD scores in the range of suspicious lesions; thus, our decision to treat

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these lesions as melanoma consistently increased the sensitivity of the model. However, the number of false-positive results was high with experienced and less experienced observers (specificity range, 27%-66%). As in the report by Rao et al,[27] we included in our study a high number of histologically atypical MN (114 of 225 lesions), and most of them showed dermoscopic asymmetry (often in 2 axes). Because of its relevant weight for the final dermatoscopy score (asymmetry scores: in 1 axis, 1.3; in 2 axes, 2.6), in our study, the presence of asymmetry was thought to be the principal factor for the high rate of false-positive results (**Figure 8** and **Figure 9**). In contrast, most of the CMs missed with the ABCD rule showed a relatively symmetrical silhouette and distribution of colors and structures within the lesion (in these lesions, the maximum asymmetry score was 1.3) (**Figure 10**, **Figure 11**, and **Figure 12**).

In conclusion, the ELM 7-point checklist provides a simplification of standard pattern analysis because of the low number of features to identify and because of the scoring diagnostic system. As with the ABCD rule of dermatoscopy, it can be easily learned and easily applied and has proven to be reliable for diagnosing melanoma. However, experience plays an important role in improving diagnostic accuracy for melanoma, as demonstrated by the lower number of false-positive results obtained by the ELM experts vs the nonexperts. The 7-point checklist, compared with the ABCD rule, allowed better diagnostic accuracy values because of the tendency of the latter to overclassify atypical MN as melanomas.

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