INVESTIGATIVE REPORT

Shiny White Streaks: A Sign of Malignancy at Dermoscopy of Pigmented Skin Lesions

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The aim of this study was to evaluate the practical importance of the presence of shiny white streaks (SWS) (chrysalis or crystalline structures in polarized dermoscopy) for suspicion of malignancy, diagnosis of melanoma, and pre-operative estimation of Breslow thickness and its correlation with total dermoscopy score (TDS). SWS were present in 13.6% of 800 consecutive excised lesions. The presence of SWS was associated with malignancy (odds ratio (OR) 10.534, 95% confidence interval (95% CI) 6.357–17.455, $p < 0.0005$), in the context of melanocytic lesions with invasive melanoma (OR 10.333, 95% CI 3.812–28.014) and melanomas with high TDS (OR 6.286, 95% CI 1.673–23.619), but was also a factor in the diagnosis of featureless and some thin melanomas. These results corroborate the clinical applicability of SWS in aiding the diagnosis of malignancy and helping to raise the general dermatologist's awareness in cases of doubt and featureless lesions. *Key words: dermoscopy; shiny white streaks; polarized light; chrysalis; melanoma; basal cell carcinoma.*

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Dermoscopy has proven valuable in aiding the diagnosis of melanoma compared with naked-eye examination (1–3). In fact, not only can dermoscopy yield a 10–27% higher sensitivity than clinical diagnosis of melanoma, the use of the dermatoscope also improves recognition of its simulators, such as benign tumours (e.g. seborrhoeic keratosis (4)) or malignant tumours (e.g. pigmented basal cell carcinomas (BCC)) (4).

Previous studies have shown a good correlation between selected dermoscopy criteria and the histopathology of melanoma for the pre-operative evaluation of tumour depth (5, 6). In these studies, the presence of some dermoscopic features such as pigment network and radial streaming were associated with radial growth, whereas grey-blue areas and dotted vessels were related to the vertical growth phase. Furthermore, the dermoscopy ABCD rule was tested as a predictor of melanoma thickness, with increasing total dermoscopy score (TDS) values being related to increasing thickness of the lesions (7).

Among the dermoscopic algorithms described in the literature (8–14), the ABCD rule is a simple, easily learned, simplified semi-quantitative approach that calculates the TDS for the diagnosis of melanoma, with reported sensitivity varying from 84.4% to 97.9% and specificity from 74.5% to 90.3% (10, 13). It is of note that, in spite of the increment in sensitivity in melanoma diagnosis, there is still a chance of misdiagnosing melanoma (false-negative cases (15)), depending on dermoscopic expertise (3, 16, 17). Even so, despite the experience of the dermoscopists, melanomas diagnosed in follow-up programmes of high-risk patients were misclassified by TDS (50% of cases) and the majority did not present a multi-component or unspecific pattern, as observed in a recent study (18). The authors suggested that early-diagnosed melanomas might not yet present characteristic features of melanoma, thus imposing difficulties in their early recognition.

With the recent use of polarized dermatoscopes (PD), some differences compared with contact non-polarized dermoscopy (NPD) in the dermoscopy image have been pointed out regarding: colour (melanin appears darker), visualization of structures (improvement in visualization of vessels, but not of peppering or regression, nor of superficial structures such as milia-like cysts and comedo like openings), as well as recognition of structures not seen under NPD. PD appears to block the superficially reflected light more efficiently than non-polarized dermatoscopes, accounting for these differences in image and depth of structure visualization: NPD allows better visualization of superficial structures, whilst PD allows better appreciation of deeper structures, such as collagen and vessels (19, 20).

Shiny white streaks (SWS) (also named chrysalis or, as recently proposed, crystalline structures) were described as shiny, bright, often orthogonal, linear streaks, seen only under PD, in dermatofibromas, scars, melanomas, BCCs (21–24) and, more recently,

melanocytic naevi, mainly Spitz naevi (25). Recently, a classification of SWS types has been proposed according to different diagnoses (26). Differing from negative pigment network, which was described by Menzies and revised recently by Bassoli et al. (27) as relatively light areas making up the "cords" of the network, and darker areas filling the holes; SWS are often linear unconnected white lines that do not make up a network pattern (28). SWS were related to angular dependence of polarized light and collagen orientation in the underlying stroma of tumours with an increased amount of dermal collagen, but its definite histopathological counterpart is unknown (21, 25, 26, 29).

It has been suggested that SWS may be of importance in the diagnosis of melanoma, as a clue to their differentiation from naevi, and in the identification of more advanced lesions (26).

In a recent study SWS were observed more commonly in invasive melanomas compared with *in situ* melanomas, and melanomas with SWS were thicker than those without SWS, suggesting that the presence of this dermoscopic parameter may be related to a higher chance of dermal invasion and thicker tumours (26).

The aim of this study was to evaluate the importance of the presence of SWS in the suspicion of malignancy, in the diagnosis of melanoma and in the prognostic evaluation regarding depth of invasion (Breslow) in melanoma.

MATERIALS AND METHODS

All lesions excised from January 2010 to August 2011 in the Melanoma Unit of Hospital Clinic, Barcelona, with dermoscopy images were included in this retrospective study.

Dermoscopy images were retrospectively evaluated using images obtained with a Dermlite Foto (3GEN, LLC, Dana Point, CA), and a Canon PowerShot G7 (Canon Inc, Japan).

Only lesions with a histopathological diagnosis were included in the study. Lesions were primarily analysed for the presence or absence of SWS. In the case of surgical scarring due to a previous partial biopsy (e.g. lentigo maligna melanoma (LMM) on the face) the evaluation of the SWS did not include this part of the tumour. The lesions were then matched to the histopathological diagnosis. In cases of melanoma, the following clinical and histopathological parameters were also obtained: lesion site, Breslow thickness and melanoma histopathological subtype (LMM, superficial spreading melanoma (SSM), nodular melanoma (NM), Spitzoid melanomas (SM), melanoma metastasis, or recurrent melanoma (RM)). Dermoscopy of melanoma cases was analysed according to the ABCD dermoscopy rule, leading to a TDS based on the following parameters: asymmetry –2 (axis ×1.3), borders (×0.1), colour (white, red, brown, blue-grey and black) (×0.5) and different structures (network, dots, globules, streaks and structureless areas ×0.5). The melanomas were also evaluated for the presence or absence of scar, global pattern (reticular, globular, cobblestone, starburst, homogeneous, multi-component, unspecific), dermoscopy local features (atypical network, dots and globules, streaks, blue white veil, regression (e.g. scar-like depigmentation and/or peppering), hypopigmentation, blotch), vascular structures (milky-red globules, comma vessels, dotted vessels, polymorphic vessels). Lesions on the face and acral sites were excluded from the evaluation of TDS score due to peculiarities in the dermoscopic diagnosis of melanomas at these sites. However, melanomas on the face were evaluated according to previously described dermoscopic criteria for facial areas: presence or absence of asymmetrically pigmented follicular openings, rhomboidal structures, annular-granular pattern, homogeneous areas, fingerprint-like areas, pseudo-cysts, moth-eaten border.

Basal cell carcinomas (BCCs) were analysed according to the following dermoscopy parameters: colours (brown, black, white, pink, blue), presence or absence of scars, ulceration, maple-leaf-like structures, spoke-wheel areas, ovoid blue-grey areas, blue-grey globules, arborizing vessels, short fine telangiectasia, micro-ulcerations, concentric structures, multiple in-focus blue-grey dots. The clinical site of the tumour and histopathological subtypes of BCC (nodular BCC (nBCC), superficial BCC (sBCC), trichilemmal BCC (tBCC), infiltrative BCC (iBCC)) were recorded.

Statistical analysis

Pearson's χ^2 test was used to evaluate the association between categorical variables. If the expected frequency was < 5, Fisher's exact test was used (Table I). The 95% CIs were obtained by the exact binomial method, and the overall risk (OR) calculated. Means and median were calculated. Student's *t*-test was used to compare the mean of quantitative variables.

RESULTS

A total of 800 dermoscopic images were analysed for the presence or absence of SWS. The data-set is shown in Table I, including benign and malignant, melanocytic and non-melanocytic tumours (Figs 1–6).

Of the melanoma set (n = 125), 56 were *in situ* (44.8%), 69 invasive (55.2%; mean Breslow thickness 1.7 mm), 27 were thin melanomas (48.2%; < 1 mm;) and 29 were thick (51.8%; ≥ 1 mm). There were 13 melanomas with no Breslow thickness noted in the histopathological record (4 recurrent melanomas, 5 metastasis, 4 not evaluable). As regards histopathological subtype, 69 were SSM (55.2%), 46 LMM (36.8%), 5 melanoma metastasis (4%), 3 NM (2.4%) and 2 SM (1.6%). Regarding the lesion site, 47 melanomas were located on the head, 38 on the trunk, and 40 on the limbs. Scarring from a previous biopsy was observed in 18 melanomas (5 SSM and 13 LMM). The majority of melanomas had a TDS score higher than or equal to the threshold for malignancy (5.45; 67.6%), with mean TDS: 5.97. Nevertheless, 25 melanomas scored less than 5.44 (32.4%), including 17 that scored in the benignancy range (< 4.75; 22.7%) (Table I).

SWS was present in 41 melanomas (6/56 *in situ*, 31/56 with measurable Breslow thickness and 4/13 other lesions, i.e. metastasis, recurrent melanoma, melanomas without measurable Breslow thickness) (Figs 1, 3 and 4), these being 24 SSM (58.5%), 11 (26.8%) LMM, 3 NM (7.4%), 2 SM (4.9%) and 1 metastasis (2.4%); while only 1.6% of all excised melanocytic naevi presented SWS (Table I).

The presence of SWS was associated with a 10-fold increased risk of malignancy (melanomas, BCCs, SCCs, neuroendocrine carcinoma) (see Table I).

Table I. *Presence of shiny white streaks (SWS) according to diagnosis, total dermoscopy score (TDS) in melanomas and Breslow thickness in invasive melanomas*

Diagnosis	Cases	SWS Yes	SWS No	*p*-value	Odds ratio	95% confidence interval
Melanoma *in situ*	56	6	50			
Invasive melanoma[a]	56	31	25	<0.0005	10.333	3.812–28.014
Breslow thickness <1 mm[a]	27	10	17			
Breslow thickness ≥1 mm[a]	29	21	8	0.009[d]	4.463	1.444–13.792
Others[b]	13	4	9			
TDS <5.45[c]	25	3	22			
TDS ≥5.45[c]	52	24	28	0.006	6.286	1.673–23.619
Total melanoma	125	41	84			
Other malignant tumours						
Basal cell carcinoma (BCC)	3	1	2			
Infiltrative BCC	20	6	14	Not significant	Not significant	
Nodular BCC	35	12	23	Not significant	Not significant	
piBCC	1	1	0			
Superficial BCC	65	19	46	Not significant	Not significant	
Trichilemmal BCC	9	2	7	Not significant	Not significant	
Total BCC	133	41	92			
Squamous cell carcinoma	21	3	18			
Merkel	1	1	0			
Total malignant	280	86	194			
Naevus	305	5	300	<0.0005[e]	10.534	6.357–17.455
Seborrhoeic keratosis	49	2	47			
Dermatofibroma	11	6	5			
Other benign lesions	91	0	91			
Actinic keratosis	36	4	32			
Lichen planus like keratosis	9	2	7			
Solar lentigos	19	2	17			
Total benign	520	21	499			

[a]Only invasive melanomas with measurable Breslow were included.

[b]Includes lesions without measured Breslow thickness (i.e. metastasis, relapses). These lesions were not included in the *in situ*/invasive evaluation.

[c]Only melanomas not located in face or acral sites were included.

[d]Lesions described in [b] were also not included in the evaluation of thin/thick melanomas.

[e]comparing total malignant with total benign

Only 6 out of 56 (10.7%) *in situ* melanomas presented SWS, while 35 of 69 of the invasive melanomas (50.7%) had SWS (*p* < 0.005). The presence of SWS correlated with a 10.33-fold increased risk of a diagnosis of invasive melanomas compared with *in situ* melanomas (OR 10.33, 95% CI 3.812–28.014, *p* < 0.005). In invasive melanoma, the mean Breslow value for melanomas with SWS was 2.28 mm, significantly higher than in mela-
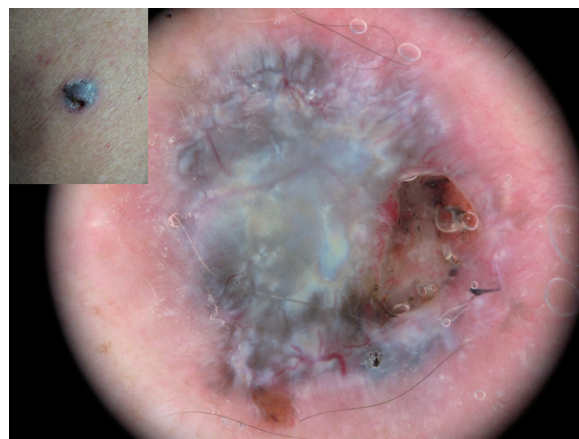

Fig. 1. Clinical image (*upper left*) of a symmetrical, keratotic pigmented lesion on the leg of a 35-year-old woman. Dermoscopy (*main image*) shows a black and bluish, symmetrical lesion, with a total dermoscopy score (TDS) of 3.3 within benignity level (3 colours; black, blue-grey, white = 1.5 + all abrupt borders = 0.8 + 2 dermoscopic features; homogeneous areas and globules = 1). Presence of shiny white streaks aided the suspicion of melanoma. Histopathological diagnosis was a Spitzoid melanoma, Breslow 1.5 mm, Clark IV.

Fig. 2. Clinical image (*upper left*) and dermoscopy (*main image*) with polarized light of a basal cell carcinoma showing multiple shiny white streaks associated with the presence of prominent, perfectly focused, arborizing vessels, ulcerations and blue ovoid nests.
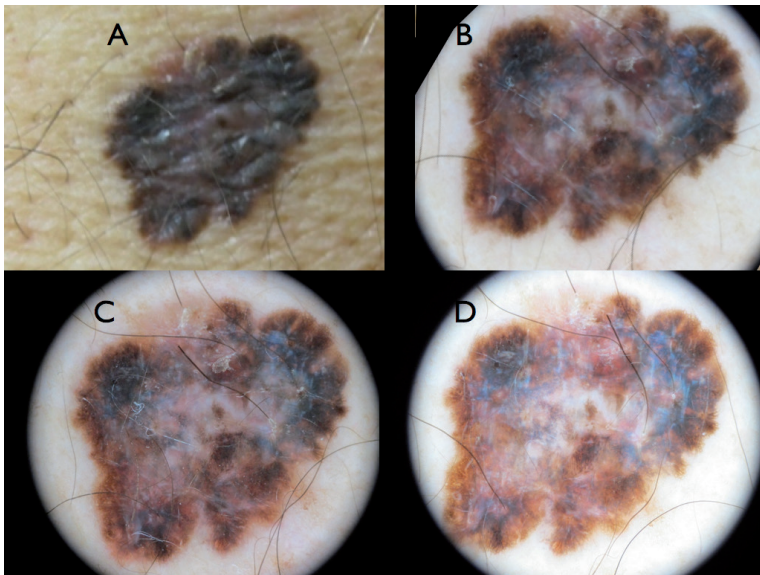
Fig. 3. (A) Clinical picture, and (B–D) dermoscopy images with polarized light at different angles (B 0º, C 45º and D 90º). Change in the polarization angle changes the number, location and morphology of shiny white streaks (SWS). Dermoscopy total dermoscopy score (TDS) of 7.9 (asymmetry in 2 axes: 2.6; all abrupt borders=0.8; 5 colours: brown, black, blue-grey, white and red=2.5; 4 dermoscopic features; homogeneous areas, pigment network, dots and globules=2).

nomas without SWS (0.9 mm) ($p < 0.005$). Melanomas with SWS had a 4.46-fold increased risk of being thick melanomas (see Table I).

Of all LMM with SWS, 4 were *in situ*, 5 invasive and 2 had no Breslow value available. Interestingly, invasive LMM with SWS were thicker than SSM with SWS, the mean and median Breslow values for LMM with SWS were 4.62 mm and 3.6 mm, respectively, and for SSM with SWS 1.43 mm and 1.03 mm.

SWS statistical findings regarding the dermoscopic parameters evaluated for melanoma are summarized in Table SI[1].

The mean TDS score for melanomas with SWS was 6.61 and without SWS 5.62 ($p < 0.05$). When controlled for TDS, SWS were more frequent in TDS scores higher than 5.45 ($p < 0.05$) (Fig. 3). Notwithstanding the small number of cases, SWS were also observed in 3 cases with TDS < 4.75 (3.8%), 1 of which was a Spitzoid melanoma (Fig. 1).

The BCC data-set is detailed in Table SI[1]. Of all the BCCs, 30.8% presented SWS (Fig. 2) and there was no statistically significant difference regarding histopathological subtype.

Interestingly, SWS were also observed more frequently in BCCs with ulceration ($p < 0.005$) (Fig. 2). None of the other criteria evaluated presented a statistically significant difference.

As previously described, SWS were only visible when polarized light was used and

Fig. 5. Clinical picture (*upper right*) and dermoscopy (*main image*) with polarized light of a Merkel carcinoma (neuroendocrine tumour) showing shiny white streaks (SWS). SWS (some of them indicated with an arrow) were associated with the presence of ulceration and thick arborizing vessels.
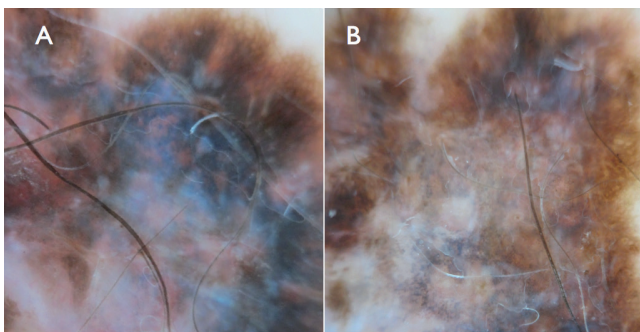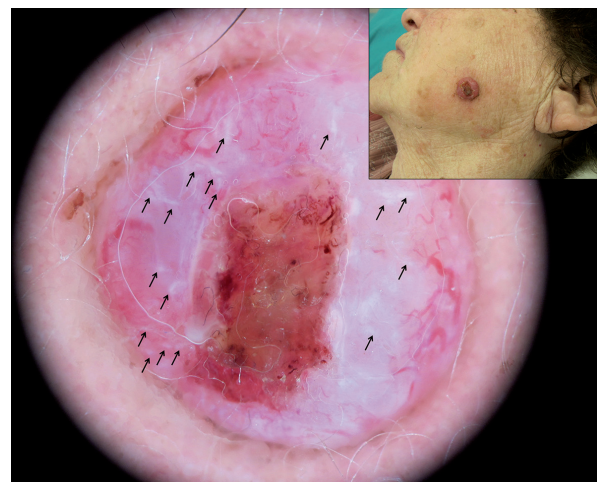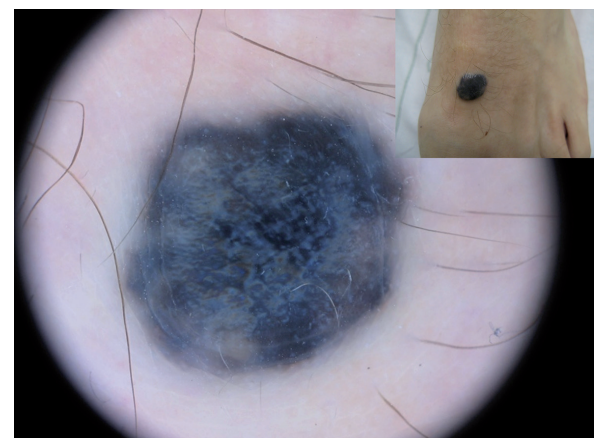

Fig. 4. Change in polarization angle influences the observation of shiny white streaks (SWS). (A) Dermoscopy with polarized light of a melanoma at a polarization angle that enhances the presence of SWS. (B) Dermoscopy with polarized light of the same melanoma at a 90º polarization angle as (A). SWS are less evident, while regression (peppering) is more visible.

Fig. 6. Clinical picture (*upper right*) and dermoscopy (*main image*) with polarized light of a blue naevus showing shiny white streaks (SWS). The deep stromal component of this blue naevus may be the cause of the presence of SWS.

SWS change according to the angle of polarization (Fig. 3). The angle that enhances SWS is 90º contrary to the angle that enhances regression structures (Fig. 4).

DISCUSSION

As an example of structures seen only under PD, SWS were described in a variety of lesions including melanomas, BCCs, dermatofibromas, biopsy scars and melanocytic naevi (22–25). SWS has been suggested to represent dermal fibroplasia seen in benign lesions such as dermatofibromas and scars, and in malignant lesions, due to tumour-induced stromal reaction and extracellular matrix changes (21).

It has been suggested in previous studies (Table SII[1]) (22, 25, 26) that SWS may be of importance in the diagnosis of melanoma, as a clue to their differentiation from naevi. In fact, we observed SWS in 32.8% of melanomas, while only 1.6% of all excised melanocytic naevi presented SWS, thus corroborating the results from previous studies. Table SII[1] compares the results of 4 different studies.

Apart from its usefulness in melanoma diagnosis, the presence of SWS implied a 10-fold increased risk of malignancy (melanomas, BCC, SCC, neuroendocrine carcinoma) (OR: 10.534, 95% CI 6.357–17.455, $p < 0.0005$) (Fig. 5). Thus, with the exception of dermatofibromas in which SWS were frequently observed, the presence of this dermoscopic parameter is a strong clue to malignancy.

Recently, Balagula et al. (25) described the presence of SWS in 1.8% of lesions, melanocytic as well as non-melanocytic, in contrast with the 13.4% in our study. This difference is probably due to differences in the data-set of each study: only 264 lesions in the former study were suspicious of malignancy and were biopsied, whilst only lesions with histopathological diagnosis were included in our study (800 lesions) (Table SII[1]). We observed SWS in 32.8% of melanoma, similar to the 31% observed by Di Stefani et al. (22) (Table SII[1]). The percentage of BCCs with SWS in our sample (30.8%) was smaller than in previous reports (47.6% and 42.4%) (25, 26). It is notable that SWS did not correlate with any histopathological subtype of BCC. In a recent study by Liebman et al. (26) the presence of SWS of any length accompanied by white shiny areas was most suggestive of BCC. In the present study, SWS were evaluated overall and the length of the streaks was not evaluated, but this criterion was present in some cases (Fig. 2).

In 2 recent studies (22, 25), SWS were more frequent in invasive melanomas compared with *in situ* melanomas, and those with SWS were also thicker than those without. In our study, the presence of SWS correlated with a 10.33-fold increased risk of a diagnosis of invasive melanoma compared with *in situ* melanomas (OR 10.33, 95% CI 3.812–28.014, $p < 0.005$), greater than the value obtained by Balagula et al. (25) (OR 3.4, 95%

CI 1.9–6.3). Also, the presence of SWS gave a 4.46-fold increased risk of thick melanomas compared with thin (OR=4.46, 95% CI 1.444–13.792, $p = 0.009$). This data suggests that SWS may be related to an increased probability of invasive melanoma and thicker tumours. Nevertheless, the presence of SWS could also be helpful in the diagnosis of thin melanomas, especially those with few diagnostic criteria. In our study melanoma set, 10 out of 27 thin melanomas and 6 out of 56 *in situ* melanoma presented SWS.

As regards the clinical evaluation of melanoma thickness pre-operatively, the presence of SWS resulted in a sensitivity of 67.7% and specificity of 68% for thick melanoma (>1 mm thickness), which is in agreement with previous studies (6, 30).

Nachbar et al. (8) described a simplified semi-quantitative approach to the diagnosis of melanoma, the ABCD rule (TDS score), The threshold for malignancy was stipulated as 5.45, with values between 5.44 and 4.75 being suspicious lesions and those below 4.75 being benign. This yields a sensitivity of 84.4–97.9% and a specificity of 74.5–90.3% in the literature. The present study was the first, to our knowledge, to correlate the TDS score with the presence of SWS. SWS were more frequent in melanomas with a TDS score suggestive of malignancy (>5.45). Nonetheless, SWS were also observed in 3 cases with TDS in the benignancy range (<4.75; 3.8%), highlighting the possible importance of SWS in the diagnostic aid of featureless melanomas, such as the case of Spitzoid melanoma (Fig. 1).

Melanomas with the following dermoscopic diagnostic criteria had a greater possibility of displaying SWS: presence of structureless areas, irregular blotch; also multi-component or unspecific pattern (Table SI[1]).

In contrast to previous data in the literature, our study obtained a significant association between SWS and regression, such that melanomas with regression were 3.2 times more likely to display SWS than those without (Table SII[1]). This fact could be related to the previously suggested histopathological correlation to SWS, dermal fibroplasia, since regression may be related to further stromal reaction and thus justify the increased detection of SWS in melanomas with regression. Also, the presence of SWS in our study was associated with other dermoscopy criteria that are associated with dermal invasion, such as blue-white veil, milky-red globules or polymorphous vessels in melanoma, or white patch in dermatofibromas, or deep blue colour in blue naevus (Fig. 6), reinforcing the hypothesis that the optical artefact responsible for to SWS is located in the dermis (Fig. 5). We have observed that the change in the angle of polarization may enhance observation of either SWS or regression structures such as peppering. We speculate that the reflection of light related to dermal fibroplasia, which on the one hand favours SWS observation, may on the other hand interfere with the visualization of other structures such as peppering (Fig. 4).

ACKNOWLEDGEMENTS

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