Vascular Structures in Skin Tumors

A Dermoscopy Study

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Objectives: To describe the different vascular structures seen by dermoscopy and to evaluate their association with various melanocytic and nonmelanocytic skin tumors in a large series of cases.

Design: Digital dermoscopic images of the lesions were evaluated for the presence of various morphologic types of vessels.

Setting: Specialized university clinic.

Patients: From a larger database, 531 excised lesions (from 517 patients) dermoscopically showing any type of vascular structures were included.

Main Outcome Measures: The frequency and positive predictive value of the different vascular structures seen in various tumors were calculated, and the differences were evaluated by the $\chi^2$ or Fisher exact test.

Results: Arborizing vessels were seen in 82.1% of basal cell carcinomas, with a 94.1% positive predictive value ($P<.001$). Dotted vessels were generally predictive for a melanocytic lesion (90.0%, $P<.001$), and were especially seen in Spitz nevi (77.8% of lesions). In melanoma, linear-irregular, dotted, and polymorphous/atypical vessels were the most frequent vascular structures, whereas milky-red globules/areas were the most predictive ones (77.8%, $P=.003$). The presence of erythema was most predictive for Clark nevus, whereas comma, glomerular, crown, and hairpin vessels were significantly associated with dermal/congenital nevi, Bowen disease, sebaceous hyperplasia, and seborrheic keratosis, respectively ($P<.001$ for all).

Conclusions: Different morphologic types of vessels are associated with different melanocytic or nonmelanocytic skin tumors. Therefore, the recognition of distinctive vascular structures may be helpful for diagnostic purposes, especially when the classic pigmented dermoscopic structures are lacking.

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Dermoscopy is a noninvasive diagnostic technique allowing visualization of pigmented and vascular structures that are not visible to the naked eye. As previously demonstrated, clinicians using dermoscopy can improve their diagnostic performance by differentiating benign from malignant pigmented skin tumors. Although various pigmented dermoscopic structures have been described and assessed for their diagnostic validity, the value of the various morphologic types of vessels seen by dermoscopy has been previously demonstrated in only a few reports.

This study describes the different vascular structures seen by dermoscopy and evaluates their association with various melanocytic and nonmelanocytic skin tumors in a large series of cases.
Table 1. Definitions of the Different Morphologic Types of Vessels Seen by Dermoscopy

<table>
<thead>
<tr>
<th>Vascular Structure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arborizing vessels</td>
<td>Stem vessels with a large diameter, branching irregularly into the finest terminal capillaries. The vessel is bright red, which is perfectly in focus in the images because of their location on the surface of the tumor (just below the epidermis) (Figure 1A).5</td>
</tr>
<tr>
<td>Dotted vessels</td>
<td>Tiny red dots densely aligned next to each other in a regular fashion (Figure 1B).5,6</td>
</tr>
<tr>
<td>Erythema</td>
<td>Pinkish color usually seen within areas of regression or at the border of the lesion (Figure 2A).7</td>
</tr>
<tr>
<td>Linear-irregular vessels</td>
<td>Linear and irregularly shaped, sized, and distributed red structures (Figure 2B).6,5</td>
</tr>
<tr>
<td>Comma vessels</td>
<td>Coarse vessels that are slightly curved and barely branching (Figure 3A).5</td>
</tr>
<tr>
<td>Polymorphous/atypical vessels</td>
<td>Any combination of 2 or more different types of vascular structures. The most frequent is the one occurring between linear-irregular and dotted vessels (Figure 3B).6,11</td>
</tr>
<tr>
<td>Hairpin vessels</td>
<td>Vascular loops sometimes twisted and bending, usually surrounded by a whitish halo when seen in keratinizing tumors (Figure 4A).5,12</td>
</tr>
<tr>
<td>Glomerular vessels</td>
<td>Variation on the theme of dotted vessels. They are tortuous capillaries often distributed in clusters, mimicking the glomerular apparatus of the kidney (Figure 4B).13</td>
</tr>
<tr>
<td>Milky-red globules/areas</td>
<td>Globules and/or larger areas of fuzzy or unfocused milky-red color usually corresponding to an elevated part of the lesion (Figure 5A).10</td>
</tr>
<tr>
<td>Crown vessels</td>
<td>Groups of orderly, bending, scarcely branching vessels located along the border of the lesion (Figure 5B).5</td>
</tr>
</tbody>
</table>

Figure 1. Striking arborizing vessels in a basal cell carcinoma (A) and dotted vessels (enlarged from the inset) in a Spitz nevus (B) (original magnification ×10).

Figure 2. Erythema (asterisk) seen in a largely regressive melanoma in situ (A) and a nodular melanoma exhibiting linear-irregular vessels (square) (B) (original magnification ×10). In A, 1 of 4 pathologists diagnosed this case as a Clark nevus with regression.

carcinomas, 41 seborrheic keratoses, 30 in situ and invasive squamous cell carcinomas (including 7 keratoacanthomas), and 6 sebaceous hyperplasias. Absolute numbers and percentages (given as frequency and positive predictive value) of the various tumors showing the different morphologic types of vessels were calculated, and the differences between rates of various lesions showing a particular vascular pattern were evaluated by the χ² or Fisher exact test when appropriate.
RESULTS

Of the 531 lesions dermoscopically showing vascular structures, only 56 (including 4 melanomas) were considered amelanotic because of the complete absence of any pigmentation. The rest of the lesions were pigmented, at least partially. Vessels can usually be seen by dermoscopy in nonheavily pigmented tumors.

As shown in Table 2, the most common type of vascular structure seen in our series was the arborizing vessels that were found in 82.1% of basal cell carcinomas, with a positive predictive value of 94.1% (P<.001). This value reflects the probability of a lesion with arborizing vessels being a basal cell carcinoma.

Dotted vessels were the second most frequent type of vascular structure seen in our series. They were significantly associated with Spitz nevi (77.8% of lesions) when compared with Clark nevi and melanoma (P<.001), in which dotted vessels were also seen in 25.7% and 22.7% of cases, respectively. In contrast, the probability of a lesion with dotted vessels being a Spitz nevus was only 15.6%, increasing up to 37.8% for melanoma. This result might be explained by the lower prevalence of Spitz nevi (18 cases) in our series compared with the prevalence of melanoma (150 cases). Dotted vessels showed a positive predictive value for a melanocytic lesion of 90.0% (81 of 90 lesions showing dotted vessels were melanocytic, P<.001).

In melanoma, linear-irregular vessels were the most common vascular structures (33.3%), exhibiting a positive predictive value of 67.6% (P<.001), followed by dotted vessels and polymorphous/atypical vessels. Milky-red globules/areas were seen only in 7 melanomas, but their positive predictive value for melanoma was 77.8% (P=.003). Remarkably, when gathering the 3 malignant tumors (melanoma, basal cell carcinoma, and squamous cell carcinoma) together, linear-irregular vessels had 81.1% positive predictive value (P<.001), followed by polymorphous vessels, with 68.4% probability for malignancy (P=.01).

A erythema was seen, as a single vascular structure, in 75 (14.1%) of 531 lesions. It was most predictive for Clark nevus (42.7%), and the difference between the latter and melanoma was statistically significant (P<.001). Erythema was also found in combination with different types of vessels in an additional 159 lesions, including 43 melanomas, 43 Clark nevi, and 34 basal cell carcinomas. However, the latter combination was not considered in the group of polymorphous vessels (Table 1). Besides a slight prevalence of erythema in the cases of melanoma in situ, no particular differences were noticed comparing in situ with invasive melanoma.

Additional different morphologic types of vessels were significantly associated with different types of tumors, namely, comma vessels in dermal/congenital nevi, glo-
merular vessels in Bowen disease, crown vessels in sebaceous hyperplasia, and hairpin vessels in seborrheic keratosis ($P<.001$ for all). Although hairpin vessels were also seen in 28.6% of squamous cell carcinomas (including 7 cases of keratoacanthoma), the probability of a lesion with hairpin vessels being a seborrheic keratosis was much higher (70.0% for seborrheic keratosis vs 13.3% for squamous cell carcinoma).

Dermoscopy is becoming more and more popular among clinicians dealing with the diagnosis of skin tumors. This noninvasive diagnostic tool allows visualization of pigmented and vascular structures that are not visible to the naked eye. In the first consensus report on dermoscopy, besides the various pigmented structures seen in melanocytic and nonmelanocytic lesions, the arborizing vessels were first described as a useful dermoscopic feature for the diagnosis of basal cell carcinoma. Since then, several additional morphologic types of vessels were reported and recently refined in the last consensus article on dermoscopy, published in 2003. In this dermoscopic study based on 531 skin lesions with vascular structures, arborizing vessels have been confirmed to be the most common type of vascular pattern (seen in 19.2% of all cases); in particular, they were seen in basal cell carcinoma (82.1% of cases). Menzies et al reported the presence of arborizing vessels in a lower percentage of basal cell carcinomas (52%), but this difference may be explained by the fact that in their study pigmented basal cell carcinomas showing no vascular structures were also included. In general, it has to be emphasized that, from a collection of 2621 excised melanocytic and nonmelanocytic skin tumors, only those lesions dermoscopically showing any type of vessels have been included in this study. Therefore, the vascular structures are supposed to be less frequent when considering the overall number of tumors with and without vessels. In contrast, the positive predictive values of vascular structures are not influenced by the inclusion criteria used in this study.

Previously, the most extensive description of vascular patterns seen by dermoscopy, to our knowledge, was provided by Kreusch and Koch, who performed a detailed morphologic characterization of the vessels that can be seen in different pigmented and nonpigmented skin tumors. In the experience of Kreusch and Koch, dotted vessels can be present in melanocytic and nonmelanocytic lesions, only those lesions dermoscopically showing any type of vessels have been included in this study. Therefore, the vascular structures are supposed to be less frequent when considering the overall number of tumors with and without vessels. In contrast, the positive predictive values of vascular structures are not influenced by the inclusion criteria used in this study.

In our study, dotted vessels were highly predictive for a melanocytic lesion (90.0% of lesions with dotted vessels were melanocytic). In this context, dotted ves-

![Figure 5. Milky-red globules/areas (circle) in an invasive melanoma (A) and crown vessels (asterisks) in a sebaceous hyperplasia (B) (original magnification x10).](image)

**Table 2. Various Melanocytic and Nonmelanocytic Skin Tumors Showing Different Vascular Structures by Dermoscopy**

<table>
<thead>
<tr>
<th>Vascular Structure</th>
<th>Melanoma</th>
<th>Basal Cell Carcinoma</th>
<th>Dermal/ Congenital Nevus</th>
<th>Clark Nevus</th>
<th>Seborrheic Keratosis</th>
<th>Spitz Nevus</th>
<th>Bowen Disease</th>
<th>Squamous Cell Carcinoma†</th>
<th>Sebaceous Hyperplasia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arborizing vessels</td>
<td>1 (1.0)</td>
<td>96 (94.1) [82.1]</td>
<td>3 (2.9) [3.2]</td>
<td>0</td>
<td>1 (1.0) [2.4]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1 (1.0) [16.7]</td>
<td>102 (19.2)</td>
</tr>
<tr>
<td>Dotted vessels</td>
<td>34 (37.8)</td>
<td>25 (26.7) [19.1]</td>
<td>1 (1.1) [0.9]</td>
<td>14 (15.6)</td>
<td>17 (19.1) [17.5]</td>
<td>21 (22.1)</td>
<td>25 (25.7)</td>
<td>5 (5.6) [12.2]</td>
<td>14 (15.6) [77.8]</td>
<td>90 (16.9)</td>
</tr>
<tr>
<td>Erythema</td>
<td>26 (34.7)</td>
<td>67 (67)            [94.0]</td>
<td>8 (12.0) [8.5]</td>
<td>32 (42.7)</td>
<td>4 (4.9) [18.6]</td>
<td>2 (2.7) [12.5]</td>
<td>0</td>
<td>0</td>
<td>5 (5.6) [9.5]</td>
<td>76 (14.1)</td>
</tr>
<tr>
<td>Linear-irregular</td>
<td>50 (67.6)</td>
<td>33 (33)            [33.3]</td>
<td>6 (8.1) [5.1]</td>
<td>11 (14.9)</td>
<td>14 (18.4) [14.8]</td>
<td>2 (2.7) [4.9]</td>
<td>0</td>
<td>0</td>
<td>4 (5.4) [28.6]</td>
<td>74 (13.9)</td>
</tr>
<tr>
<td>Comma vessels</td>
<td>30 (52.6)</td>
<td>60 (60)            [20.0]</td>
<td>6 (10.5) [5.1]</td>
<td>63 (84.0)</td>
<td>6 (6.0) [5.4]</td>
<td>5 (8.0) [12.2]</td>
<td>2 (3.5) [11.1]</td>
<td>0</td>
<td>3 (5.3) [21.4]</td>
<td>67 (12.6)</td>
</tr>
<tr>
<td>Polymorphous/typical vessels</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hairpin vessels</td>
<td>2 (9.5)</td>
<td>13 (13)            [13]</td>
<td>0</td>
<td>21 (70.0)</td>
<td>1 (3.3) [9.6]</td>
<td>0</td>
<td>4 (13.3) [28.6]</td>
<td>0</td>
<td>30 (5.6)</td>
<td>0</td>
</tr>
<tr>
<td>Glomerular vessels</td>
<td>5 (22.8)</td>
<td>57 (57)            [12.2]</td>
<td>0</td>
<td>13 (61.9)</td>
<td>1 (4.8) [7.1]</td>
<td>0</td>
<td>1 (2.7) [4.9]</td>
<td>0</td>
<td>21 (4.9)</td>
<td>0</td>
</tr>
<tr>
<td>Milky-red globules/areas</td>
<td>7 (77.8)</td>
<td>4.7 [4.7]</td>
<td>1 (11.1) [0.9]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5 (83.3)</td>
<td>83.3</td>
</tr>
<tr>
<td>Crown vessels</td>
<td>0</td>
<td>0</td>
<td>1 (16.7) [1.1]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5 (83.3)</td>
</tr>
<tr>
<td>Total</td>
<td>150 (28.2)</td>
<td>117 (22.0)</td>
<td>95 (17.9)</td>
<td>74 (13.9)</td>
<td>41 (7.7)</td>
<td>18 (3.4)</td>
<td>16 (3.0)</td>
<td>14 (2.6)</td>
<td>6 (1.1)</td>
<td>531</td>
</tr>
</tbody>
</table>

*Data are given as number (positive predictive value) [frequency]. The positive predictive value is the number in each group/row total. The frequency is the number in each group/column total. Some percentages may not total 100 because of rounding.
†Seven keratoacanthomas are included in this group.
sels were the most common vascular pattern in Spitz nevi, although more than one third of lesions exhibiting dotted vessels were melanomas. Therefore, based on our results, lesions with dotted vessels should be considered suspicious and should be excised for histopathologic evaluation. Dotted vessels may be even more important when seen in amelanotic and hypopigmented melanomas, in which the diagnosis could be difficult because of the lack of pigmented structures. In these cases, dotted vessels can often be the only clue raising the suspicion for melanoma, as reported previously by Bono et al.\textsuperscript{17}

In our study, the most common vascular pattern seen in melanoma was the linear-irregular typology (67.6% positive predictive value for melanoma), followed by dotted vessels and polymorphous/atypical vessels (Table 1 provides specific definitions of the 3 most frequent vascular patterns in melanoma). Although rarely seen, milky-red globules/areas showed the highest predictive value for melanoma (77.8%). Zalaudek et al.,\textsuperscript{9} also performing a study on amelanotic and hypopigmented melanomas, reported that combined linear-irregular and dotted vessels were the most frequent dermoscopic findings in this particular group of melanomas, especially when associated with a white to red veil that can be assimilated to the milky-red globules/areas as defined by us (Table 1). Similar to the observation of Zalaudek et al, in our study, the most common combination of vessels (called the polymorphous/atypical pattern) was the one occurring between linear-irregular and dotted vessels (data not shown). When gathering the 3 malignant tumors (melanoma, basal cell carcinoma, and squamous cell carcinoma) together, linear-irregular vessels had 81.1% positive predictive value for malignancy, followed by polymorphous vessels (68.4%).

In a recent article dealing with a patient population from Miami, Fl (thus, presumably characterized by a light skin phototype), it was reported that melanocytic lesions clinically typified by a pink color might represent a major diagnostic problem, especially in the differentiation between Clark nevi and melanoma.\textsuperscript{18} In our series from southern Italy, we noticed that melanocytic nevi are usually heavily pigmented, perhaps because of the dark skin phototype of the stereotypical southern Italian population. Only a few Clark nevi were sufficiently hypopigmented to show vascular structures in our series (data not shown). In this type of nevi, a erythema was the most frequent vascular pattern, which was defined as a pinkish color usually seen within regressive areas. Therefore, the clinical relevance of the differential diagnosis between Clark nevi and melanoma dermoscopically showing vascular structures was, in our cases, only restricted to a small group of lesions dermoscopically exhibiting regression structures. In a recent article by Zalaudek et al, melanocytic lesions with regression were studied and an algorithm, based on the type and degree of regression seen by dermoscopy, was suggested for the clinical management of this subset of lesions.\textsuperscript{19}

Besides the vascular structures that can be seen in the most common pigmented malignant tumors (basal cell carcinoma and melanoma) and in the most frequent melanoma simulators (Spitz nevi and Clark nevi), additional morphologic types of vessels were closely associated with various neoplasms. As mentioned in previous observations in the literature, a\textsuperscript{4,5,8,13} comma vessels were strongly associated with dermal/congenital nevi, glomerular vessels with Bowen disease, crown vessels with sebaceous hyperplasia, and hairpin vessels with seborrheic keratosis. For example, Braun et al.,\textsuperscript{20} reported a comparable number of seborrheic keratoses exhibiting hairpin vessels. When hairpin vessels are surrounded by a whitish halo, they are strong indicators for the epithelial differentiation of the neoplasm. Hairpin vessels were also seen in 28.6% of our squamous cell carcinomas, but the probability of a lesion with hairpin vessels being a seborrheic keratosis was much higher (Table 2).

In conclusion, various vascular structures can be seen in pigmented and nonpigmented skin tumors when using dermoscopy. Special morphologic types of vessels are associated with different melanocytic or nonmelanocytic skin tumors. Therefore, the recognition of distinctive vascular structures may be helpful for the correct diagnosis, especially when the classic pigmented dermoscopic structures are lacking.

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