Dermoscopy of pigmented skin lesions: Results of a consensus meeting via the Internet

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A case-by-case summary of data from all colleagues taking part of this virtual study is presented in an atlas called *Dermoscopy of Pigmented Skin Lesions: An Atlas Based on the Consensus Net Meeting on Dermoscopy 2000.* Milan, Italy: Edra Medical Publishing and New Media; 2001.

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Background: There is a need for better standardization of the dermoscopic terminology in assessing pigmented skin lesions.

Objective: The virtual Consensus Net Meeting on Dermoscopy was organized to investigate reproducibility and validity of the various features and diagnostic algorithms.

Methods: Dermoscopic images of 108 lesions were evaluated via the Internet by 40 experienced dermoscopists using a 2-step diagnostic procedure. The first-step algorithm distinguished melanocytic versus nonmelanocytic lesions. The second step in the diagnostic procedure used 4 algorithms (pattern analysis, ABCD rule, Menzies method, and 7-point checklist) to distinguish melanoma versus benign melanocytic lesions. κ Values, log odds ratios, sensitivity, specificity, and positive likelihood ratios were estimated for all diagnostic algorithms and dermoscopic features.

Results: Interobserver agreement was fair to good for all diagnostic methods, but it was poor for the majority of dermoscopic criteria. Intraobserver agreement was good to excellent for all algorithms and features considered. Pattern analysis allowed the best diagnostic performance (positive likelihood ratio: 5.1), whereas alternative algorithms revealed comparable sensitivity but less specificity. Interobserver agreement on management decisions made by dermoscopy was fairly good (mean κ value: 0.53).

Conclusion: The virtual Consensus Net Meeting on Dermoscopy represents a valid tool for better standardization of the dermoscopic terminology and, moreover, opens up a new territory for diagnosing and managing pigmented skin lesions. (J Am Acad Dermatol 2003;48:679-93.)

The introduction of dermoscopy into the clinical practice of dermatology has disclosed a new and fascinating morphologic dimension of pigmented skin lesions (PSL). Dermoscopy is a noninvasive diagnostic technique that uses optic magnification to permit the visualization of morphologic features that are not visible to the naked eye, thus, forming a link between macroscopic clinical dermatology and microscopic dermatopathology.[1,2] This "submacroscopic" observation of PSL adds to the available in vivo diagnostic tools by providing new morphologic features for the differentiation of melanoma from other melanocytic and nonmelanocytic PSL.[3,4] As a result, the practice of dermoscopy is becoming more and more popular, not only among dermatologists, but also among oncologists, surgeons, pediatricians, and even general physicians.[5]

As in other purely morphologic methods, the conventional diagnosis in dermoscopy is on the basis of the simultaneous assessment of morphologic criteria. Consequently, the reproducibility and validity of dermoscopic criteria is of utmost importance. There is a need for better standardization of the dermoscopic terminology, which was last reviewed more than a decade ago at the first Consensus Meeting on Dermoscopy (Hamburg, Germany, November 1989).[6] We organized a new consensus meeting to refine the dermoscopic terminology, and to investigate the interobserver and intraobserver reproducibility and validity of the various dermoscopic criteria and diagnostic algorithms.

To evaluate the diagnostic algorithms we assessed the performance of a 2-step procedure for the dermoscopic classification of PSL. Differentiating melanocytic from nonmelanocytic lesions is the focus of the first-step algorithm (Appendix 1). The second step in the 2-step procedure focuses on differentiating melanoma from benign melanocytic lesions using 4 different diagnostic algorithms: (1) modified pattern analysis; (2) ABCD rule of dermoscopy; (3) Menzies method; and (4) 7-point checklist (Appendices 2 to 5). The 2-step procedure for the dermoscopic classification of PSL represents the morphologic backbone of the consensus meeting.[6-25]

Because dermoscopic images today can be easily transmitted electronically, we organized a virtual consensus meeting via the Internet known as the Consensus Net Meeting on Dermoscopy (CNMD). In all, 40 international participants completed this endeavor within a time period of 4 months (July 14 to November 8, 2000). The preliminary results of this Internet consensus meeting were discussed on 2 occasions: at the first World Congress of Dermoscopy in Rome, Italy, in February 2001, and in New Orleans, Louisiana, in February 2002 at a working session of the Dermoscopy Working Group.

MATERIALS AND METHODS

Selection of participants and dermoscopic criteria

In all, 51 experienced clinicians in the field of dermoscopy were invited to participate in the CNMD. The selection for invitation was on the basis of the experience of the colleagues in dermoscopy,

as demonstrated by publications and lectures on the topic. Colleagues from many different countries were invited to get a consensus panel with a broad geographic distribution.

The preliminary scientific design, including the list of selected criteria and diagnostic methods to be evaluated, was presented for discussion during a meeting of the CNMD board members in San Francisco, Calif, at the American Academy of Dermatology meeting on March 10, 2000. A unifying concept of dermoscopy was developed on the basis of a 2-step procedure for the dermoscopic classification of PSL (see Appendices I-V, pages 690-693). The first step is the evaluation of a given PSL using an algorithm for differentiating melanocytic from nonmelanocytic lesions. In the second step, 4 diagnostic algorithms are used for the differentiation of melanoma from benign melanocytic lesions (modified pattern analysis, ABCD rule of dermoscopy, Menzies method, and 7-point checklist).[6-25]

Selection of PSL for evaluation

PSL included in this study were obtained from the Department of Dermatology, University Federico II (Naples, Italy); the Department of Dermatology, University of L'Aquila (Italy); the Department of Dermatology, University of Graz (Austria); the Sydney Melanoma Unit, Royal Prince Alfred Hospital (Camperdown, Australia); and the Skin and Cancer Associates (Plantation, Fla).

Nearly all lesions included in this study had a diameter of less than 14 × 10 mm. This was a basic prerequisite to evaluate the entire surface of the lesion. Other prerequisites were: sufficient photographic quality of clinical and dermoscopic images; relevant clinical data; and, most important, availability of histopathologic specimens to be judged by the histopathology panelists. In addition, cases were selected to provide representative distribution of the various diagnostic categories. Two of the authors (G. A. and H. P. S.) carried out this preselection. The final number of preselected PSL cases was 172.

The 172 preselected PSL cases were reviewed by a panel of 6 histopathologists, who selected 128 histopathologically unequivocal lesions to include in this study. Diagnostic categories of the 128 lesions were as follows: melanoma (33 cases); benign melanocytic lesion (70 cases, including 36 "Clark" nevi [defined as acquired, junctional, or compound melanocytic nevi with more or less dysplastic histopathologic features], 17 pigmented Spitz nevi, 7 congenital nevi, 4 combined nevi, 3 dermal nevi, 2 lentigines, and 1 blue nevus); basal cell carcinoma (10 cases); and other nonmelanocytic PSL (15 cases, including 10 seborrheic keratoses, 2 vascular lesions, 2 dermatofibromas, and 1 lichen planus–like keratosis).

Clinical data were obtained for each patient and included the following: (1) age, sex, skin phototype, total number of nevi, and personal and/or familial history of melanoma; (2) location, diameter, and duration of the lesion; and (3) history of any morphologic changes within the last year before excision of the lesion. The lesions were obtained from 65 men and 63 women ranging in age from 11 to 97 years (median age: 38 years). All patients were Caucasian except for one, who was Japanese with early melanoma on the sole. The locations of the PSL included in this study were as follows: back (49), limbs (44), head-neck (15), chest (9), acral sites (7), and abdomen (4).

Standards used for digital documentation of dermoscopic images

Clinical and dermoscopic images of each lesion had been obtained using Dermaphot (Heine Optotechnik, Herrsching, Germany), with 10-fold magnification of the lesion. The color slides were converted to digital format using a photo CD system (Kodak, Rochester, NY). Using software (Photoshop, Version 5.0, Adobe Systems Inc, San Jose, Calif) all digitized images (RGB [red, green, blue] 768 × 512 pixels, 72 dots per inch) were converted to Joint Photographic Expert Group format (the high-quality option was used for compression). All images were then optimized for color, brightness, and contrast by using the software standards (autolevel and unsharp mask). For a small series of lesions we used a digital dermoscopic workstation (Digital ELM Teledermatology Workstation, Vanguard Imaging Ltd, Cambridge, Mass) that uses a Dermaphot (Heine Optotechnik) lens and a digital camera with 6-megapixel charge-coupled device sensor (Kodak).

Methodology of evaluation of cases via the Internet

The 128 cases were randomly divided into a training set of 20 cases and a test set of 108 cases. A World Wide Web–based tutorial was provided to describe the unifying concept of dermoscopy with complete definitions of criteria and example images (Appendix and http://www.dermoscopy.org). At the beginning, each participant was asked to complete a questionnaire, including preferred diagnostic method used for dermoscopic examination. After entering a password, each participant was able to evaluate the 20 lesions from the training set. For each case, the participants completed the following electronic data sheets (Appendix): (1) algorithm for differentiating melanocytic from nonmelanocytic PSL; (2) criteria for diagnosing melanocytic lesions by pattern analysis; (3) criteria for the ABCD rule with automatic calculation of the score; (4) criteria

for the 7-point checklist with automatic calculation of the score; (5) criteria for the Menzies method with automatic calculation of the score; and (6) diagnostic categories for the final diagnosis together with management recommendations and final remarks. For further details see also http://www.dermoscopy.org.

Immediately after submission of the completed electronic data sheets, the participants received the set of dermoscopic criteria of that case as judged by the instructors (G. A., H. P. S., and S. W. M.) and the histopathologic diagnosis provided by the histopathology panelists. This real-time feedback was designed to assist the participants in mastering the dermoscopic criteria.

After completing the training set of 20 cases, each participant was asked to evaluate the 108 lesions of the test set using a similar World Wide Web–based approach. The same electronic data sheets were used; however, feedback was no longer provided. Participants were permitted to evaluate only 1 lesion at a time, and each case had to be submitted as soon as it was completed. Each participant was given 4 months (July to October 2000) to complete the evaluation of the lesions of the test set. To test for intraobserver agreement, 20 lesions were randomly selected from the test set and included for re-examination; thus, each participant performed 128 test evaluations.

Statistics

Reproducibility analysis. The interobserver reproducibility among the 40 observers who completed the study was assessed according to the method of Fleiss et al[26-28] to calculate the κ statistics for multiple ratings for patient. Each category j of each diagnostic criterion included in each diagnostic algorithm was classified as: absent (code 0) or present (code 1). The agreement on single criterion of each diagnostic algorithm was evaluated on a subset of 85 lesions judged as being melanocytic by at least 30 out of 40 observers. According to this procedure, the average number of observation for each lesion belonging to this subset was 38.4.

Denote by $\bar{p}_j$ the overall proportion of ratings in category j, $\bar{q}_j = 1 - \bar{p}_j$, and k_j the value of kappa for category $j, j = 1,\ldots,k$, the overall measure of agreement for a given diagnostic criterion can be expressed as:

$$\bar{k} = \frac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j k_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$$

The standard errors of k_j and $\bar{k}$ and the 95% confidence intervals (CI) were calculated as described by Fleiss.[28]

The intraobserver reproducibility was assessed on a subset of 20 lesions, randomly selected from the test set of 108 lesions and resubmitted to each study participant. Median κ values and ranges were reported for all diagnostic criteria. Regarding the interpretation of κ values: a value of 1.0 indicates perfect agreement; values greater than 0.75 are considered excellent; values between 0.40 and 0.75 are fair to good; and values less than 0.40 are poor.[27]

Diagnostic accuracy analysis. For all diagnostic algorithms and within each algorithm, for each criterion's category, log odds ratios and 95% confidence intervals of prevalence of positive tests in the population of melanomas versus nonmelanomas (defined by the histopathologic diagnosis) were estimated by marginal logistic regression, using generalized estimating equations methodology with robust estimates of the variance and covariance of estimated coefficients.[29] Only univariate odds ratios were calculated because of the high colinearity between the considered variables. Sensitivity, specificity, 95% confidence intervals, and positive likelihood ratios (measuring the likelihood of finding a specific test result in melanomas rather than in benign melanocytic lesions) were calculated for each diagnostic algorithm with the same model. Sensitivity and specificity of the dermoscopic consensus diagnosis, ie, the diagnosis made by the majority of 40 dermoscopists, were also calculated.

A comparison between the diagnostic systems was performed according to Leisenring et al.[30] Briefly, considering pattern analysis as the reference algorithm, and indicating with dummy variables that represent ABCD rule, Menzies method, and 7-point checklist, respectively, then the models for sensitivity and 1-specificity are:

$$\text{logit } P(Y = 1 \mid D = 1, X_1, X_2, X_3) = \beta^1{}_0 + \beta^1{}_1 X_1 + \beta^1{}_2 X_2 + \beta^1{}_3 X_3$$

$$\text{logit } P(Y = 1 \mid D = 0, X_1, X_2, X_3) = \beta^0{}_0 + \beta^0{}_1 X_1 + \beta^0{}_2 X_2 + \beta^0{}_3 X_3$$

with $D = 1$ denoting that disease is present and $Y = 1$ denoting a positive test result.

Under this parameterization a test $\beta^1{}_1 = 0$ is equivalent to a test where 2 diagnostic algorithms, namely, pattern analysis and ABCD rule, have equal sensitivity. Similarly, a test $\beta^0{}_1 = 0$ is equivalent to a test where their specificities are equal.

Table I. Interobserver and intraobserver agreement on the dermoscopic diagnosis of pigmented skin lesions using various diagnostic algorithms

	Interobserver agreement*		Intraobserver agreement	
Variable	**κ**	**95% CI**	**κ**	**Range**
First-step†	0.63	0.62-0.63	1.00	0.73-1.00
Pattern analysis	0.55	0.54-0.56	0.85	0.12-1.00
ABCD rule	0.48	0.47-0.48	0.72	0.11-1.00
Menzies method	0.52	0.51-0.52	0.75	0.21-1.00
7-point checklist	0.47	0.46-0.47	0.72	0.29-1.00

CI, Confidence interval.
*Distribution of 4320 observations (40 observations for each of 108 lesions) according to the ratings made by the observers
†Melanocytic versus nonmelanocytic lesion.

RESULTS

In all, 51 experienced clinicians in the field of dermoscopy were invited to participate in the CNMD, and 40 actively participated in this study. Geographic distribution of the participating board members is as follows: 24 participants from Europe (9 countries); 11 from the United States; and 5 from the rest of the world (2 participants from Japan, and 1 each from Argentina, Australia, and Mexico). In response to the initial questionnaire, 21 of the 40 participants selected pattern analysis as their preferred method for dermoscopic examination of PSL, whereas ABCD rule, Menzies method, and 7-point checklist were preferred by 9, 4, and 3 participants, respectively. Three board members indicated that they were not using specific diagnostic systems.

Tables I and II show the results concerning the interobserver and intraobserver reproducibility on diagnostic algorithms and dermoscopic criteria, respectively, as expressed by κ values. Concerning the reproducibility of the first-step diagnosis, pattern analysis, the ABCD rule, Menzies method, and the 7-point checklist, the 40 observers were able to classify PSL with fair to good interobserver agreement and nearly excellent to perfect intraobserver agreement (Table I). Fair interobserver agreement was found in the assessment of global dermoscopic patterns, pigment network, regression and vascular structures, ABCD asymmetry, and Menzies symmetry of pattern. However, 10 dermoscopic features (dots/globules, streaks, blue-whitish veil, blotches, and hypopigmentation from pattern analysis; border, color, and dermoscopic structures from the ABCD rule; and color and positive features from the Menzies method) did not exhibit sufficient interobserver reproducibility, with κ values less than 0.40. Because the 7-point checklist is on the basis of the assessment of the same criteria considered in pattern analysis, similar reproducibility results were obtained for both diagnostic methods. Remarkably, the intraobserver agreement was shown to be good to excellent for all dermoscopic criteria considered (Table II).

To assess the validity of dermoscopic criteria for the diagnosis of melanoma, odds ratios were calculated; the results are shown in Tables III and IV. Among the various global features of a given PSL, the feature most predictive for the diagnosis of melanoma was the multicomponent pattern, whereas the globular, cobblestone, homogeneous, and starburst patterns were most predictive for the diagnosis of benign melanocytic lesions (see Appendix II for detailed definitions of criteria). Atypical pigment network, irregular streaks, and regression structures were the local features (included in both pattern analysis and the 7-point checklist) that showed the highest association with melanoma, followed by irregular dots/globules, irregular blotches, and blue-whitish veil (Table III). Vascular structures were not found to be significantly associated with melanoma because they were rarely detectable in this series of cases. Typical pigment network, regular dots/globules, regular streaks, and regular blotches were mostly associated with benign melanocytic lesions. Among the features assessed in the ABCD rule, the asymmetry on both axes exhibited the highest association with melanoma, followed by the presence of more than 4 colors and more than 3 different dermoscopic features. Within the Menzies method the highest association with melanoma was scored by the presence of an asymmetrical distribution of dermoscopic patterns, followed by the presence of more than 1 color and 1 or more positive dermoscopic features. By contrast, the presence of a single color and a symmetrical distribution of pattern were associated with benign melanocytic lesions (Table IV) (see Appendix IV for definitions of criteria).

Table V shows the results in terms of sensitivity and specificity that were obtained by 40 observers evaluating 108 PSL. The 40 colleagues were able to correctly classify more than 95% of melanocytic lesions and more than 90% of nonmelanocytic lesions (first step of the unifying concept of dermoscopy) with a positive likelihood ratio of 10. Concerning the differentiation between benign melanocytic lesions and melanoma (second step), the classic dermoscopic approach for diagnosing melanoma, ie, pattern analysis, allowed the best diagnostic performance (sensitivity, 83.7%; specificity, 83.4%; and positive likelihood ratio, 5.1), whereas the alternative algorithms (ABCD rule, Menzies method, and 7-point checklist) revealed similar sensitivity compared with pattern analysis but lower specificity

Table II. Interobserver and intraobserver agreement on individual diagnostic criteria used in pattern analysis, ABCD rule, Menzies method, and seven-point checklist

	Interobserver agreement*		Intraobserver agreement†	
Variable	**κ**	**95% CI**	**κ**	**Range**
Pattern analysis				
Global pattern	0.43	0.42-0.43	0.55	0.01-0.98
Pigment network	0.44	0.43-0.45	0.63	0.09-1.00
Dots/globules	0.33	0.32-0.34	0.61	0.11-1.00
Streaks	0.30	0.29-0.31	0.63	0.11-1.00
Blue-whitish veil	0.32	0.32-0.33	0.60	0.13-1.00
Blotches	0.21	0.20-0.21	0.67	0.06-1.00
Hypopigmentation	0.25	0.24-0.26	0.68	0.21-1.00
Regression structures	0.44	0.43-0.45	0.72	0.28-1.00
Vascular structures	0.50	0.49-0.51	1.00	0.28-1.00
ABCD rule				
Asymmetry	0.41	0.40-0.42	0.82	0.08-1.00
Border	0.22	0.22-0.23	0.62	0.08-1.00
Color	0.35	0.35-0.36	0.64	0.30-1.00
Dermoscopic structures	0.25	0.24-0.25	0.60	0.20-1.00
Menzies method				
Color of the lesion	0.17	0.16-0.18	1.00	0.07-1.00
Symmetry of pattern	0.57	0.56-0.58	0.85	0.04-1.00
Positive features	0.21	0.20-0.22	0.61	0.09-1.00
7-point checklist				
Atypical pigment network	0.45	0.44-0.46	0.63	0.09-1.00
Blue-whitish veil	0.33	0.32-0.33	0.52	0.21-1.00
Atypical vascular pattern	0.27	0.26-0.28	1.00	0.06-1.00
Irregular streaks	0.32	0.31-0.33	0.61	0.04-1.00
Irregular blotches	0.24	0.24-0.25	0.67	0.07-1.00
Irregular dots/globules	0.34	0.33-0.35	0.70	0.11-1.00
Regression structures	0.46	0.45-0.47	0.66	0.18-1.00

CI, Confidence interval.
*Interobserver agreement is on the basis of 85 melanocytic lesions classified by at least 30 of 40 observers; distribution of 3264 observations (38.4 observations for each of 85 lesions) according to the ratings made by the observers.
†Intraobserver agreement is on the basis of 20 lesions of the test set that were re-evaluated by 40 observers.

(11.9%-13.4% less specificity) and lower positive likelihood ratio (from 2.8-3.0). Remarkably, when sensitivity and specificity were calculated as a "consensus diagnosis," meaning the specific diagnosis made by the majority of observers, all diagnostic methods allowed better results in terms of sensitivity (100% by pattern analysis; 96.3% by alternative algorithms).

Table VI shows the comparison of the 4 diagnostic algorithms for sensitivity and specificity. The sensitivity of the Menzies method was higher than those of the ABCD rule ($P = .010$) and the 7-point checklist ($P = .039$), whereas it was not different from that of pattern analysis ($P = .442$). Remarkably, pattern analysis showed specificity significantly higher than all other systems ($P = .000$).

The lesions included in this study were all considered equivocal from a clinical point of view and had been excised for histopathologic examination. The results assessing the role of dermoscopy for the management decision of PSL show that, on average, 99.2% of melanomas and 98.7% of basal cell carcinomas were judged to require excision or at least follow up examination using digital documentation systems. The mean proportion of melanomas and basal cell carcinomas judged to require excision were 94.8% and 96.6%, respectively, whereas the mean proportion of melanomas and basal cell carcinomas judged to require follow up examination were 4.4% and 2.2%, respectively. Remarkably, 46.4% (mean value) of benign PSL were judged by dermoscopy not to require excision. The interobserver agreement on management decisions made by dermoscopy was fairly good, with a mean κ value of 0.53 (+/− 0.08 SD). Definitions of dermoscopic criteria and diagnostic methods (Appendices I-V) were refined on the basis of the comments and suggestions of the participants.

DISCUSSION

For the CNMD, 40 experienced clinicians from 14 countries worldwide convened virtually over a

Table III. Association between individual diagnostic criteria and melanoma diagnosis obtained by pattern analysis in 85 melanocytic lesions classified by at least 30 of 40 observers: odds ratios and 95% confidence intervals obtained by generalized estimating equation regression models

	Distribution of assignments*			
Variable	Melanoma	Nonmelanoma	Odds ratio	95% CI
Global pattern				
Reticular	0.33	0.32	1.1	0.5-2.1
Globular	0.03	0.17	0.1	0.05-0.4†
Cobblestone	0.001	0.05	0.02	0.002-0.1†
Homogeneous	0.01	0.07	0.1	0.0-0.5†
Starburst	0.001	0.07	0.01	0.002-0.1†
Parallel	0.04	0.06	0.6	0.1-5.7
Multicomponent	0.51	0.19	4.3	2.5-7.4†
Nonspecific	0.09	0.06	1.4	0.7-3.0
Pigment network				
Absent	0.14	0.42	0.2	0.1-0.5†
Typical	0.09	0.32	0.2	0.1-0.4†
Atypical	0.77	0.27	9.0	5.1-16.0†
Dots/globules				
Absent	0.21	0.22	0.9	0.5-1.8
Regular	0.06	0.42	0.1	0.1-0.1†
Irregular	0.73	0.36	4.8	2.8-8.0†
Streaks				
Absent	0.45	0.70	0.4	0.2-0.6†
Regular	0.03	0.14	0.2	0.1-0.3†
Irregular	0.52	0.16	5.8	3.5-9.6†
Blue-whitish veil				
Present	0.49	0.25	2.9	1.6-5.0†
Blotches				
Absent	0.53	0.66	0.6	0.4-0.9†
Regular	0.04	0.19	0.2	0.1-0.3†
Irregular	0.42	0.15	4.1	2.7-6.4†
Hypopigmentation				
Present	0.44	0.28	2.0	1.3-3.0†
Regression structures				
Present	0.64	0.25	5.4	2.9-10.0†
Vascular structures				
Present	0.18	0.13	1.5	0.7-3.3

CI, Confidence interval.
*Distribution of 3264 observations (38 ± 4 observations for each of 85 lesions) according to the ratings made by the observers
†Odds ratio is statistically significant for differentiation between melanoma and nonmelanoma since 95% CI does not include the unit

4-month period to redefine the dermoscopic terminology and to examine the various algorithmic methods for differentiating melanoma from benign melanocytic lesions. The CNMD convened via the World Wide Web at the domain www.dermoscopy.org from July to November 2000. To our knowledge the CNMD was the first consensus meeting using the Internet within the dermatologic community. The clinical and dermoscopic images of the 108 PSL, including the cumulative descriptive data of the virtual examination and the unifying concept of dermoscopy (with complete definitions of criteria and example images), were published recently.[31]

Parameters to consider in evaluating the advantages and disadvantages of a virtual consensus meeting in contrast to a traditional one include the dropout rate, the time commitment, the logistics of convening a large number of participants, and problems specific to Internet connections. A total of 11 participants did not finish the consensus meeting, for a dropout rate of about 20%, which seems acceptable. The time spent by the participants working on the CNMD was certainly more than 50 hours, although the exact working time for each individual colleague has not been calculated. The average time of 50 hours was on the basis of the comments of several participants stating that the working time for evaluating 1 given case was approximately 10 to 15 minutes for a nonmelanocytic lesion and 20 to 30 minutes for a melanocytic lesion. It would have

Table IV. Association between individual diagnostic criteria and melanoma diagnosis obtained by ABCD rule, Menzies method, and 7-point checklist on 85 melanocytic lesions classified at least by 30 of 40 observers*

Variable	Distribution of assignments†		Odds ratio	95% CI
	Melanoma	Nonmelanoma		
ABCD rule				
Asymmetry				
0	0.02	0.35	0.04	0.01-0.1‡
1	0.13	0.35	0.3	0.1-0.5‡
2	0.86	0.30	13.7	7.0-26.6‡
Border				
0-2	0.39	0.56	0.5	0.3-0.8‡
3-5	0.38	0.19	2.6	1.7-4.0‡
6-8	0.24	0.25	0.9	0.5-1.5
Color				
1-2	0.06	0.29	0.2	0.1-0.4‡
3	0.28	0.40	0.6	0.4-0.9‡
4	0.34	0.27	1.8	1.3-2.5‡
5-6	0.30	0.08	5.0	2.7-9.4‡
Dermoscopic structures				
1	0.07	0.14	0.4	0.2-1.2
2-3	0.44	0.68	0.4	0.2-0.5‡
4-5	0.49	0.17	4.5	2.6-7.8‡
Menzies method				
Color of the lesion				
Single color	0.003	0.05	0.05	0.01-0.25‡
More than 1 color	0.99	0.95	18.5	4.1-83.7‡
Symmetry of pattern				
Symmetrical pattern	0.02	0.49	0.02	0.01-0.05‡
Asymmetrical pattern	0.98	0.51	43.8	19.7-97.6‡
>1 positive features	0.94	0.68	7.5	3.0-18.9‡
7-point checklist				
Atypical pigment network	0.77	0.27	9.0	4.9-16.3‡
Blue-whitish veil	0.49	0.26	2.9	1.7-5.0‡
Atypical vascular pattern	0.09	0.06	1.5	0.6-3.7
Irregular streaks	0.55	0.16	6.1	3.7-9.8‡
Irregular pigmentation	0.65	0.31	4.0	2.7-5.7‡
Irregular dots/globules	0.75	0.36	5.2	3.0-8.8‡
Regression structures	0.64	0.24	5.7	3.0-10.6‡

CI, Confidence interval.
*Odds ratios and 95% confidence intervals obtained by generalized estimating equation regression models.
†Distribution of 3264 observations (38.4 observations for each of 85 lesions) according to the ratings made by the observers
‡Odds ratio is statistically significant for differentiation between melanoma and nonmelanoma since 95% CI does not include the unit.

been rather difficult to gather together such a considerable number of experienced clinicians for at least 1 week (50 working hours) for a traditional consensus meeting. No particular impediments were reported other than the usual technical problems that commonly can occur when using the Internet, such as difficulties with the connection speed, and the variability in visualizing colors and structures within the dermoscopic images. However, during the time of the actual CNMD a hot line for troubleshooting was established using conventional E-mail and this service proved helpful.

One anticipated drawback of this virtual approach was that all dermoscopic images were just examined indirectly on a monitor. One may assume that the real clinical "feeling" when studying a given PSL directly is certainly more authentic. However, in 2 recent studies examining teledermoscopy of PSL, one of them an international multicenter study, Piccolo et al.[32,33] demonstrated that the diagnostic accuracy of the remote diagnosis could compare well with diagnoses carried out face-to-face when experienced clinicians are involved. Moreover, the asynchronous and individual evaluation by each expert, intrinsic to a virtual consensus meeting via the World Wide Web, seems to insure a more independent result: in a conventional consensus meeting of 1-week duration, informal communication would

Table V. Sensitivity, specificity, 95% confidence intervals, and positive likelihood ratio of the various diagnostic systems obtained by generalized estimating equation regression models

	Sensitivity		Specificity			Consensus diagnosis*	
	%	95% CI	%	95% CI	LR+	Sensitivity	Specificity
First step†	95.2	93.3-96.6	90.5	86.9-93.2	10.0	100.0	95.2
Pattern analysis	83.7	80.0-87.5	83.4	78.7-87.4	5.1	100.0	87.7
ABCD rule‡	82.6	76.0-87.7	70	61.0-77.8	2.8	96.3	70.4
Menzies method	85.7	79.2-90.4	71.1	60.9-79.5	3	96.3	72.8
7-point checklist	83.6	76.7-88.8	71.5	61.9-79.6	2.9	96.3	72.8

CI, Confidence interval; *LR+*, positive likelihood ratio.
*Specific diagnosis made by the majority of observers (>50%).
†Melanocytic vs nonmelanocytic lesion.
‡A total score of 4.75 was used as the threshold for differentiating benign melanocytic lesions from melanoma.

Table VI. *P* values of the test comparing sensitivity and specificity of the diagnostic systems

	ABCD rule	7-point checklist	Menzies method
Sensitivity			
Pattern analysis	.644	.973	.442
ABCD rule		.389	.010
7-point checklist			.039
Specificity			
Pattern analysis	.000	.000	.000
ABCD rule		.239	.413
7-point checklist			.520

certainly have developed and probably influenced the results. We conclude that the concept and design of a virtual consensus meeting presented here is workable and feasible, at least for the examination of PSL using dermoscopy.

The CNMD results show that dermoscopy is a valuable tool for improving both clinical classification and treatment of patients with PSL. A 2-step procedure was used to facilitate: (1) differentiation between melanocytic and nonmelanocytic PSL; and (2) differentiation between melanoma and benign melanocytic nevi. In this study we evaluated reproducibility and validity of the various diagnostic methods and dermoscopic criteria. Concerning reproducibility, all diagnostic methods exhibited a fair to good interobserver agreement and nearly excellent to perfect intraobserver agreement (Table I). Although a fair interobserver agreement was found in the assessment of several dermoscopic criteria, namely, global patterns, pigment network, regression structures, vascular pattern, and asymmetry (as calculated by both the ABCD rule and Menzies method), 10 features exhibited poor interobserver reproducibility (Table II). Remarkably, the intraobserver agreement was shown to be good to excellent for all dermoscopic criteria considered.

On the basis of these results we speculate that the poor interobserver agreement on several criteria may be a result of the different levels of expertise of the observers who certainly represented diverse influences of individual schools of dermoscopy. The great morphologic variability of dermoscopic criteria in general seems not to be a valid explanation, because of the good to excellent intraobserver agreement. Remarkably, despite the poor interobserver agreement on the dermoscopic criteria there was a fair to good interobserver agreement on the dermoscopic diagnosis with a κ value ranging from 0.47 to 0.63. This result may be explained by the fact that the perception of the overall dermoscopic "gestalt" (impression) of a given lesion is rather unique and clearly related to the dermoscopic diagnosis independently of whether there is agreement on individual criteria. Comparable findings have also been reported in other fields of medicine, particularly in histopathology, which is a diagnostic tool on the basis of subjective assessment of morphologic features. In a previous study, Corona et al[34] reported a generally poor interobserver agreement among pathologists for a number of histopathologic features for diagnosing melanoma, such as level of dermal invasion (κ = 0.38), presence of regression (κ = 0.22), and lymphocytic infiltration (κ = 0.27). As in our study the interobserver agreement on the diagnosis of melanoma versus other PSL was fair to good (κ value of 0.61).

A number of features were strongly associated with melanoma, including asymmetry (as calculated by both ABCD rule and Menzies method), multicomponent global pattern, atypical pigment network, irregular streaks, and regression structures (Tables III and IV). Various global patterns–specifically, the globular, cobblestone, homogeneous, and starburst patterns–were most predictive for the diagnosis of benign melanocytic lesions. A few local features such as typical pigment network, regular dots/glob-

ules, regular streaks, and regular blotches were also associated with benign melanocytic lesions.

The 40 colleagues were able to correctly classify more than 95% of melanocytic lesions and more than 90% of nonmelanocytic lesions (with high positive likelihood ratio), with the classic dermoscopic approach for diagnosing melanoma, ie, pattern analysis, producing the best diagnostic performance (sensitivity, 83.7%; specificity, 83.4%; positive likelihood ratio, 5.1). Remarkably, the alternative algorithms (ABCD rule, Menzies method, and 7-point checklist) revealed similar sensitivity compared with pattern analysis but about 10% less specificity and lower positive likelihood ratios (Table V). The favorable results of pattern analysis were not unexpected, because this method probably reflects best the way the human brain is working when categorizing morphologic images, namely, by the subjective perception of the gestalt of a given lesion and integration of this perception to an internalized knowledge base, which is the result of expertise on the subject. In contrast, simplified algorithms were designed to allow nonexperts not to miss detection of melanomas, even at the cost of decreased specificity. The fact that most of the participants declared pattern analysis as their preferred diagnostic method for dermoscopic examination of PSL may also explain the favorable results of pattern analysis compared with alternative algorithms.

The Internet approach to the dermoscopic diagnosis of PSL gave us the opportunity to introduce the concept of the consensus diagnosis, the specific diagnosis made by the majority of observers. Consensus diagnosis uses the potential of the World Wide Web, allowing experienced clinicians from all over the world to convene within a given short time period and compile their knowledge. At least from a purely scientific viewpoint, this approach opens up a new dimension of managing dermoscopic diagnoses. Kittler et al[35] reported improvement of diagnostic performance in dermoscopy when the diagnosis is made by a group of examiners in consensus. In our study, when sensitivity and specificity were calculated as a consensus diagnosis, all diagnostic methods allowed better results in terms of sensitivity (100% by pattern analysis; 96.3% by alternative algorithms). Interestingly, specificity was not affected (Table V).

Interobserver agreement (mean κ value of 0.53) supported the role of dermoscopy for the management decision of PSL: nearly all melanomas and basal cell carcinomas were judged to require excision or at least follow up examination using digital documentation systems. Remarkably, 46.4% (mean value) of benign PSL were judged by dermoscopy not to require excision; consequently, the use of dermoscopy may have avoided the excision of nearly half of benign PSL in a real clinical setting. Obviously, this Internet study does not at all reflect today's clinical setting for the treatment of patients and is quite artificial; for example, the magnification of images available in this study is not comparable with what clinicians are exposed to when visiting patients directly. Sparing individuals with equivocal PSL a superfluous surgical procedure certainly has great implications on national health care services worldwide, but this approach for the clinical management of PSL needs confirmation by prospective clinical trials using digital follow-up examinations.

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Appendix I. First-step algorithm for differentiation between melanocytic and nonmelanocytic lesions*

Dermoscopic criterion	Definition	Diagnostic significance
Pigment network-pseudonetwork†	Network of brownish interconnected lines over a background of tan diffuse pigmentation. In facial skin a peculiar pigment network, also called pseudonetwork, is typified by round, equally sized network holes corresponding to the pre-existing follicular ostia.	Melanocytic lesion
Aggregated globules	Numerous, variously sized, more or less clustered, round to oval structures with various shades of brown and gray-black. They should be differentiated from multiple blue-gray globules.	Melanocytic lesion
Streaks	These have been previously described separately as pseudopods and radial streaming, but are now combined into the one term. They are bulbous and often kinked or finger-like projections seen at the edge of a lesion. They may arise from network structures but more commonly do not. They range in color from tan to black.	Melanocytic lesion
Homogeneous blue pigmentation‡	Structureless blue pigmentation in the absence of pigment network or other distinctive local features	Melanocytic lesion
Parallel pattern	Seen in melanocytic lesions of palms/soles and mucosal areas. On palms/soles the pigmentation may follow the sulci or the cristae (ie, furrows or ridges) of the dermatoglyphics. Occasionally arranged at right angles to these structures.	Melanocytic lesion
Multiple milia-like cysts	Numerous, variously sized, white or yellowish, roundish structures	Seborrheic keratosis
Comedo-like openings	Brown-yellowish to brown-black, round to oval, sharply circumscribed keratotic plugs in the ostia of hair follicles. When irregularly shaped, comedo-like openings are also called irregular crypts.	Seborrheic keratosis
Light-brown fingerprint-like structures	Light-brown, delicate, network-like structures with the pattern of a fingerprint	Seborrheic keratosis
Cerebriform pattern	Dark-brown furrows between ridges typifying a brain-like appearance	Seborrheic keratosis
Arborizing vessels	Tree-like branching telangiectases	Basal cell carcinoma§
Leaf-like structures	Brown to gray/blue discrete bulbous structures forming leaf-like patterns. They are discrete pigmented nests (islands) never arising from a pigment network and usually not arising from adjacent confluent pigmented areas.	Basal cell carcinoma§
Large blue-gray ovoid nests	Well-circumscribed, confluent or near confluent pigmented ovoid or elongated areas, larger than globules, and not intimately connected to a pigmented tumor body	Basal cell carcinoma§
Multiple blue-gray globules	Multiple globules (not dots) that should be differentiated from multiple blue-gray dots (melanophages)	Basal cell carcinoma§
Spoke-wheel areas	Well-circumscribed radial projections, usually tan but sometimes blue or gray, meeting at an often darker (dark brown, black or blue) central axis	Basal cell carcinoma§
Ulceration‖	Absence of the epidermis often associated with congealed blood, not due to a well-described recent history of trauma	Basal cell carcinoma§
Red-blue lacunas	More or less sharply demarcated, roundish or oval areas with a reddish, red-bluish, or dark-red to black coloration	Vascular lesion
Red-bluish to reddish-black homogeneous areas	Structureless homogeneous areas of red-bluish to red-black coloration	Vascular lesion
None of the listed criteria	Absence of the above-mentioned criteria	Melanocytic lesion

*Data from Soyer HP, Argenziano G, Chimenti S, Menzies S, Pehamberger H, Rabinovitz H, et al. Dermoscopy of pigmented skin lesions. An atlas based on the Consensus Net Meeting on Dermoscopy 2000. Milan: Edra Medical Publishing and New Media; 2001.

†Exception 1: Pigment network or pseudo-network is also present in solar lentigo and rarely in seborrheic keratosis and pigmented actinic keratosis. A delicate, annular pigment network is commonly seen also in dermatofibroma and accessory nipple (clue for diagnosis of dermatofibroma: central white patch).

‡Exception 2: Homogeneous blue pigmentation (dermoscopic hallmark of blue nevus) is also seen (uncommonly) in some hemangiomas and basal cell carcinomas and (commonly) in intradermal melanoma metastases.

§To diagnose a basal cell carcinoma the negative feature of pigment network must be absent and one or more of the positive features listed here must be present (from Menzies SW, Esterhoff K. Rabinovitz H, Kopf AW, McCarthy WH, Katz B. Arch Dermatol 2000;36:1012-6).

‖Exception 3: Ulceration is also seen less commonly in invasive melanoma.

Appendix II. Second-step algorithm: pattern analysis criteria for the dermoscopic differentiation between benign melanocytic lesions and melanoma*

Dermoscopic criterion	Definition	Diagnostic significance
Global features		
Reticular pattern	Pigment network covering most parts of the lesion	Melanocytic nevus
Globular pattern	Numerous, variously sized, round to oval structures with various shades of brown and gray-black	Melanocytic nevus
Cobblestone pattern	Large, closely aggregated, somehow angulated globule-like structures resembling a cobblestone	Dermal nevus
Homogeneous pattern	Diffuse, brown, gray-blue to gray-black pigmentation in the absence of other distinctive local features	Melanocytic (blue) nevus
Starburst pattern	Pigmented streaks in a radial arrangement at the edge of the lesion	Spitz/Reed nevus
Parallel pattern	Pigmentation on palms/soles that follows the sulci or the cristae (furrows or ridges), occasionally arranged at right angles to these structures	Acral nevus/melanoma
Multicomponent pattern	Combination of three or more above patterns	Melanoma
Nonspecific pattern	Pigmented lesion lacking above patterns	Possible melanoma
Local features		
Pigment network	Typical pigment network: light- to dark-brown network with small, uniformly spaced network holes and thin network lines distributed more or less regularly throughout the lesion and usually thinning out at the periphery.	Benign melanocytic lesion
	Atypical pigment network: black, brown or gray network with irregular holes and thick lines	Melanoma
Dots/globules	Black, brown, round to oval, variously sized structures regularly or irregularly distributed within the lesion	If regular, benign melanocytic lesion If irregular, melanoma
Streaks	These have been previously described separately as pseudopods and radial streaming. Streaks are bulbous and often kinked or finger-like projections seen at the edge of a lesion. They may arise from network structures but more commonly do not. They range in color from tan to black.	If regular, benign melanocytic lesion (Spitz/Reed nevus) If irregular, melanoma
Blue-whitish veil	Irregular, structureless area of confluent blue pigmentation with an overlying white "ground-glass" film. The pigmentation cannot occupy the entire lesion and usually corresponds to a clinically elevated part of the lesion	Melanoma
Regression structures	White scar-like depigmentation and/or blue pepper-like granules usually corresponding to a clinically flat part of the lesion	Melanoma
Hypopigmentation	Areas with less pigmentation than the overall pigmentation of the lesion	Nonspecific
Blotches	Black, brown, and/or gray structureless areas with symmetrical or asymmetric distribution within the lesion	If symmetrical, benign melanocytic lesion If asymmetrical, melanoma
Vascular structures	Comma-like vessels	Dermal nevus
	Hairpin vessels	If uniformly distributed, seborrheic keratosis. If irregularly distributed, consider melanoma
	Dotted vessels	Melanoma
	Linear irregular vessels	Melanoma
	Vessels and/or erythema within regression structures	Melanoma
Site-related features		
Face	Typical pseudonetwork (round, equally sized network holes corresponding to the pre-existing follicular ostia)	Benign melanocytic lesion
	Annular-granular structures (multiple blue-gray dots surrounding the follicular ostia with an annular-granular appearance)	Melanoma
	Gray pseudonetwork (gray pigmentation surrounding the follicular ostia, formed by the confluence of annular-granular structures)	Melanoma

*Data from Soyer HP, Argenziano G, Chimenti S, Menzies S, Pehamberger H, Rabinovitz H, et al. Dermoscopy of pigmented skin lesions. An atlas based on the Consensus Net Meeting on Dermoscopy 2000. Milan: Edra Medical Publishing and New Media; 2001.

Appendix II. Cont'd

Dermoscopic criterion	Definition	Diagnostic significance
Face (cont'd)	Rhomboidal structures (gray-brown pigmentation surrounding the follicular ostia with a rhomboidal appearance)	Melanoma
	Asymmetric pigmented follicles (eccentric annular pigmentation around follicular ostia)	Melanoma
Site-related features Palms/soles	Parallel-furrow pattern (pigmentation following the sulci superficiales)	Acral nevus
	Lattice-like pattern (pigmentation following and crossing the furrows)	Acral nevus
	Fibrillar pattern (numerous, finely pigmented filaments perpendicular to the furrows and ridges)	Acral nevus
	Parallel-ridge pattern (pigmentation aligned along the cristae superficiales)	Melanoma

Appendix III. Second-step algorithm: ABCD rule for the dermoscopic differentiation between benign melanocytic lesions and melanoma*

Dermoscopic criterion	Definition	Score	Weight factor
Asymmetry	In 0, 1, or 2 perpendicular axes; assess not only contour, but also colors and structures	0-2	×1.3
Border	Abrupt ending of pigment pattern at the periphery in 0-8 segments	0-8	×0.1
Color	Presence of up to six colors (white, red, light-brown, dark-brown, blue-gray, black)	1-6	×0.5
Dermoscopic structures	Presence of network, structureless (homogeneous) areas, branched streaks, dots, and globules	1-5	×0.5

*Formula for calculating total score: [(A score × 1.3) + (B score × 0.1) + (C score × 0.5) + (D score × 0.5)]. Interpretation of total score: <4.75, benign melanocytic lesion; 4.75-5.45, suspicious lesion (close follow-up or excision recommended); >5.45, lesion highly suspicious for melanoma.

Appendix IV. Second step algorithm: Menzies scoring method for the dermoscopic differentiation between benign melanocytic lesions and melanoma*

Dermoscopic criterion	Definition
Negative features	
Symmetry of pattern	Symmetry of pattern is required across all axes through the lesion's center of gravity (center of the lesion). Symmetry of pattern does not require shape symmetry
Presence of a single color	The colors scored are black, gray, blue, dark brown, tan and red. White is not scored as a color
Positive features	
Blue-white veil	An area of irregular, structureless confluent blue pigmentation with an overlying white "ground-glass" haze. It cannot occupy the entire lesion and cannot be associated with red-blue lacunas
Multiple brown dots	Focal areas of multiple brown (usually dark brown) dots (not globules)
Pseudopods	Bulbous and often kinked projections that are found at the edge of a lesion either directly connected to the tumor body or pigmented network. They can never be seen distributed regularly or symmetrically around the lesion. When connected directly to the tumor body, they must have an acute angle to the tumor edge or arise from linear or curvilinear extensions. When connected to the network, the width of the bulbous ending must be greater than the width of any part of the surrounding network and at least double that of its directly connected network projection

*For melanoma to be diagnosed a lesion must have neither of both negative features and 1 or more of the 9 positive features. (See citation for Soyer et al, Appendix I.)

Appendix IV. Cont'd

Dermoscopic criterion	Definition
Radial streaming	Finger-like extensions at the edge of a lesion which are never distributed regularly or symmetrically around the lesion
Scar-like depigmentation	Areas of white distinct irregular extensions (true scarring), which should not be confused with hypo- or depigmentation due to simple loss of melanin
Peripheral black dots/globules	Black dots/globules found at or near the edge of the lesion
Multiple (5-6) colors	The colors scored are black, gray, blue, dark brown, tan and red. White is not scored as a color
Multiple blue/gray dots	Foci of multiple blue or gray dots (not globules) often described as "pepper-like" granules in pattern
Broadened network	A network made up of irregular thicker "cords" of the net, often seen focally thicker

Appendix V. Second step algorithm: 7-point checklist for the dermoscopic differentiation between benign melanocytic lesions and melanoma*

Dermoscopic criterion	Definition	Score
1. Atypical pigment network	Black, brown or gray network with irregular holes and thick lines	2
2. Blue-whitish veil	Irregular, structureless area of confluent blue pigmentation with an overlying white "ground-glass" film. The pigmentation cannot occupy the entire lesion and usually corresponds to a clinically elevated part of the lesion	2
3. Atypical vascular pattern	Linear-irregular or dotted vessels not clearly seen within regression structures	2
4. Irregular streaks	Brown to black, bulbous or finger-like projections irregularly distributed at the edge of a lesion. They may arise from network structures but more commonly do not.	1
5. Irregular dots/globules	Black, brown, round to oval, variously sized structures irregularly distributed within the lesion	1
6. Irregular blotches	Black, brown, and/or gray structureless areas asymmetrically distributed within the lesion	1
7. Regression structures	White scar-like depigmentation and/or blue pepper-like granules usually corresponding to a clinically flat part of the lesion	1

*By simple addition of the individual scores a minimum total score of 3 is required for the diagnosis of melanoma, whereas a total score of less than 3 is indicative of nonmelanoma. (See citation for Soyer et al, Appendix I.)