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Special Article - Diagnosis and Usefulness of Dermoscopy

Dermoscopy for the Diagnosis of Melanoma: An Overview

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Abstract

Dermoscope is a noninvasive and useful tool in the diagnosis or differentiation of melanoma. Contact polarized-light dermoscopes with photography equipment are better to obtain and record fine images constantly. After capturing the dermoscopic images, they should be projected onto a large-sized display device for detailed inspection and review. The revised two-step algorithm is a popular and reliable approach to differentiate melanoma from benign nevus. In the first-step, one can identify if the lesion is melanocytic or not. If it is, then the second-step should be followed for the differentiation of the melanoma. Six methods are available in the second-step and pattern analysis is the most specific method, although it needs experience to master. It is better to choose an easy method for daily use.

Keywords: Melanoma; Melanocytic nevus; Pattern analysis; Polarized-light dermoscope; Revised two-step algorithm

Abbreviations

ALM: Acral Lentiginous Melanoma; **BWV:** Blue-Whitish Veil or Blue White Vail; **CNMD 2000:** Consensus Net Meeting on Dermosocopy; **NM:** Nodular Melanoma; **TDS:** Total Dermoscopic Score

Introduction

Dermoscope is a noninvasive and useful tool for detecting the color and structural details of superficial skin lesions [1]. Primarily, non-polarized dermoscopes were the standard instruments for capturing images at approximately 10x magnification, especially for inspection of structures in pigmented lesions [2]. In the last 10 years, polarized-light dermoscopes have become common because non-pigmented lesions or vascular structures in the skin can be easily detected and viewed using them [1,3,4]. To obtain and record fine images constantly, contact dermoscopes with a photography equipment are recommended. When using the contact dermoscopes, the contact glass plate must be set carefully on the skin lesion without excessive downward pressure [5]. It is also important to apply a sufficient amount of nonirritant and translucent ultrasound gel to the lesion, which prevents diffuse reflection of the illuminant caused by the rough and scaly surface of the lesion. After capturing the dermoscopic images, they should be projected onto a large-sized display device for detailed inspection and review [6].

Differentiation of Melanoma

Revised two-step algorithm

A two-step algorithm for a dermoscopic diagnosis, which resulted from the Consensus Net Meeting on Dermoscopy (CNMD 2000), was established after the first World Congress of Dermoscopy in 2001 [7]. It was, however, mainly for pigmented skin lesions. Subsequently, some studies reported the usefulness of polarized dermoscopy to evaluate amelanotic/hypomelanotic neoplasms, including their vascular structures [3,8,9]. Furthermore, in 2010, Marghoob and Braun proposed a revised two-step algorithm that includes polarized dermoscopy and blood vessel morphology (Figure 1) [10,11]. It showed a very high sensitivity (98%) for both, non-nodular invasive melanoma and Nodular Melanoma (NM), and had a high sensitivity for benign nodular melanocytic lesions (95%); meanwhile, the prototype form of this algorithm did not achieve good sensitivity (84% NM, 88% benign lesions) [12,13]. However, the diagnostic specificity may differ depending on the race of the patient or amount of exposure to ultraviolet rays in general.

In the first-step of this algorithm, the findings of a melanocytic lesion (Level 1) are evaluated to identify whether the lesion is melanocytic or not (Figure 2) [7,10]. If the following six melanocytic features can be recognized in the lesion (Figure 3), one can skip to the second step for judging if it is a benign lesion or melanoma: a) pigment network, b) streaks, c) aggregated globules, d) homogenous

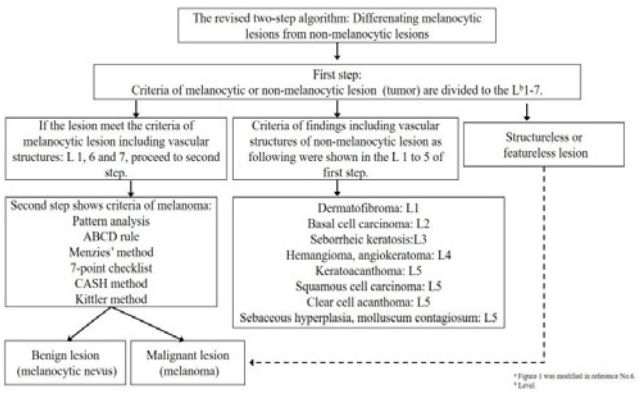

Figure 1: Revised two-step algorithm for dermoscopy[a]
In the first-step, the findings are evaluated to identify whether the lesion is melanocytic or not. If the melanocytic features can be recognized, one can skip to the second step for judging if it is a benign lesion or melanoma.

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Level 1: criteria of melanocytic lesion
- pigment network[b]
- streaks
- aggregated globules (excluding multiple blue-gray globules)
- homogenous blue pigmentation
- parallel pattern (acral)
- pseudonetwork (face)[c]

If any above one is filled, melanocytic lesion will be suspected and go to second step.

Level 2: criteria of basal cell carcinoma
Absence of pigment network and
- arborizing vessels
- leaf-like areas
- large blue-gray ovoid nests
- multiple blue-gray globules
- spoke wheel areas
- ulceration[d]
- shiny white areas

If any above one is filled, basal cell carcinoma will be suspected.

Level 3: criteria of seborrheic keratosis
- multiple milia-like cysts
- comedo-like openings
- light-brown fingerprint-like structures
- cerebriform pattern/fissures and ridges
- crypts
- moth-eaten borders
- network-like structures
- fat finger-like structures

If any above one is filled, seborrheic keratosis will be suspected.

Level 4: vascular disease
- red-blue to black lacunae/lagoonlike structures (hemangioma or angiokeratoma
- red-bluish to reddish black homogenous areas (hematoma)

Level 5: vascular findings of non-melanocytic lesion
- glomerular vessels (squamous cell carcinoma or Bowen's disease)
- crown vessels (sebaceous hypaerplasia, molluscum contagiosum)
- pearls on a string/serpiginous vessels (clear cell acanthoma)
- hairpin vessels (keratoacanthoma, seborrheic keratosis)

Level 6: vascular findings of melanocytic lesion
- comma-shaped blood vessels (dermal nevus)
- dotted vessels (melanoma and same as following)
- linear irregular vessels
- atypical hairpin vessels
- corkscrew/tortuous vessels
- polymorphous vessels

Level 7: non-specific structureless/featureless lesion can never exclude melanoma
- structureless/featureless lesion

Biopsy is recommended.

[a]Figure 1 was modified in reference No.6.
[b]Dermatofibroma somtimens shows delicate pigment network around central white patch.
[c]Senile fleck or seborrheic keratosis also show it sometimes. [d]Advanced melanoma also show it sometimes.

Figure 2: Levels 1 to 7 of the first step of the revised two-step algorithm[a].
All of these findings in each levels are basic for diagnosis.

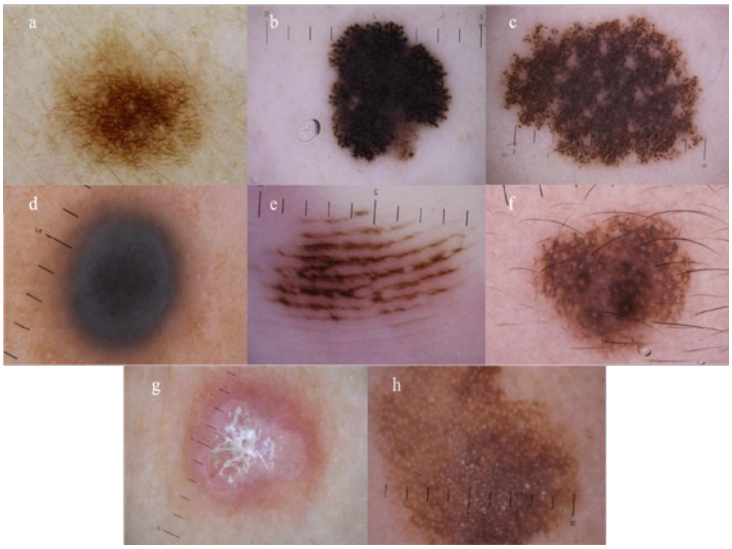

Figure 3: Six features of melanocytic lesions at level 1 of first step.
a) pigment network (melanocytic nevus), **b)** streaks (Reed/Spitz nevus), **c)** aggregated globules (congenital melanocytic nevus), **d)** homogenous blue pigmentation (Blue nevus), **e)** parallel pattern (acral nevus which shows parallel furrow pattern), **f)** pseudonetwork (melanocytic nevus on the face). Exceptions are shown in **g)** delicate pigment network (dermatofibroma), and **h)** pseudonetwork of non-melanocytic lesion (seborrheic keratosis on the face).

blue pigmentation, e) parallel patterns in palms and soles, and f) pseudonetwork in the face. In this process, the pigment network or pseudonetwork can be seen in solar lentigo and seborrheic keratosis as well. Delicate pigment network at the periphery in dermatofibroma has been added to the exclusion features of melanocytic lesions [10]. However, most dermatofibromas show whitish central scar-like area or central white patch, which is more important to exclude the diagnosis of melanoma than the delicate pigment network at the periphery (Figure 3). These central whitish areas can be observed as white stellate structures or chrysalis-like structures with polarized dermoscopy. Furthermore, these central white findings sometimes form white networks because of thickened and widened rete ridge in the epidermis. It helps differentiate from melanomas, which show blue-white veil only in the thick part of the lesion, although blue nevi usually have uniform blue-white veil on the surface that is called homogenous blue pigmentation (Figure 3). However, it is better to use both, non-polarized and polarized types of dermoscopy together, since it is often difficult to distinguish the uniformity of blue pigmentation or blue-white veil with polarized type dermoscopy alone. In a lesion composed of only pink structureless area or non-specific features, that is "featureless lesion," the lesion could also be a risk factor for melanoma. If there is no evidence of distinctive melanocyte features, proceed to differentiation of seborrheic keratosis as level 2, and the following subsequent levels in order: level 3, basal cell carcinoma; level 4, vascular disease; level 5, vasculature of non-melanocytic lesions; level 6, vasculature of melanocytic lesions; and finally level 7, structureless lesions, which are the rare signs of featureless melanoma. The vasculature related to levels 6 and 7 is

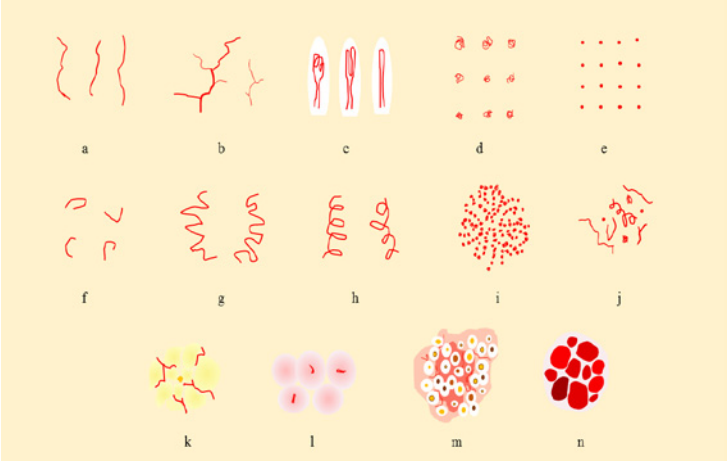

Figure 4: Vessel morphology related with two-step algorithm [1].
a-f six main morphologic categories of vascular patterns. **a)** linear irregular (linear or serpentine), **b)** arborizing (serpentine, branched), **c)** hairpin (looped), **d)** glomerular (coiled), **e)** dotted, **f)** comma (curved), **g)** tortuous (serpentine), **h)** corkscrew (helical), **i)** pearls on a string or serpiginous pattern (serpiginous), **j)** polymorphous (polymorphous), **k)** crown (radial branched and serpentine), **l)** milky-red globules (structureless zone, pink), **m)** strawberry pattern (structureless, red, interrupted by follicular openings), **n)** red-purple lacunas (clods, various reddish colors). **a,e,f** and **l** are associated with amelanotic/hypomelanotic melanoma, Spitz nevi, and dermal nevi, respectively. **b,c**, and **d** are generally indicative of non-melanocytic tumors such as basal cell carcinoma, seborrheic keratosis or squamous cell carcinoma including keratoacanthoma, Bowen disease or intra epidermal carcinoma, respectively. **g** and **h** are indicative of melanoma collaborated with dotted, linear irregular, and atypical hairpin vessel on a pink background. **i** is the hallmark of clear cell acanthoma, **j.** polymorphous vessels such as an atypical linear vessels in combination with any other vascular pattern should be ruled out for malignant skin tumors, **k.** crown vessels surrounding a white-yellow polylobular center are diagnostic for sebaceous hyperplasia, **l.** diagnostic finding for thick amelanotic/hypomelanotic melanoma, **m.** specific feature of facial actinic keratosis, **n.** hallmark of hemangioma.

shown in figure 4. If the evaluation of the lesion in levels 1, 6, and 7 matches the findings of the melanocytic lesion, the second-step for differentiation of the melanoma should be followed.

In the second-step, the following six methods for detecting melanoma are available: pattern analysis (Figure 5) [7,14], ABCD rule [15], 7-point check list [16], the Menzies method [17], the CASH method [18,19], and the Kittler method [20], which is a new concept of pattern analysis (Figure 6). Although the sensitivity of detecting melanoma in the ABCD method, 7-point check list, and Menzies method (82.6 to 85.7%) is comparable that of pattern analysis (83.7%) in CNMD2000, the specificity of pattern analysis was 83.4% and it was most excellent in these three (70 to 71.5%) [21].

Pattern analysis

Currently pattern analysis is the most reliable method for detecting melanoma, although it can be influenced by subjective factors and requires a more trained skill compared with other diagnostic methods [7,14]. The terms used in the pattern analysis, which are recommended by consensus meeting of 1990, were improved and redefined in CNMD2000 [14]. First, the global pattern of the whole image of the lesion should be evaluated and then the local features should be identified as follows (Figure 4).

a) Global pattern: The whole image of the lesion is classified into the following eight patterns: reticular (pigment network or pseudonetwork), globular, cobblestone, homogeneous (structureless), parallel (palm and sole in acral), starburst, multicomponent (>2 components above), and unspecific (nonspecific).

Asymmetric pattern including multicomponent pattern is suggestive melanoma (Figure 7A), although symmetric pattern insists usually benign lesion (Figure 7B). However one should keep in mind that some melanoma show symmetric pattern or nonspecific pattern.

b) Local features: The pigment network is simply classified as typical or atypical. A typical pigment network shows symmetry of colors and structures. If the sizes and colors of the holes and grids in a pigment network lack uniformity and the distribution of pigment network itself shows asymmetric distribution, the pigment network is regarded as atypical. Brown globules and black dots are categorized as regular or irregular dots/globules depending on the symmetry of distribution. Blue-Whitish Veil or Blue White Veil (BWV) is a translucent blue-white veil-like area, which is detected on the surface of dark structureless areas. If BWV is detected in a part of the lesion, melanoma is suspected. However, blue nevi usually show BWV existing on the entire surface of the lesion. Black or dark colored structureless area that covers over 10% of the lesion (spots-like pigmentation) are defined as blotches. If it is located in the center of the lesion or distributed symmetrically, it is sign of benign melanocytic lesion. However, if it is recognized as off center blotches, melanoma is highly suspected. Streaks are the linear structures that are composed of radial streaming and/or pseudopods, which are seen in the periphery of the lesion. Radial streaming includes simple lines with dark color, while pseudopods are lines with bulbs at their ends. If it is distributed evenly, it is defined as regular, but if it shows segmental distribution, it is called irregular. Regression structure is composed of white scar-like areas and blue-gray dots. Hypopigmentation includes hypopigmented areas and reticular depigmentation and is an important factor in deciding the asymmetry depending on the distribution.

c) Vascular features: Comma shaped, hairpin, dotted (the shape of a small point), and linear-irregular vessels (line irregularity), and vessels within regression structures are generally seen in melanocytic

Methods	Criterion	Definition	Interpretation	Case 1	Case 2
Pattern analysis	Global pattern	Global patterns were classified in to: reticular, globular, cobblestone, homogenous, parallel, starburst, multicomponent (more than 2 pattern), unspecific	Features of melanoma Multicomponent, reticular, globular, parallel-ridge, unspecific	Multicomponent (asymmetric)	Reticular and globular (symmetric)
	Local features Pigment network	Gridlike pattern consisting of interconnecting pigmented lines surrounding hypopigmented	Atypical pigment network	Atypical pigment network	Typical pigment network
	• Typical pigment network	Network with minimal variability in the color, thickness, and spacing of the lines; symmetrically distributed.			
	• Atypical pigmen tnetwork	Network with increased variability in the color, thickness, and spacing of the lines of the network; asymmetrically distributed; gray.			
	Streaks	Radial linear extensions at the lesion edge or bulbous and often kinked projections seen at the lesion edge, either directly associated with a network or solid tumor border.	Irregular streaks	Irregular streaks	Absent
	• Regular streaks	Symmetrically and distributed streaks at the edge of the entire perimeter of the lesion			
	• Irregular streaks	Asymmetrically distributed streaks at the edge of the lesion and not clearly arising from network structures			
	Dots/globules	Granules/small, round or oval clods	Irregular dots/globules	Irregular dots/globules	Regular dots/globules
	• Regular dots/globules	Dots clustered at the center of the lesion, or located on the network lines or globules with minimal variability in their color, size, and shape.			
	• Irregular dots/globules	Any distribution of dots other than dots as described for regular dots or globules with variability in color, size, shape, or spacing and distributed in an asymmetric fashion			
	Blue-whitish veil	An irregular shaped blotch of blue hue with an overlying whitish ground-glass haze	Present	Absent	Absent
	Regression structures	White areas (white scarlike areas) and blue areas (gray-blue areas, peppering, multiple blue-gray dots) .	Present	Absent	Absent
	Hypopigmentation	Diffuse or localized (focal and multifocal) areas of decreased pigmentation	Present	Absent	Absent
	Blotches • Regular blotches • Irregular blotches	Dark structureless areas One blotch within center of lesion and surrounded by network More than one blotch or a blotch that is located off center Focal, multifocal, diffuse	Irregular blotches	Absent	Absent
	Vascular pattern	Comma, hairpin, dotted, linear-irregular, corkscrew vessels or polymorphous vessels which show more than 1 type of vessel morphology.	Atypical hairpin, dotted, linear-irregular, corkscrew vessels or polymorphous vessels consist of centrally paced dotted and linear-irregular vessels, milky red areas (multiple shade of pink)	Absent	Absent
	Site-related features Facial skin: Pseudonetwork	A structureless pigment area interrupted by nonpigmented adnexal openings	Pseudonetwork with increased variability in the color, thickness, and spacing of the network-like lines.		
	Annular-granular pattern	Dots and structureless areas arranged around follicle openings (and involving adnexal opening)	Present		
	Gray pseudonetwork,	Gray pigmentation surrounding the follicles, formed by the confluence of annular-granular structures	Present		
	Rhomboidal structures	Gray-brown angulated lines forming a polygonal shape around adnexal ostial openings	Present		
	Asymmetric pigmented follicular openings	Pigment associated with adnexal opening that does not uniformly surround the entire opening or curved (or crescent-shaped) pigment lines partially surrounding adnexal openings	Present		
	Volar skin:				
	Parallel-furrow pattern	pigmentation forming solid or dotted lines, parallel, thin, on the furrows (sulci superficiales or invaginations in dermatoglyphics); the lines are occasionally doubled, each line is beside the furrows	Absent (fundamentally)		
	Lattice-like pattern	Volar pigmentation forming thin lines, parallel on the furrow or sulci superficialis (invaginations in dermatoglyphics) and crossing perpendicular on the ridges	Absent (fundamentally)		
	Fibrillar pattern	Linear pigmented filamentous lines of similar length with one end at the furrows and oriented at a certain angle to the furrows and crossing the ridges	Absent (fundamentally)		
	Parallel-ridge patterns	Volar pigmentation forming lines, parallel, diffuse, and irregular, along the ridges or cristae superficiales (raised portion of the dermatoglyphics)	Present		
	Diagnosis		Melanoma is suspected if the lesion shows asymmetric global pattern and/or has one of melanoma specific features described above.	Melanoma	Melanocytic nevus

Figure 5: Summary of pattern analysis.
The definition and interpretation of global pattern and local features are shown with two diagnostic examples (the cases 1 and 2 correspond to Figure 7A and B, respectively).

Methods	Criterion	Definition	Interpretation		Case 1		Case 2	
ABCD rule	Asymmetry	In 0, 1, or 2 axes; assess not only contour, but also colors and structures	0-2 X1.3 (score X weight factor)		2 X 1.3 = 2.6		0 X 1.3 = 0	
	Border	Abrupt ending of pigment pattern at the periphery in 0-8 segments	0-8 X 0.1		2 X 0.1 = 0.2		1 X 0.1 = 1.0	
	Colors	Presence of up to 6 colors (white, red, light brown, dark brown, blue-gray, black)	1-6 X 0.5		5 X 0.5 = 2.0		4 X 0.5 = 2.0	
	Different structural components	Presence of network, structureless or homogeneous areas, branched streaks, dots, and globules	1-5 X 0.5		4 X 0.5 = 2.0		3 X 0.5 = 1.5	
	Diagnosis		Total score <4.75 benign 4.8-5.45 suspicious lesion >5.45 melanoma		6.8 Melanoma		4.5 Benign	
7-point checklist	Atypical pigment network	Combination of at least two types of pigment network (in terms of colour and thickness of the lines) asymmetrically distributed within the lesion	Score (original algorism) +2	Score (revised algorism) +1	Score (original algorism) +2	Score (revised algorism) +1	Score (original algorism) -	Score (revised algorism) -
	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	+1	-	-	-	-
	Atypical vascular pattern	Linear-irregular vessels, dotted vessels and /or milky-red areas not clearly seen within regression structures	+2	+1	-	-	-	-
	Irregular streaks	More than three brown to black, bulbous or finger-like projections asymmetrically distributed at the edge of the lesion and not clearly arising from network structures	+1	+1	+1	+1	-	-
	Irregular blotches	Black, brown and /or grey structureless areas asymmetrically distributed within the lesion	+1	+1	-	-	-	-
	Irregular dots/globules	More than three round to oval structures, brown or black in color, asymmetrically distributed within the lesion	+1	+1	+1	+1	-	-
	Regression structures	White scar-like depigmentation and /or blue pepper-like granules usually corresponding to a clinically flat part of the lesion	+1	+1	-	-	-	-
	Diagnosis		Total score ≥3 melanoma	≥1 melanoma	4 Melanoma	3 Melanoma	0 Melanocytic nevus	0 Melanocytic nevus
Menzies' methods	Criterion Negative features Symmetry of pigmentation	Description 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.	Suggestive of melanoma Neither can be found.		-		+	
	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-whitish veils	An irregular, structureless area of confluent blue pigmentation with an overlying white "ground-glass" haze.	At lease one feature can be found.		-		-	
	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 directly connected to either the tumor body or pigmented network.			-		-	
	Radial streaming	Finger-like extensions at the edge of a lesion that 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" in pattern.			-		-	
	Atypical network	A network made up of irregular, thick "cords", often seen focally thicker.			+		-	
	Diagnosis				Melanoma		Melanocytic nevus	
CASH algorithm	Colors	The number of following 6 color variation: light brown, dark brown, black, red, white, blue.	Score One point for each colors (1-6)		5		4	
	Architectural disorder	Severity of architectural disorder.	0 = none/mild, 1 = moderate 2 = marked		1		1	
	Symmetry	Symmetry related the shape of the lesion and dermoscopic structures within the lesion	0 = biaxial symmetry 1 = monoaxial symmetry 2 = biaxial asymmetry		2		0	
	Homogeneity/heterogeneity	Homogeneity/heterogeneity based on the number of following 7 dermoscopic structures: network; dots/globules; streaks/pseudopods, blue-white veil, regression structures, blotches and polymorphous vessels	One point for each of the 7 structures (1-7)		3		2	
	Diagnosis		A total CASH score (range: 2-17) and cutoff point for melanoma ≥8)		11 (≥8) Melanoma		7 (<8) Melanocytic nevus	
Chaos and clues method	Chaos	Asymmetry of pattern and/or color within a lesion	Suggestive of melanoma Present (necessary)		Present		Absent	
	Nine clues Gray or blue structures	Gray or blue dots, clods, circles, or lines	Present (≥1)		-		Not applicable	
	Eccentric structureless area	Eccentric located structureless area on the lesion with any color except skin color			-			
	Thick lines reticular or branched	The line must be thicker than the space they surround and must cover a significant part of the lesion (one or two thick lines are not sufficient to call it a clue)			+			
	Black dots or clods, peripheral	Black dots or clods can be seen on periphery of the lesion and not located on reticular lines			-			
	Lines radial or pseudopods, segmental	Segmental radial linear extensions or bulbous and often kinked projections at the lesion edge segmentally, directly associated with a network or solid tumor border			+			
	White lines	Superficial fibrosis and hypergranulosis are seen as white lines regardless of whether the dermoscope uses polarized or non-polarized light. They may be arranged in a reticular pattern or perpendicular to each other but without closing each other.			-			
	Lines parallel, ridges (acral) or chaotic (nails)	Pigment may be present in both ridges and furrows, but it is the location of the lines that decides whether the pattern is a ridge pattern or a furrow pattern.			Not applicable			
	Polymorphous vessels	Vessels are called polymorphous when more than one type of vessel pattern is seen. One or two vessels do not constitute a pattern.			-			
	Angulated lines (polygons)	Angulated lines on non-facial skin form complete or incomplete polygonal shapes which are larger than the holes caused by individual follicles and larger by far than the holes bounded by reticular lines. Angulated lines of facial skin are situated around follicular openings and therefore border a smaller zone than angulated lines on non-facial skin.			-			
	Diagnosis		If chaos is present, proceed to final 9 clues. Present at least one clue is suggestive melanoma or other malignancy including pigmented basal cell carcinoma, pigmented Bowen's disease are also suggestive.		Melanoma		Melanocytic nevus	
3-point checklist	Asymmetry	asymmetry of color and structure in one or two perpendicular axes	Suggestive of melanoma More than one of the three criteria present (basal cell carcinoma is also suggestive).		1		0	
	Atypical network	pigment network with irregular holes and thick lines			1		0	
	Blue-white structures	any type of blue and/or white color, i.e. combination of blue-white veil and regression structures			0		0	
	Diagnosis				2 (>1) Melanoma		1 (≤1) Melanocytic nevus	

Figure 6: Other methods of the second-step and 3-point checklist.
Six methods are summarized in this figure. The cases 1 and 2, shown as diagnostic examples, correspond to Figure 7A and B, respectively.

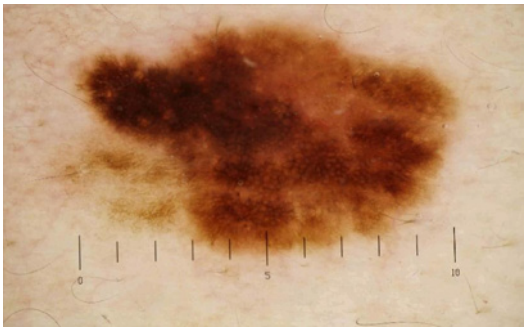

Figure 7A: Dermoscopic image of melanoma on the trunk.
This case is represented in Figure 5 and 6 as case 1. Asymmetric multicomponent pattern, which is composed of atypical pigment network, Irregular streaks and dots/globules can be found.

Figure 7B: Dermoscopic image of melanocytic nevus on the trunk
This case is represented in Figure 5 and 6 as case 2. It shows symmetric reticular and globular pattern. Typical pigment network and regular dots/globules can be seen.

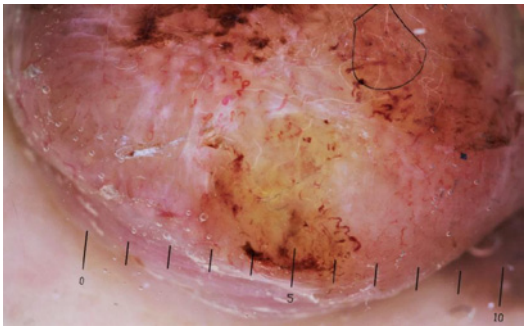

Figure 7C: Dermoscopic vasculature of melanoma.
In this amelanotic nodular part of melanoma, polymorphous vessels composed of comma, irregular hairpin, dotted, linear-irregular, and corkscrew vessels can be seen. In the center part of the lesion, white lines that are distributed perpendicularly are usually regarded as one of the clues for melanoma in the kittler method, although this is an artifact of polarized-light dermoscope.

lesions (Figure 4). Of them, only comma-shaped vessels are specific for banal nevus, while the others are findings sometimes seen in melanoma. Polymorphous vessels are a combination of more than two such patterns. They are sometimes seen in melanoma, especially dotted and linear-irregular vessels (Figure 7C).

d) The findings in a special part (site-related features):

1) Face

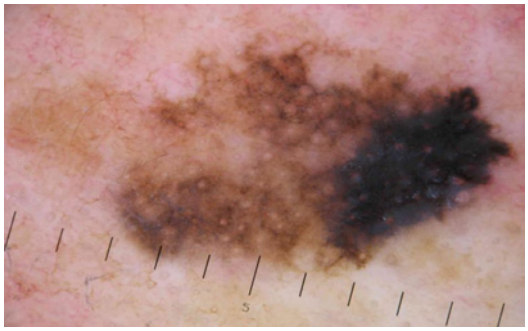

Figure 7D: Dermoscopic image of melanoma on the face.
Annular-granular pattern (in the upper and lower sides of the lesion), asymmetric pigmented follicular openings and angulated lines (in the upper side) can be detected. Rhomboidal structures with blue-whitish veil are also seen in the right side of the lesion.

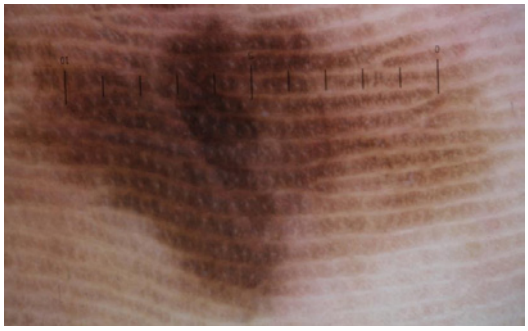

Figure 7E: Dermoscopic image of melanoma on the sole.
This lesion was mainly composed of parallel-ridge patterns. Color variation was also important clues for melanoma.

Structureless pattern, which is a pattern interrupted by hair follicles, is a common finding of melanocytic lesions and solar lentigo. Asymmetric pigmented follicular openings (asymmetric pigmentation of hair follicle) are findings of early melanoma that infiltrate the asymmetry of hair follicles (Figure 7D). There are other 3 features of facial melanoma. Annular-granular structures are those that consist of gray dots irregularly scattered around the follicles. Rhomboidal structures are dark pigmented areas that avoid the perifollicular space in polygonal residual non-pigmented fashion. In addition, regression structures are detected as burry whitish gray areas with blue-gray dots because of regression of the lesion.

2) Palm and sole

From the early stages, melanomas of the palms and soles (acral lentiginous melanoma, ALM) show a parallel-ridge pattern, because melanoma cells usually proliferate around crista profunda intermedia (Figure 7E). In growing melanomas, irregular diffuse pigmentation can be seen, which are composed of structureless areas with multiple shades of brown color, and some part of the lesion corresponds to a blotch. A multicomponent pattern is also sometimes seen in acral melanomas. In contrast, acral nevi usually show parallel furrow pattern since basal nevicells tend to be located in crista superficial is limitans. Parallel furrow pattern has four variants of lines: single line, single dotted line, double line, and double dotted line. Furthermore, there are two subtypes related to the parallel furrow pattern. The first

is fibrillar pattern, and it results from the lateral pressure of the sole. The transverse pressures on the sole encourage slanted keratinization of the cornified layer of the epidermis and it causes slanted melanin column in the stratum corneum resulting in fibrillar appearance. The benign fibrillar pattern presents as a fine brown fibrillary pattern in which the lines show little variation in thickness and color, although atypical "malignant" fibrillar pattern shows variations in thickness and colors. This pattern is commonly seen on the weight bearing parts of the sole such as heel. The second is lattice-like pattern, which can be seen on the palms and arches of the sole. The pattern has a ladder-like appearance, which is composed of parallel lines on the furrow and parallel lines crossing over the ridges from one furrow to the next.

e) How to manage: While differentiating benign melanocytic lesion from melanoma, attention should be paid to both, global pattern and local features [7]. When melanoma is suspected with a global pattern, local features suggestive of malignancy should also be checked. Checking the local features alone will lead to a misdiagnosis. The important three points for diagnosis are 1) the irregularity of the outline of a lesion is not related to malignancy in dermoscopic diagnosis, 2) mixed global pattern (multicomponent) is not related to malignancy when symmetry of the pattern is observed, and 3) the asymmetric structures in the periphery (dots/globules, pigment network, blotches etc.) show a high possibility of malignancy. Non specific or structureless lesions without any findings always show the possibility of melanoma. A special diagnostic approach is better for melanoma on the face or palms and soles because melanoma in such parts is usually recognized as lentiginous type and specific findings mentioned above are quite helpful for such differentiation. The "beauty and the beast sign" reported by Marghoob et al with the revised two-step algorithm is useful for differentiating between benign and malignant lesions based on images [22].

Other methods

The five methods of others which are described below are quite simple compared with pattern analysis.

What one need is basically to find out whether some items fulfill the criteria or not. For the purpose of referring and comparing to these diagnostic criteria quickly, examples of diagnosis using 6 methods including pattern analysis and 3-point checklist are shown (Figure 6).

a) ABCD rule: ABCD rule was reported by Stoltz et al. in 1994 as an easy-to-learn checklist [15]. The four initial letters of asymmetry, border sharpness, color, dermoscopic structures are the origin of this method. These only 4 features are required to analysis whether the lesion is melanoma or not. However, identification of a melanoma is not so easy. After asymmetry is judged by two 90% axis, border sharpnes is evaluated with dividing the lesion into eight parts equally. One needs to count the number of following six color in the lesion: white, red, light brown, dark brown, blue-gray, and black. The dermoscopic structures which are five features should be evaluated as flowing: strcutureless areas, pigment network, branched streaks, dots, and globules. The sum of total points of these 4 features is named Total Dermoscopic Score (TDS). A melanoma is strongly suspected if TDS is 5.45 or more. The lesions with 4.75-5.45 TDS in which melanoma cannot be ruled out, excision is recommended and if TDS is lower than 4.75, it is considered to be a benign lesion [21]. In this rule, the reported data was 92.8% sensitivity for melanoma and 91.2% of sensitivity, although 82.6% and 70%, respectively, were reported in CNMD2000 [21].

b) 7-point check list: The 7-point check list was reported by Argenziano et al. in 1998 [16]. They have seven specific structures of the melanoma as following, atypical pigment network, BWV, atypical vascular pattern, irregular streaks, irregular dots/globules/ irregular blotches, regression structures. These are common in pattern analysis, and the scores are calculated depending on the presence of those structures. The sensitivity and specificity of the 7-point checklist in CNMD2000 were 83.6% and 71.5%, respectively [21]. In order to improve the sensitivity of detecting early melanoma while screening pigmented lesions, the assessment was modified that each score was counted by one point in 2011[23]. Although the sensitivity reached as high as 87.8% from the77.9% of the original methods, the degree of singularity decreased from 87.8% to 74.5%.

c) The Menzies method: The Menzies method is method to identify advanced melanomas and was reported in 1996 [17]. This method is very simple and clear because if both the negative findings cannot be detected and at least 1 of 9 positive findings can be found, the lesion is suspected to be a melanoma. Two negative findings are symmetry of pigment pattern and single color. Nine positive findings are BWV, multiple brown dots, radial streaming, pseudopods, scar-like depigmentation, peripheral black dots/ globules, multiple (5 or 6) colors, multiple blue-gray dots, broadened network. The sensitivity and specificity of this test in CNMD2000 were 85.7% and 71.1%, respectively [21].

d) The CASH method: The CASH method was advocated by Braun et al. in 2002 [24]. It was named by considering the initial letters of color, architecture (structure), symmetry, and homogeneity (heterogeneity). After that in 2007, Henning et al. reported the scoring method with a total of 8 points is suggestive of melanoma and includes calculating the score of each of the 4 structures above [19]. One should evaluate the colors same as 6 colors as ABCD rules. Architecture and symmetry are classified into three step, mild, moderate and marked, and none, monoaxial and biaxial respectively. Homogeneity are evaluated by the numbers of the following 7 structures: network, dots/globules/ blotches, regression, streaks, veil (blue), polymorphous vessels. The sum of the each score is called as total CASH score (range 2-17) and the cutoff point is defined more than 7. The sensitivity and specificity were reported as 68% and 98%, respectively. Furthermore, they reported that although the CASH method was similar to the ABCD method and there was almost no difference in their diagnostic accuracies, the specificity was higher than with the Menzies method or 7-point checklist.

e) The Kittler method (of modified pattern analysis): The Kittler method was presented online (DERMA101.COM) in 2007 [20], and the text book was published in 2011with the second edition published recently [25,26]. As a diagnostic procedure, the method is very simple because it requires only five base elements-lines, pseudopods, circles, clods, and dots, in addition to structureless patterns, which are needed to express the structure of a lesion. A report on the standardization of terminology between these simple terms and metaphoric terms was also published [27]. The diagnosis is made by combining three

elements-pattern, color, and clues (pattern+color+clues=diagnosis). In the procedure, the pattern of a lesion is decided by the combination of these five elements with structureless pattern, and the color of the structures including the number of colors and clues, which are specific structures for the lesion, is also evaluated. The possibility of a diagnosis is expanded with the classification of the pattern of the non-pigmented lesion by the findings of blood vessels and clues that could not be detected in the conventional pattern analysis, such as melanoma, seborrheic keratosis, and Bowen disease. However, since the diagnostic algorithm is rather complicated in itself, experience and skill training are required. As a simpler version of the Kittler method, the Chaos and Clues method was reported by Rosendahlet al [28]. In this method, we find the color of a lesion and the asymmetry of the structure named "chaos" at first, followed by checking for the eight clues for melanoma. The sensitivity is 90.6% and the specificity is 62.7%. Recently, angulated lines including "polygons" reported by Keir [29] were added and the methods now consists of a total of 9 clues. Unique findings such as chaos, which is asymmetric distribution of the structures or colors and eccentric structureless area i.e., a peripherally located dark pigmented homogenous area, are the practical findings in medical examination. In addition, the podcast about the Kittler method can be accessed for free on the homepage of the International Dermoscopy Society.

f) 3-point checklist: Although it was not contained in the diagnostic method of the second-step mentioned above, the 3-point checklist, which was reported by Soyer et al. in 2004 [30], is the simplest diagnostic method that can be used for differentiating a melanoma and basal cell carcinoma from benign tumor. It has good diagnostic accuracy with 91% sensitivity (86.7% in non-experienced clinicians) and 71.9% specificity [31]. When using a dermoscopy, at least this 3-point checklist should be kept in mind.

Conclusion

It is better to use and master one's favorite diagnostic method. The best way to master dermoscopy is learn to use a dermoscope without preconceived notions. In the most cases of melanocytic lesion, symmetry in the distribution of colors and structures is a sign of benign, although the irregularity of the outline of a lesion is not related to malignancy in dermoscopy. On the other hand, melanoma tends to show asymmetric pattern with many colors and structures. However, one should always keep in mind that some melanoma show symmetric pattern or nonspecific/featureless pattern.

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