Dermoscopy Two Step Algorithm

Szkoła Dermatologii Onkologicznej

Introduction to the top-down 2-step approach

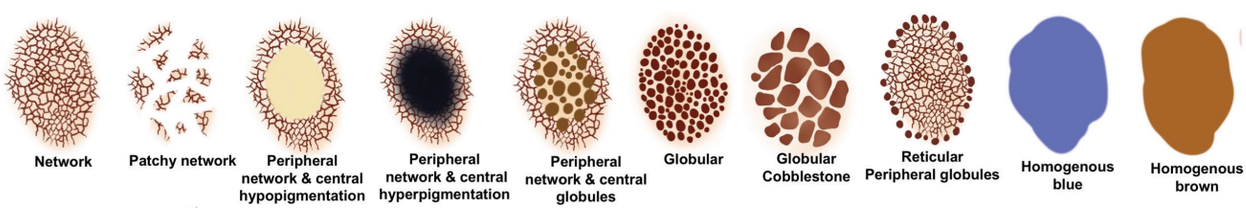
The top-down 2-step pattern analysis approach builds upon the previous classic [1] and revised [2] 2-step approaches by eliminating the requirement to differentiate melanocytic from non-melanocytic lesions in step 1. This algorithm hinges on the concept that the observer's diagnostic accuracy for skin cancer, specifically melanoma, is, metaphorically, like a two-sided coin. One side of the coin requires the observer to make a specific diagnosis by recognizing the classic patterns/structures associated with nevi, dermatofibromas (DF), intradermal nevi (IDN), basal cell carcinomas (BCC), squamous cell carcinomas (SCC), lentigines & seborrheic keratoses (SK), angiomas, angiokeratomas, sebaceous hyperplasias, and clear cell acanthoma (CCA). Needless to say, the individual dermoscopic structures present in a lesion, within each diagnostic category (nevus, DF, BCC, etc), need to be placed within the context of the other features within the lesion. In other words, the global pattern defining a specific diagnosis is defined by the presence of distinct structures that have previously been found to carry a high predictive value for that specific diagnosis.

The other side of the coin requires the observer to acknowledge the nevus patterns that require context for their interpretation and the patterns and structures associated with melanoma. Armed with a clinical differential diagnosis followed by evaluation of the lesion via this top-down 2-step approach can facilitate the rendering of an accurate diagnosis or at least guide the clinician towards the most appropriate management plan.

In a simplified way, the main queries of the top-down 2-step analysis are: Step-1: To establish a specific diagnosis (if possible) Step-2: To rule out melanoma

Step 1

Level 1:
The most common patterns found in nevi (excluding IDN).



Network or reticular pattern:
consists of an organized network with minimal variation in its thickness and color (i.e., regular/typical network). The holes of the network are relatively uniform in their appearance.

Patchy network/reticular pattern:
patches of typical network distributed in an organized manner. The network patches all have the same type of network with minimal variability in the thickness and color of the lines. It is important to remember that melanoma on sun damaged skin can sometimes appear as an isolated large lentiginous lesion with a patchy network. The clues to the diagnosis include the age of the patient since these melanomas occur in the elderly, the network is usually not distributed in an organized fashion, and there is usually focal granularity present.

Peripheral network with central hypopigmentation:
The peripheral network is typical/regular and the central hypopigmented area is lighter in color compared to the network but darker than the surrounding skin.

Peripheral network with central hyperpigmentation.
The peripheral network is typical/regular and the central hyperpigmented area consists of a blotch. This blotch often due to the accumulation of melanin laden corneocytes in the straum corneum (i.e., lamella). This lamella can usually be tape stripped off revealing an underlying typical network.

Peripheral network with central brown globules:
The peripheral network is typical/regular and the central brown globules are also regular displaying minimal variation in their size and color.

Globular pattern:
This pattern consists only of globules that display minimal variability in their sizes and colors (i.e., regular/typical) and are distributed in an organized manner within the lesion. The globules can have different shades of brown. On rare occasion the globules can be white as seen on balloon cell nevi. While black and blue globulescan on occasion be seen in congenital nevi, their presence should raise suspicion for melanoma.

Cobblestone globular pattern:
This is a specific type of globular pattern that consists of large brown angulated globules that create a pattern reminiscent of cobblestones. This is a pattern associated with congenital nevi.

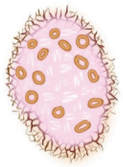
Reticular pattern with peripheral globules:
This pattern consists of a typical network nevus that has a peripheral rim of regular brown globules. This pattern is associated with the radial growth phase of Clark's/dysplastic nevi and is commonly encountered in younger patients with the atypical mole syndrome.

Homogeneous blue:
A homogeneous blue color with a whitish veil that encompasses the entire lesion's surface is the hallmark of a blue nevus. The blue color and white veil in blue nevi will have minimal variation in hues. If there are multiple hues (i.e, heterogeneous blue color or non-homogeneous veil) then one should consider the diagnosis of melanoma. In addition, the differential for blue nevi should include epidemiologic metastasis and if nodular then one needs to consider the diagnosis of nodular melanoma.

Homogeneous brown:
This pattern consists of a nevus with homogeneous brown color with minimal to no variation in its hues. While it is usually devoid of any other structures, on rare occasions one can see a few regular dots/globules and fragments of network. This pattern is seen in congenital nevi.

Level 2:
Dermatofibromas

DF: network with central white blotch



DF: network with ring-like globules, shiny white streaks & pink hue

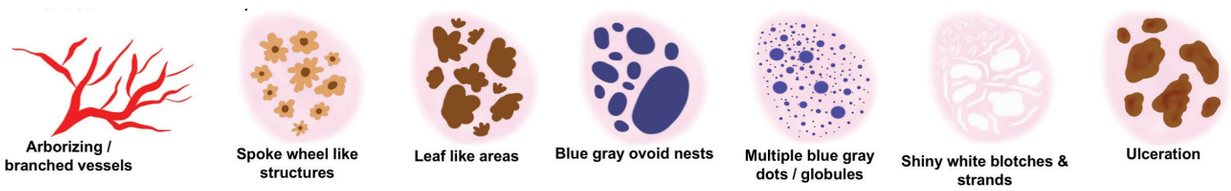
Dermatofibromas (DF) are defined first and foremost by their clinical characteristics of being firm papules that dimple on lateral pressure. A DF with this clinical morphology will usually reveal the following features when viewed with dermoscopy: A symmetric lesion with a thin, typical, peripheral network with a central white scar-like area. In the region between the network and the central scarlike area one can see ring like globules and vessels. When viewed with polarized light the central scarlike area will usually manifests a pink hue and will often also reveal shiny white lines.

Level 3:
Intradermal nevi

IDN: comma/curved vessels, brown halo, brown pigmentation, globules

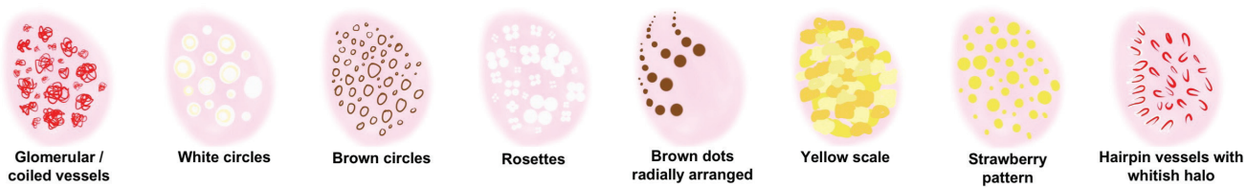
Intradermal nevi (IDN) are first and foremost defined by their clinical morphology as either raised dome shaped lesions or as sessile mamillated lesions. IDN with this clinical morphology will usually reveal one or more of the following features: comma vessels, brown halo, globules, small foci of tan structureless pigmentation, hypopigmented areas. They can also reveal arborizing vessels making it difficult to differentiate them from BCC. The clues to the diagnosis of IDN include the presence of the aforementioned features and lack of other BCC-specific features. In addition, the arborizing vessels in IDN are often a tad out of focus and have a bluish hue. In contrast, in BCC the arborizing vessels are usually sharply in focus and bright red in color.

Level 4:
BCC: Features associated with BCC



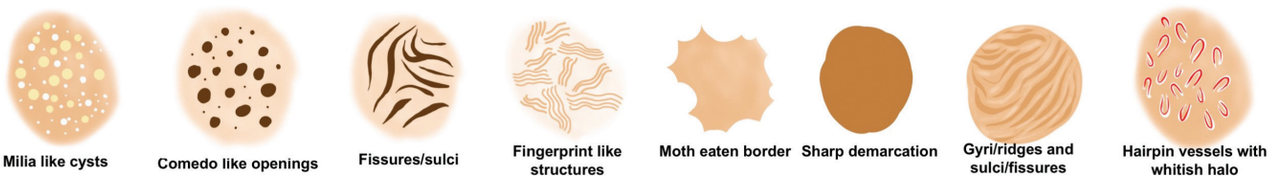
- Arborizing (branched) vessels
- Spoke wheel structures/concentric structures
- Leaf like areas
- Blue gray ovoid nest
- Blue gray non-aggregated globules
- Multiple blue gray dots distributed in a buckshot scatter
- Shiny white blotches and strands
- Ulceration

Level 5:
SCC: Features associated with SCC



- Scale (rough texture) is present in almost all lesions
- Glomerular (coiled) vessels
  - Focally distributed towards the periphery
  - Diffusely present throughout lesion
  - Aligned linearly within lesion
- White circles
- Brown circles
- Rosettes (seen with polarized light)
- Brown dots aligned in a linear fashion
- Strawberry pattern seen in actinic keratosis (AK)
- Hairpin (looped) vessels with a white halo can be seen in keratoacanthomas (KA). In KA these looped-vessels tend to be aligned at the periphery.
- Polymorphous vascular pattern composed of dotted, short linear and long linear irregular (serpentine) vessels.

Level 6:
Seborrheic Keratosis (SK)&lentigo:
Features associated with SK and lentigo



- Moth eaten borders
- Sharp boarders
- Fingerprint like structures
- Multiple milia-like cysts
- Comedo-like openings
- Gyri and sulci (crypts) creating a cribriform pattern
- Hairpin (looped) vessels with a white halo

Level 7:
angioma/angiokeratoma/hemangioma

- **Angioma and hemangiomas:** lacunae with red to maroon to bluish colors that are separated from each other with intervening stroma.

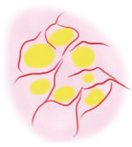
- **Angiokeratomas:** lacunae with varying shades of red, maroon and bluish. In addition ,there are thrombosed lacunae that have a black color. The center of the lesion often has a blue-whitish veil and the surrounding skin has an erythematous halo.

Level 8:
Sebaceous hyperplasia

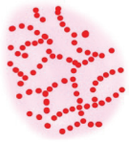
Sebaceous hyperplasia:
Crown vessels

These are small papules that reveal whitish/yellowish globules resembling pop-corn like structures. Crown vessels are also seen. These vessels are present at the periphery. They radiate towards the center but do not cross its midline. Molluscum contagiosum will manifest a similar pattern.

Level 9:
Clear cell acanthoma



**Sebaceous hyperplasia:
Crown vessels**



**CCA: Vessels in serpiginous /
string of pearls arrangement**

These lesions will reveal vessels, including dotted or glomerular, arranged in a string of pearls pattern.

Step 2

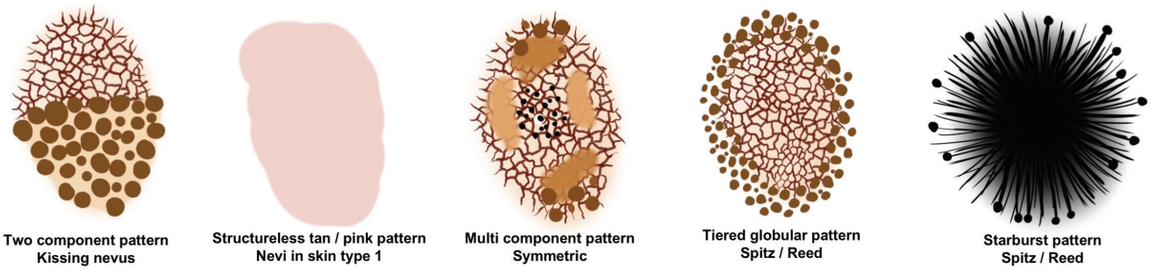
If a specific diagnosis cannot be rendered then the observer moves to the second step of the algorithm. Therefore, the second step includes lesions that are suspicious for melanoma and lesions that cannot be safely diagnosed. The latter group of morphologically equivocal tumors consists mainly of nevi that demand special attention, but also of some melanomas lacking the usual disorganized distribution of structures and colors. Consequently, the main goal of the second step is to maximize melanoma detection and, thus, all lesions entering the second step should be evaluated for the presence or absence of melanoma specific patternsand structures.

As a principle, the second step analysis should be always performed in conjunction with the overall clinical context of the lesion. This is because the diagnostic usefulness of each dermoscopic criterion for melanoma depends on the other tumors included each time in the differential diagnosis. Often, the differential diagnosis is narrowed by clinical data, since one or more diagnoses might be excluded (or considered very unlikely) based on epidemiologic characteristics of the patient (ex. age). Therefore, the dermoscopic analysis should be adjusted each time to the clinically established differential diagnosis and aim to narrow it further.

Examples:

1. A recently appeared pigmented macule in a 70 years old man, dermoscopically displaying regularly distributed brown dots: Regular dots are considered as suggestive of a nevus. However, the diagnosis of a nevus is not included in the clinical differential diagnosis of a pigmented lesion developing at this age. Therefore, an epidemiologic characteristic (age) narrows the differential diagnosis into 2 main possible entities: melanoma and seborrheic keratosis/solar lentigo. Between these 2 diagnoses, brown dots are strongly suggestive of melanoma.
2. Atypical network is generally considered a melanoma-specific criterion. However, in a young individual with multiple atypical nevi, a degree of networkatypia in a nevus might be tolerated, especially in the presence of additional nevi with similar features. Precisely the same aspect in a solitary lesion would be considered as highly suspicious.
3. A pigmented lesion dermoscopically typified by regularly distributed peripheral streaks: in a child would be considered as diagnostic of Reed nevus. In an individual of 60 years the same pattern would be strongly suspicious for melanoma.
4. A non-pigmented lesion dermoscopically displaying dotted vessels: In a child, the differential diagnosis would include a Spitz nevus and a viral wart. In an elderly individual, the differential diagnosis would include melanoma, intraepidermal carcinoma and lichen-planus like keratosis.

Nevi requiring special consideration



Two component pattern
Kissing nevus

Structureless tan / pink pattern
Nevi in skin type 1

Multi component pattern
Symmetric

Tiered globular pattern
Spitz / Reed

Starburst pattern
Spitz / Reed

- **The two component pattern** and t**he multi-component symmetric pattern** are commonly encountered in patients with the atypical mole syndrome. However, if it is an outlier lesion compared with the patient's other nevi then one should consider a biopsy or close digital monitoring to ensure stability.

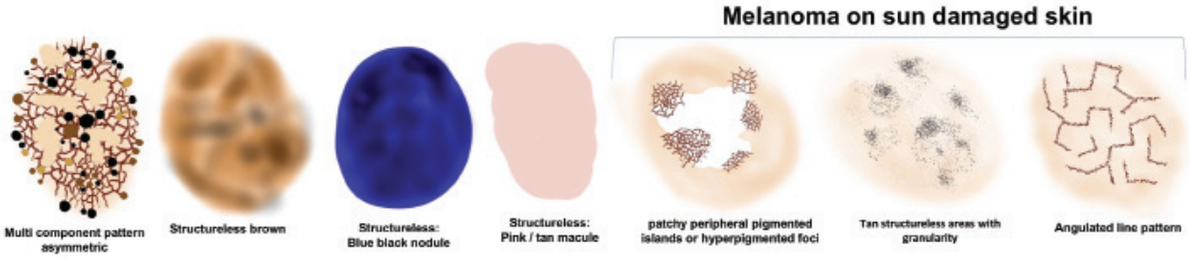
- **The homogeneous tan to pink** nevus is a common pattern seen in nevi in individuals with type I-II skin. However, this pattern can also be seen in amelanotic and hypomelanotic melanomas. Thus, if such lesions appear to be outliers, caution should be exercised.

- **The tiered peripheral globular pattern** is associated with nevi having a spitzoid morphology on dermoscopy. While the management of spitzoid lesions remains controversial, if such a lesion develops in older age, then one should consider a biopsy.

- **The typical starburst pattern** is associated with Reed's nevi. While this is usually a benign pattern, on rare occasions melanoma can masquerade itself as a starburst pattern lesion. Thus, a classic starburst pattern in individuals under the age of 12 can be monitored, however, such lesion in older individuals should be viewed with suspicion.

Melanoma patterns and structures

Melanomas will usually manifest a disorganized distribution of structures and colors making their identification quite easy. These lesions will reveal at least one, but usually more than one, of the melanoma specific structures listed below. On rare occasions melanomas will present with a symmetric and organized pattern but these tumors will almost always reveal one of the following features: starburst pattern, negative network, blue-black or gray color, shiny white structures, vessels or ulceration.
A few melanoma patterns deserve special mention.

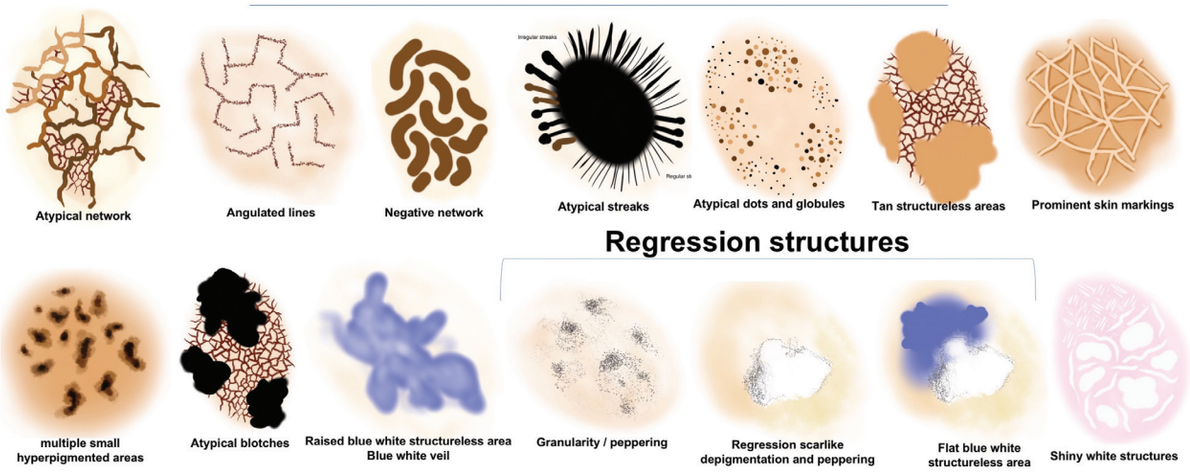


- **Featureless or structureless (non-specific or feature poor) lesions** are lesions that have no dermoscopic structures or do have dermoscopic structures but the structures present cannot be used to differentiate benign from malignant. If such lesions are non-palpable then they can be digitally monitored or can be biopsied. If such a lesion is palpable then digital monitoring is contraindicated and the lesion should be biopsied.
- Melanoma should be in the differential diagnosis for any **blue-black nodule.**
- Melanoma in situ can manifest a pattern comprised of **small foci of hyperpigmentation**. The hyperpigmented areas differ from blotches in that they are small (cover <10% surface area), multiple and do not obscure the ability to see underlying structures. These melanomas will also often reveal **prominent skin markings**.
- Melanoma on sun damaged non-facial skin (lentigo maligna) is associated with the following patterns: **patches of peripheral network islands, tan structureless areas with granularity, and a lesion with angulated lines**.

Melanoma specific structures

Structures

Almost all melanomas will reveal at least one of the following structures/features:



Atypical network

Typical network consists of brown lines with minimal variability in their color and thickness. The holes of the network are of similar size. Atypical network consists of lines with increased variability in color and thickness. The atypical lines are often broadened, smudgy in appearance and often have a grayish color.

- **Angulated lines**
- **Negative network**
- **Atypical streaks**

Typical streaks consist of streaks arranged symmetrically around the entire perimeter of the lesion as seen in Reed's nevi.Atypical streaks consist of streaks that are only focally present at the periphery.

- **Atypical dots and globules**

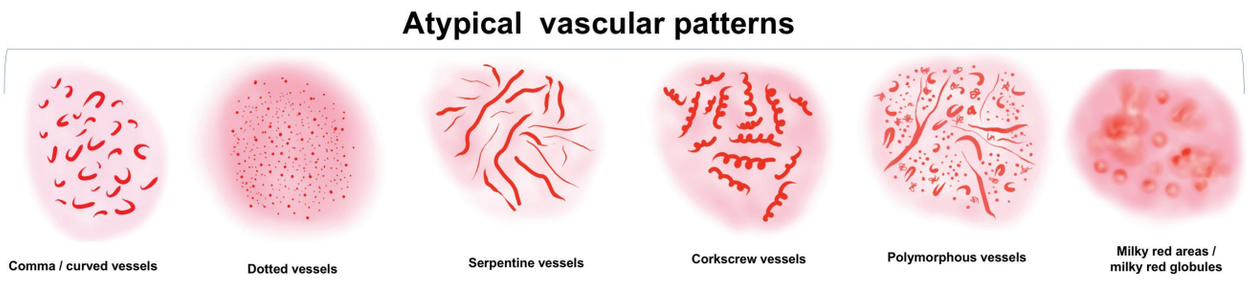
Typical dots consist of dots that are centrally located within an otherwise organized lesion or dots associated with a typical network. The typical dots associated with a typical network are located on the network lines or in the holes of the network. Any other manifestation of dots is considered atypical. Atypical dots are distributed asymmetrically, are not clustered in the center and are associated with an atypical network. Typical globules are those found in nevi described in step-1 of this algorithm. Globules of similar shape, size and color distributed throughout the lesion (including cobblestone), at the periphery of an otherwise reticular nevus, or in the center of an otherwise reticular pattern nevus are considered typical. Any other manifestation of globules would be considered atypical.

- **Peripheral tan structureless areas**
- **Atypical blotches**

Typical blotch consists of one round to oval homogeneous blotch in the center of an otherwise reticular pattern nevus. Atypical blotch consists of an off center blotch or the presence of multiple blotches. The blotches can have irregular shapes and hues.

- **Multiple small hyperpigmented areas of irregular shape**
- **Accentuated skin markings**
- **Blue-white veil over raised areas**
- **Regression structures** (flat, non-palpable areas)
- **Granularity / peppering**
- **Scar like depigmentation**
- **Blue-white veil over flat area**
- **Shiny white lines**

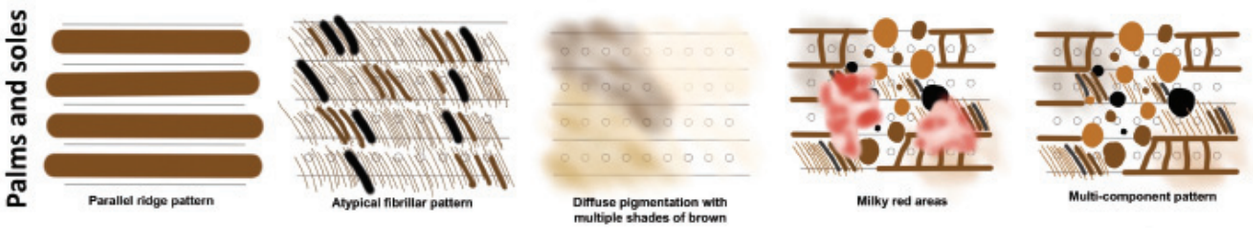
Atypical vessels



- **Comma vessels in flat lesions (not IDN)**
- **Dotted vessels**
- **Serpentine or linear vessels**
- **Milky red areas and globules**
- **Polymorphous pattern** - The most common pattern is one with both dotted and serpentine vessels
- **Corkscrew vessels**

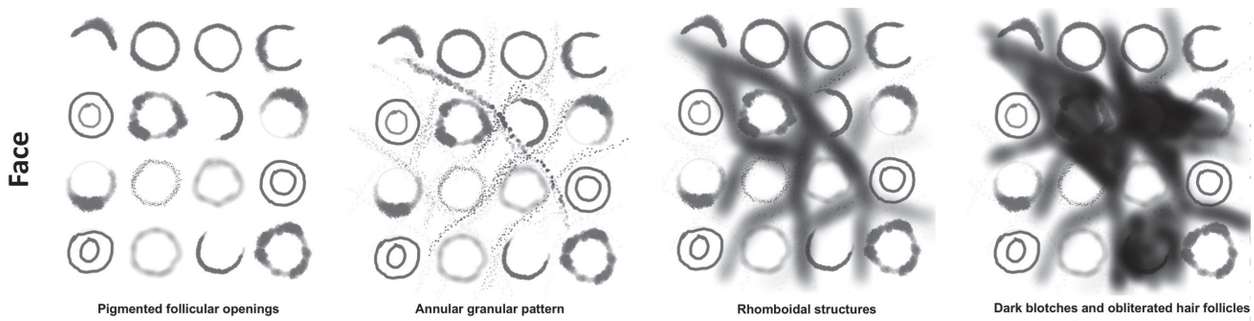
Melanoma pattern and structures on special sites

Volar: melanomas on the palms and soles



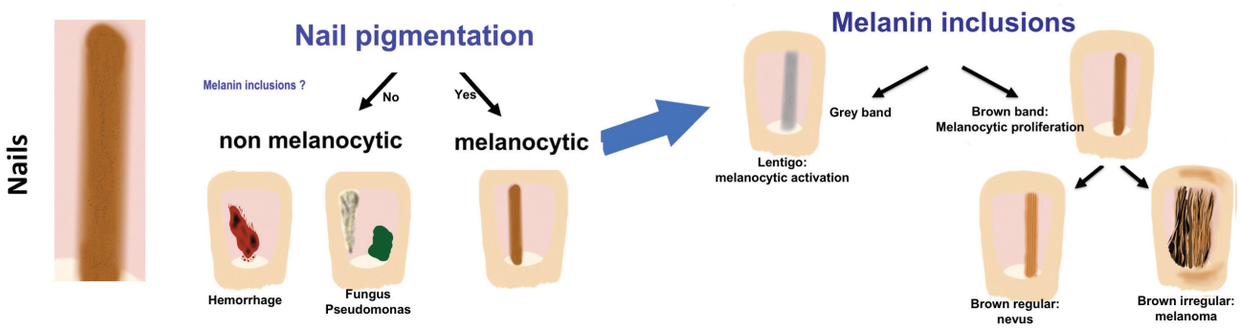
- Parallel ridge pattern
- Atypical fibrillar pattern
- Diffuse pigmentation with multiple shades of brown
- Multi-component pattern

Face:



- Annular-granular pattern
- Asymmetric follicular openings
- Gray dots/granules around ostial openings
- Circle within circle sign
- Angulated lines forming rhomboids
- Blotche

Nails:



The presence of melanin inclusions defines the lesion as melanocytic. These lesions consist of melanocyte activation as seen in lentigo or melanocytic proliferation as seen in nevi and melanoma. While evaluating the nail plate it is important not to overlook evaluating the paronychia (micro-Hutchinson's sign) area and hyponychial skin (parallel ridge pattern will be seen).

- Atypical bands

consisting of lines of different colors and thicknesses. The bands may lose their parallelism and appear to converge distally creating a triangular appearance to the band (wider at proximal end and narrow at the distal end)

Mucosa:

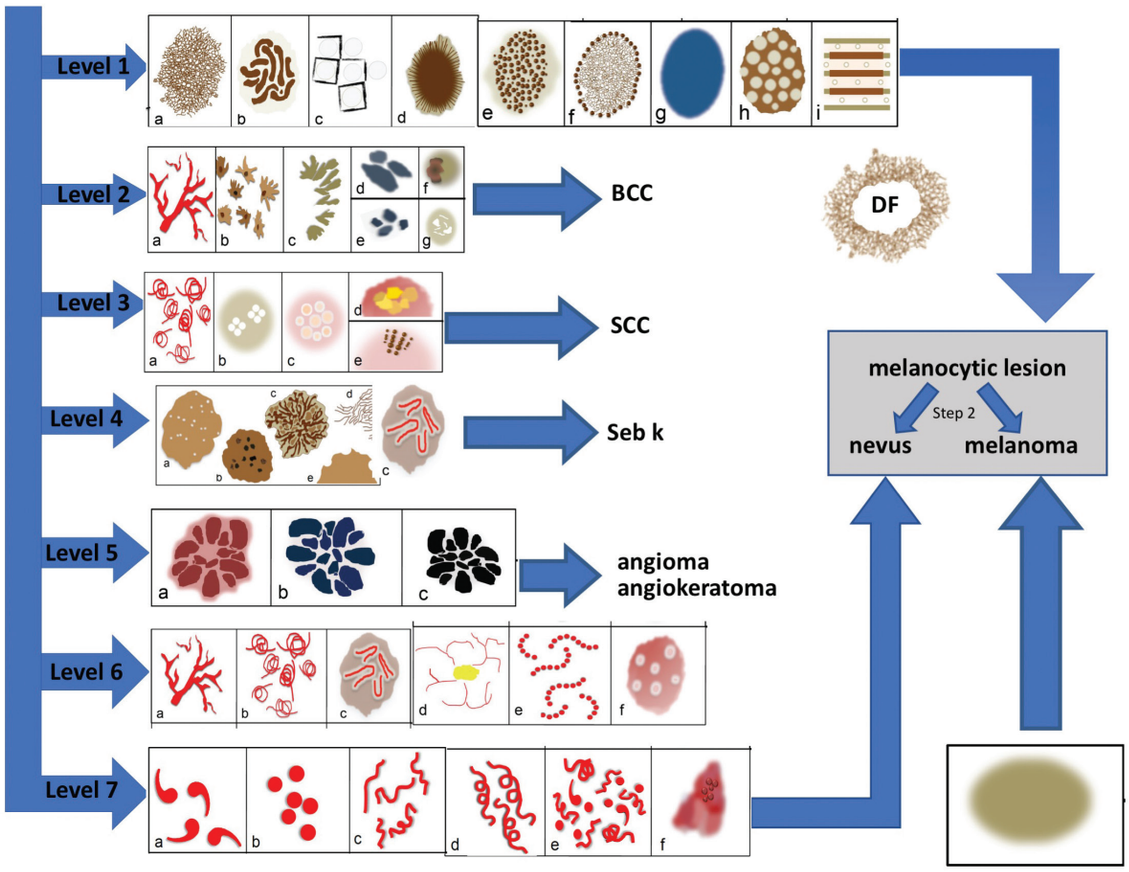
The features to define early mucosal melanoma have not yet been elucidated. Clearly any lesion with a multi-component pattern should be viewed with suspicion. In addition, any lesion manifesting the colors blue, gray or white should be view with concern for melanoma.

Classic two-step algorithm

In 2001, the Board of the Consensus Net Meeting agreed on a two-step algorithm for the classification of pigmented lesions of the skin [1]. In the first level of decision making, the observer must decide whether a lesion is of melanocytic or nonmelanocytic origin. Once the lesion is identified to be of melanocytic origin, one can move on to level two. This second step the decision must be made if a melanocytic lesion is benign, suspect, or malignant. For this purpose, the algorithms found in chapter 9 are most useful.

The revised two-step algorithm

After the initial description of the two-step algorithm, the different types of blood vessels have been described . Since the initial algorithm did not take into consideration the vascular architecture, there was a need to update this algorithm

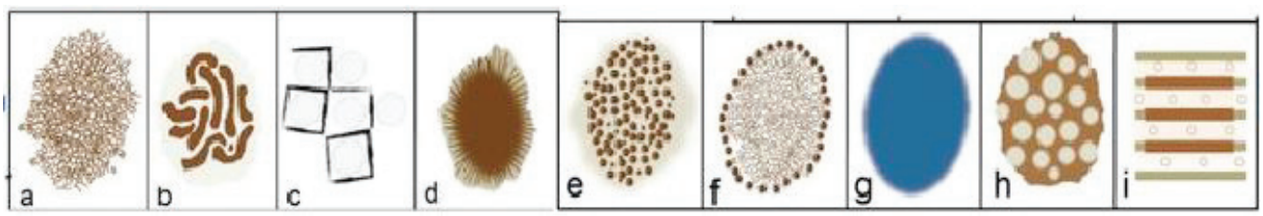


Step 1 decision: melanocytic vs. nonmelanocytic lesion

The first step of this two-step dermoscopy decision-making algorithm has different levels . However, before we use this algorithm it is important to be aware that this algorithm is designed to evaluate lesions on glabrous and nonglabrous skin only. It is not intended for special locations because in this case standard dermoscopy criteria do not apply. Each level requires that the observer evaluate the lesion for the presence of specific dermoscopy criteria in the following sequence

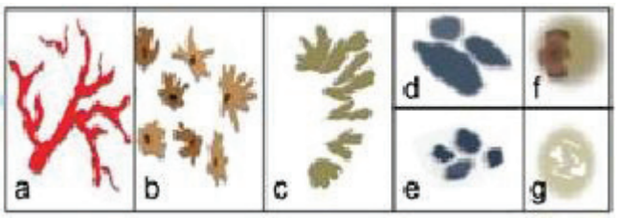
Level 1: Criteria for Melanocytic Lesions

Search for pigment network (N.B: one exception; see below), atypical network, streaks (i.e., radial streaming and pseudopods), negative network, aggregated globules, homogenous blue pigmentation, criteria for melanocytic lesions in special locations such as pseudonetwork (face), or parallel pattern (palms, soles, and mucosa). If any of these structures or features are present, the lesion is considered of melanocytic origin and hence, one can proceed directly to the second step of the two-step algorithm. One major exception to the above is when a lesion manifests a delicate peripheral reticulation with a central scar-like area as seen in a dermatofibroma. This particular pattern generally trumps the presence of a network, hence preventing the misdiagnosis of a dermatofibroma as a melanocytic lesion. A further clarification of homogenous blue pigmentation as seen in blue nevi is also warranted here. The quintessential characteristic that differentiates a blue nevus from other lesions possessing a blue-white veil is that in a blue nevus the blue pigmentation occupies the entire surface area of the lesion in a homogenous manner. If the criteria of Level 1 are not met, then one needs to proceed to Level 2.



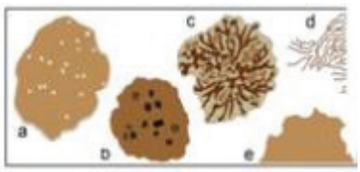
Level 2:
Criteria for Basal Cell Carcinoma

Search for the presence of specific morphologic criteria for basal cell carcinoma, which include arborizing blood vessels (telangiectasias), leaf-like areas, large blue-gray ovoid nests, multiple blue-gray nonaggregated globules, spoke-wheel-like structures, shiny white areas, or ulceration. In the absence of a pigment network, these criteria are highly suggestive of basal cell carcinoma. If, on the other hand, these structures are not seen, then proceed to Level 3.



Level 3:
Criteria for Seborrheic Keratoses

Look for multiple milia-like cysts, comedo-like openings, crypts, moth-eaten borders, network-like structures, "fissures and ridges" (also known as gyri and sulci) that sometimes give a brain-like or cerebriform appearance to the lesion, fat fingerlike structures, or light brown fingerprint-like structures. Although milia cysts and comedo openings are very easy to identify by standard nonpolarized dermoscopy, they may not be as apparent when viewed using polarized light dermoscopy. With that being said, if some of these structures are present, then the lesion is probably a seborrheic keratosis. The presence of milia like cysts does not automatically equate a diagnosis of seborrheic keratosis because milia cysts can sometimes be seen in basal cell carcinoma and in melanocytic nevi, especially of the congenital type. Thus, milia cysts should be considered a diagnostic criterion only after insuring that the lesion is not a melanocytic lesion or a basal cell carcinoma. If none of the seborrheic keratosis criteria are seen then one needs to proceed to Level 4.

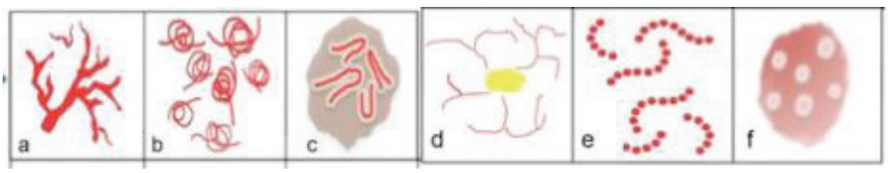


Level 4:
Criteria for Vascular Lesions

The presence of red, maroon, or red-blue to black lacunae (also known as lagoon-like structures), indicates that the lesion is a hemangioma or angiokeratoma.

Level 5:
Specific Blood Vessels in Nonmelanocytic Lesions

If none of the morphologic criteria described in the previous levels can be identified, then the lesion does not manifest any obvious features of a melanocytic lesion nor does it manifest any of the features seen in the four common nonmelanocytic tumors. These lesions are usually amelanotic or hypomelanotic. Since blood vessels are often the only "diagnostic criterion" it is important to appreciate both their morphology and distribution. Hairpin vessels surrounded by a whitish halo are characteristic of keratinizing tumors, such as keratoacanthomas and seborrheic keratosis.



Glomerular vessels

Are usually aggregated focally at the periphery of the lesion. They identify the lesion as squamous cell carcinoma. Besides the morphology and distribution of vessels, the arrangement of the blood vessels and the color surrounding the vessels can also assist in the diagnosis.

Pearls on a string

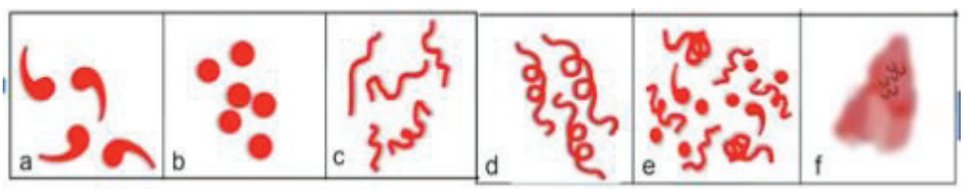
The presence of blood vessels arranged like "pearls on a string" or in a "serpiginous pattern" is a hallmark of clear cell acanthoma[4]

Crown vessels

The presence of crown vessels identifies the lesion as a sebaceous hyperplasia or molluscum contagiosum.

Level 6:
Specific Blood Vessels in Melanocytic Lesions

The presence of predominantly comma shaped blood vessels is a hallmark of intradermal nevi [5]. The blood vessel morphology encountered in melanoma includes dotted, linear irregular, atypical hairpin (serpentine) vessel in a pink background, and cork screw or tortuous vessels. If more than one type of vessel morphology is seen within the same lesion, the vascular pattern is termed "polymorphous." The polymorphous pattern that is most commonly associated with melanoma consists of centrally placed dotted and linear/serpentine vessels [6]. In addition to the blood vessel morphology described above, the presence of multiple shades of pink, also known as milky red areas, can also be seen in melanoma. The milky red color probably represents an increased vascular volume and may be a reflection of neoangiogenesis [5]. Lesions that do not display any of the structures mentioned in levels 1–6 are considered "structureless" and for such lesions one needs to proceed to Level 7.



Level 7:
„Structureless" Lesions

Lesions that fail characterization in levels 1–6 are tumors that are often completely featureless or structureless. However, it is important to highlight that these lesions are not always necessarily structureless. Level 7 is simply the default category that includes all lesions that fail to reveal any specific diagnostic structures to help classify them as melanocytic or as one of the non-melanocytic lesions mentioned in levels 1 to 6 of the twostep algorithm. For example, the presence of fine dots, peppering, blue white veil, crystalline structure, and blotches may be present in these lesions. While these structures cannot be used to differentiate melanocytic from non-melanocytic lesions, they can be clues that aid in correctly identifying melanomas and some basal cell carcinomas. With that said, for all lesions in level 7 (the so called "structureless" lesions), it is imperative that melanoma be ruled out. This "worst case scenario" avoids missing melanomas that are devoid of any specific discernable structures. Thus, these lesions either should be biopsied or should be subjected to short-term mole monitoring in an attempt to ascertain their biologic nature.

Step 2 decision: benign nevus vs. suspect melanocytic lesion vs. melanoma

Lesions that are identified as being of melanocytic origin in step one of the two-step algorithm include those described in levels 1, 6, and 7 above. Melanocytic lesions–manifesting structures and features described in these levels can be subjected to the second step of the two-step algorithm. In the second step, the presumed melanocytic neoplasm is evaluated to determine whether the lesion is benign, suspect, or malignant. To accomplish this, many different approaches have been proposed.

Limitations of the two-step algorithm

The main purpose of the two-step algorithm is to avoid missing the diagnosis of melanoma. Although some exceptions to the two-step algorithm exist, they do not affect the sensitivity for melanoma detection. In other words, the two-step process is designed to maximize the sensitivity for melanoma detection [7]. With that said, the main shortcoming of the classic two-step algorithm was that it did not adequately address the evaluation process for amelanotic and hypomelanotic neoplasms. These lesions often appear to be structureless or featureless on initial inspection. However, upon scrutiny many of these neoplasms will in fact reveal blood vessels and are not truly structureless. These new insights prompted us to modify the two-step algorithm by adding two new decision levels to the classic two-step algorithm, which are intended to assist clinicians in correctly classifying some of these so-called featureless neoplasms as either melanocytic or nonmelanocytic tumors.

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