DOI: 10.1111/jdv.17313 JEADV

ORIGINAL ARTICLE

Flat scalp melanoma dermoscopic and reflectance confocal microscopy features correspond to histopathologic type and lesion location

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Abstract

Background Dermoscopy and Reflectance Confocal Microscopy (RCM) features of scalp melanoma according to lesion location and histopathology have not been fully investigated.

Objectives To reveal dermoscopic and RCM features of scalp melanoma according to lesion location and histopathology.

Methods We retrospectively retrieved images of suspicious, atypical excised, flat melanocytic lesions of the scalp, assessed on dermoscopy and RCM at five centres, from June 2007 to April 2020. Lesions were classified according to histopathological diagnoses of nevi, lentigo maligna melanoma (LM/LMM) or superficial spreading melanoma (SSM). Clinical, dermoscopic and RCM images were evaluated; LM/LMM and SSM subtypes were compared through multivariate analysis.

Results Two hundred forty-seven lesions were included. *In situ* melanomas were mostly LM (81.3%), while invasive melanomas were mostly SSM (75.8%). Male sex, baldness and chronic sun-damaged skin were associated with all types of melanomas and in particular with LM/LMM. LMs were mostly located in the vertex area and SSM in the frontal (OR: 8.8; $P < 0.05$, CI 95%) and temporal (OR: 16.7; $P < 0.005$, CI 95%) areas. The dermoscopy presence of pseudo-network, pigmented rhomboidal structures, obliterated hair follicles and annular–granular pattern were associated with LM diagnoses, whereas bluish-white veil was more typical of SSM. Observations on RCM of atypical roundish and dendritic cells in the epidermis were associated with SSM (42.4%) and dendritic cells with LM (62.5%) diagnoses. Follicular tropism on RCM was confirmed as a typical sign of LM.

Conclusions Flat scalp melanomas reveal specific dermoscopic and RCM features according to histopathologic type and scalp location.

Received: 4 February 2021; Accepted: 13 April 2021

Conflict of interest

None declare.

Funding sources

None.

[†]These Authors share the first authorship.

Introduction

Melanoma of the scalp is an uncommon condition, accounting for nearly 3–5% of all cutaneous melanomas,[1,2] falling under the umbrella of melanoma located on special sites.[3,4] Previous studies report poor associated prognosis,[5–11] which may be due to the abundance of vessels and lymphatics in this anatomical location.[12–16] However, delayed diagnosis may also play a role, as detailed clinical and dermoscopic examination is often hindered by the presence of hair.

Sun damage, male sex and baldness are clinical factors reported to increase melanoma risk and they may also be determinant in melanoma subtype.[17,18] In particular, lentigo maligna melanoma (LMM) is more often associated with chronic sun exposure and sun damage, while superficial spreading melanoma (SSM) mostly depends on intermittent sun exposure and history of sunburns.[19–22]Dermoscopy has already been confirmed as a useful tool for early diagnosis of melanoma of the scalp.[23–28] Interestingly, previous studies have described the scalp as a transition area, because specific dermoscopic criteria of both facial and body (trunk and limbs) melanocytic lesions frequently coexist in this body site.[1,29–31]

Reflectance confocal microscopy (RCM) is a non-invasive imaging technique[32] that enables *in vivo* horizontal scanning of skin lesions at nearly histological resolution and has been proven to assist in routine evaluation of melanocytic lesions.[33–39] To date, RCM features of scalp melanocytic lesions have only been reported for a small number of cases.[4]

The current study aims to reveal dermoscopic and RCM features of atypical melanocytic lesions of the scalp, according to distinct topographic areas and histopathology melanoma classification as LMM or SSM.

Materials and methods

Study population

This multicentric study retrospectively collected atypical, suspicious melanocytic lesions of the scalp, excised between June 2007 and April 2020, from five tertiary, referral centres (Division of Dermatology, University of Modena and Reggio Emilia, Italy; Centro Oncologico ad Alta Tecnologia Diagnostica, Arcispedale S. Maria Nuova, Reggio Emilia, Italy; Dermatology Section, S. Maria alle Scotte Hospital, University of Siena, Italy; Melanoma Institute Australia and Sydney Melanoma Diagnostic Centre, University of Sydney, Australia). Only melanoma or highly suspicious nevi with high quality clinical, dermoscopy and RCM images (VivaScope 1500 or VivaScope 3000, Mavig, Munich, Germany) and histological diagnoses or >12 months follow-up were included. Nodular lesions were excluded.[40]

Histology assessment

In cases where a generic melanoma diagnosis was available, LMM or SSM type was retrospectively classified in accordance with two Pathologists (AMC and SP), according to WHO classification of skin tumours.[41]

In detail, LMM diagnoses characterized lesions of invasive melanoma, associated with a prevalent lentiginous, *in situ* component (LM); the latter, LM, although widespread, tends to be cytologically inconspicuous and mostly located in the basal epidermis. Pagetoid spread is usually absent. SSM is associated with a prevalent invasive melanoma made up by large cells with an evident pagetoid spread. Nevi were lesions with either confirmed histopathological diagnosis or referred to clinical and instrumental follow-up (12 months minimum follow-up) without excision.

Clinical, dermoscopic and RCM assessment

All clinical, dermoscopic and RCM images were retrospectively evaluated by a single author (FG) with the supervision of a dermoscopy and confocal microscopy expert dermatologist (RP), for the presence of a predefined set of criteria:

- Clinical criteria: sun damage of the scalp, presence of baldness and subsite scalp location according to Stanganelli *et al.*[29]
- Dermoscopic and RCM criteria: a list of criteria published in literature and associated with LM/LMM and SSM in other body areas was created by two expert dermatologists (CL, GP).[20,23,24,28,33,35,36,42,43] The global dermoscopic and RCM patterns were also evaluated.[44]

Statistical analysis

Quantitative variables were assessed for normal distribution and then compared using Student's *t*-test or the Mann–Whitney *U*-test. For qualitative variables, the chi-square or Fisher's exact tests were applied. For statistical purposes, *in situ* non-LM melanoma was considered SSM, and LM and LMM were classified together. Pairwise comparisons were performed between clinical/demographics, dermoscopic and RCM variables according to final diagnosis (nevus, LM/LMM, SSM). Univariate logistic regression analysis identified variables significantly associated with LM/LMM or SSM diagnoses. Multivariable logistic regression model with backward stepwise variable selection defined independent demographics, clinical, dermoscopic and RCM features associated with LM/LMM and SSM diagnosis. Alpha level was set at 0.05, while 0.10 was used as the cut-off for variable inclusion in the multivariable model. Statistical analyses were performed using the IBM SPSS 26.0 package (Statistical Package for Social Sciences, IBM SPSS Inc., Chicago, IL, USA.)

Results

Study population

A total of 247 lesions (245 patients) were included; median age was 59 years [interquartile range (IQR): 45.5–76.9 years] and most (64.9%) patients were male. Among the lesions, 39.2%

(n = 97) were diagnosed at histopathology as melanoma (49 LMs, 15 LMMs, eight *in situ* melanomas and 25 SSMs) and 20.8% (n = 53) with histological confirmation of nevi (15 blue nevi, 19 compound nevi, one congenital nevus, eight dermal nevi, nine junctional nevi, one Spitz nevus). The remaining lesions (39.6%; n = 97) underwent clinical/dermoscopic or RCM follow-up (≥12 month) without excision.

Most melanomas were diagnosed as *in situ* (58.8%), of which, most were LMs subtype (76.6% LMs vs. 24.2% SSM, $P < 0.001$). The Median Breslow thickness of all invasive melanoma was 0.5 mm (IQR: 0.4–1.3 mm), with no significant differences between LMM and SSM groups (Table 1).

Table 1 Melanoma histopathologic features

Variables		Final diagnosis		Total	*P* value
		LM/LMM	SSM		
Stage	*In situ*	49 (76.6%)	8 (24.2%)	**57 (58.8%)**	**<0.001**
	Invasive	15 (23.4%)	25 (75.8%)	**40 (41.2%)**	
Median Breslow (IQR)		0.5 (0.3–0.6)	0.6 (0.4–1.8)	**0.5 (0.4–1.3)**	**0.17**
Ulceration		0 (0.0%)	4 (12.1%)	**4 (4.1%)**	**0.012***
Mitosis		2 (13.3%)	10 (40.0%)	**12 (30.0%)**	**0.152***
Total		**64**	**33**	**97**	

The SSM groups also include *in situ* non-LM melanomas. IQR, interquartile range; LM/LMM, lentigo maligna and lentigo maligna melanoma; SSM, superficial spreading melanoma.
*Fisher's exact test.

Clinical assessment

Clinical baseline characteristics confirmed that melanoma diagnoses were significantly associated with male sex (<0.001) and baldness (<0.001) compared to nevi diagnoses (Table 2). Clinically evident sun damage of the scalp was recorded more frequently in association with LM/LMM diagnoses than SSM ($P < 0.001$) and more frequently reported among melanomas than nevi ($P < 0.001$). Nevi and SSM lesions were mostly located in the fronto-temporal area (56.7% and 51.5%, respectively), whereas LM/LMM were mainly detected on the vertex (50%).

Dermoscopy assessment

Dermoscopy evaluation revealed that atypical criteria more frequently encountered among nevi were atypical pigment network (10.6%) and atypical vascular pattern (11.3%; Table 3). Atypical network was also observed in the majority of SSMs (63.6%) and in 34.4% of LM/LMM (Figs 1 and 2). Whereas concerning atypical vessels, they were found in 36.4% of SSM, but no significant differences were observed between nevi and LM/LMM (11.3% vs. 10.9%, $P > 0.99$, respectively). According to the global pattern, the majority of nevi displayed a regular and symmetric global pattern, with a prevalence of the homogenous pattern (42.7%), whereas for both melanomas subtypes the main pattern was multicomponent /asymmetrical (in almost all cases).

Among the melanoma lesions, SSM was mainly and more frequently characterized by regression features (75.8%) and

Table 2 Clinical and demographics features

Variables		Final diagnosis			Total	*P* values	
		Nevi	LM/LMM	SSM		LM/LMM vs. SSM	Nevi vs. melanoma
Median age, years (IQR)		50 (39–61)	77.5 (65.5–81)	71 (59.5–84.5)	**59 (45.5–76.9)**	**0.529**	**<0.001**
Sex	Male	75 (51.0%)	56 (90.3%)	25 (75.8%)	**158 (64.8%)**	**0.072**	**<0.001**
	Female	72 (49.0%)	6 (9.7%)	8 (24.2%)	**87 (35.2%)**		
Total patients		**147**	**62**	**33**	**245**		
Scalp site	Frontal	36 (24.0%)	11 (17.2%)	8 (24.2%)	**55 (22.3%)**	**0.01**	**0.001***
	Parietal	22 (14.7%)	15 (23.4%)	4 (12.1%)	**41 (16.6%)**		
	Temporal	49 (32.7%)	5 (7.8%)	9 (27.3%)	**63 (25.5%)**		
	Vertex	31 (20.7%)	32 (50.0%)	9 (27.3%)	**72 (29.1%)**		
	Occipital	11 (7.3%)	1 (1.6%)	3 (9.1%)	**15 (6.1%)**		
	Nucal	1 (0.7%)	0 (0.0%)	0 (0.0%)	**1 (0.4%)**		
Hair coverage	Bald	51 (34.0%)	47 (73.4%)	19 (57.6%)	**117 (47.4%)**	**0.248**	**<0.001**
	Thinning of hair	37 (24.7%)	10 (15.6%)	7 (21.2%)	**54 (21.9%)**		
	Abundant hair	62 (41.3%)	7 (10.9%)	7 (21.2%)	**76 (30.8%)**		
Sun damage		34 (22.7%)	57 (89.1%)	19 (57.6%)	**110 (44.5%)**	**<0.001**	**<0.001**
Total lesions		**150**	**64**	**33**	**247**		

LM/LMM, lentigo maligna and lentigo maligna melanoma; SSM, superficial spreading melanoma.
The SSM groups also include *in situ* non-LM melanomas.
*No more significant when comparing nevi with SSM (*P*: 0.941).

Table 3 Dermoscopic characteristics of nevi, SSM and LM/LMM

Variables	Final diagnosis			Total	*P* values	
	Nevi	LM/LMM	SSM		LM/LMM vs. SSM	Nevi vs. melanoma
Atypical pigment network	16 (10.7%)	22 (34.4%)	21 (63.6%)	**59 (23.9%)**	**0.006**	**<0.001**
Blue-white veil	2 (1.3%)	6 (9.4%)	14 (42.4%)	**22 (8.9%)**	**<0.001**	**<0.001**
Atypical vascular pattern	17 (11.3%)	7 (10.9%)	12 (36.4%)	**36 (14.6%)**	**0.003**	**0.037‡**
Irregular streaks	2 (1.3%)	1 (1.6%)	6 (18.2%)	**9 (3.6%)**	**0.006***	**0.032*,‡‡**
Irregular pigmented blotches	6 (4.0%)	12 (18.8%)	14 (42.4%)	**32 (12.9%)**	**0.013**	**<0.001**
Irregular dots/globules	1 (0.7%)	3 (4.7%)	6 (18.2%)	**10 (4.0%)**	**0.058***	**0.001*,‡‡‡**
Inverse network	3 (2.0%)	1 (1.6%)	4 (12.1%)	**8 (3.2%)**	**0.044***	**0.094*,††**
Regression	7 (4.7%)	27 (42.2%)	25 (75.8%)	**59 (23.9%)**	**0.002**	**<0.001**
Regression ≥50%	1 (0.7%)	5 (7.8%)	8 (24.2%)	**14 (5.7%)**	**0.032***	**<0.001**
Atypical pseudo-network	5 (3.3%)	38 (59.4%)	7 (21.2%)	**50 (20.2%)**	**<0.001**	**<0.001**
Annular–granular pattern	2 (1.30%)	37 (57.8%)	4 (12.1%)	**43 (17.4%)**	**<0.001**	**<0.001**
Circle within a circle	1 (0.7%)	13 (20.3%)	2 (6.1%)	**17 (6.9%)**	**0.066**	**<0.001†**
Pigmented rhomboidal structures	2 (1.3%)	24 (37.5%)	5 (15.2%)	**31 (12.5%)**	**0.023**	**<0.001**
Obliterated hair follicle	1 (0.7%)	21 (32.8%)	2 (6.1%)	**24 (9.7%)**	**0.003**	**<0.001†**
Global pattern					**0.341**	**<0.001**
Multicomponent asymmetric	3 (2.0%)	60 (93.8%)	33 (100%)	**96 (38.9%)**		
Globular	25 (16.7%)	3 (4.7%)	0 (0.0%)	**28 (11.3%)**		
Reticular	28 (18.7%)	1 (1.6%)	0 (0.0%)	**29 (11.7%)**		
Homogeneous	64 (42.7%)	0 (0.0%)	0 (0.0%)	**64 (25.9%)**		
Multicomponent symmetrical	30 (20.0%)	0 (0.0%)	0 (0.0%)	**30 (12.1%)**		
Total	**150**	**64**	**33**	**247**		

The SSM groups also include *in situ* non-LM melanomas.
LM/LMM, lentigo maligna and lentigo maligna melanoma; SSM, superficial spreading melanoma.
*Fisher's exact test. †No more significant when comparing nevi with SSM (*P*: 0.084). ††Significant when comparing nevi with SSM (*P*: 0.021). ‡, ‡‡, ‡‡‡ no more significant when comparing nevi with LM/LMM (*P*: 0.933; $P > 0.99$; *P*: 0.081, respectively).

atypical pigmented network (63.6%), followed by blue-white veil, irregular pigmented blotches (both 42.4%) and atypical vascular pattern (36.4%). LM/LMM mainly displayed atypical pseudo-network (59.4%) and annular–granular pattern (57.8%), followed by pigmented rhomboidal structures (37.5%) and obliterated hair follicles (32.8%).

Interestingly, some LM/LMM specific criteria were also observed in SSM; in particular atypical pseudo-network (21.2% of cases) and more than one third of LM/LMM also displayed at least one 7-point check list criterion, in particular atypical pigmented network (34.4%) and regression features (42.2%).

RCM assessment

Only a minority of nevi displayed atypical features on RCM examination. More than 10% had atypical pagetoid (epidermal) or junctional atypical cells, which were almost exclusively dendritic in shape. Regarding the global confocal pattern of scalp nevi, they were almost equally characterized in our series by a ringed, meshwork, clod and aspecific pattern.

No significant differences were observed when comparing SSM and LM/LMM, with the exception of folliculotropism, which was more frequently reported in LM/LMM than SSM (68.6% vs. 42.4%, respectively, *P*: 0.012). Pagetoid cells and atypical junctional cells were observed in the great majority of melanoma cases, with a prevalence of the dendritic shape. The coexistence of dendritic and roundish pagetoid and junctional atypical cells was more frequently seen among SSMs than LM/LMMs (42.4% vs. 21.9% and 48.5% vs. 26.6%, respectively, $P < 0.001$). Concerning the global pattern, most melanoma cases had a meshwork (37.5% of LM/LMM and 45.5% of SSM) or aspecific pattern (57.8% of LM/LMM and 39.4% of SSM; Table 4).

Logistic regression analysis

Univariate logistic regression analysis was first performed to evaluate which clinical/demographics, dermoscopic, confocal and histopathological factors were significantly associated with LM/LMM or SSM diagnosis (Table S1). A multivariable model was then constructed including factors significantly associated with melanoma subtypes in univariate analysis (Table 5). We demonstrated that SSM subtype was independently associated with an invasive stage (OR: 10.1; 95% CI: 2.5–40.0, *P*: 0.001), with the temporal and frontal locations (OR: 55.8; 95% CI: 6.1–506.9, $P < 0.001$; OR: 10.5; 95% CI: 1.6–70.2, *P*: 0.015) and with the presence of blue-white veil on dermoscopic examination (OR: 9.9; 95% CI: 1.7–56.5, *P*: 0.009). Conversely, the LM/LMM

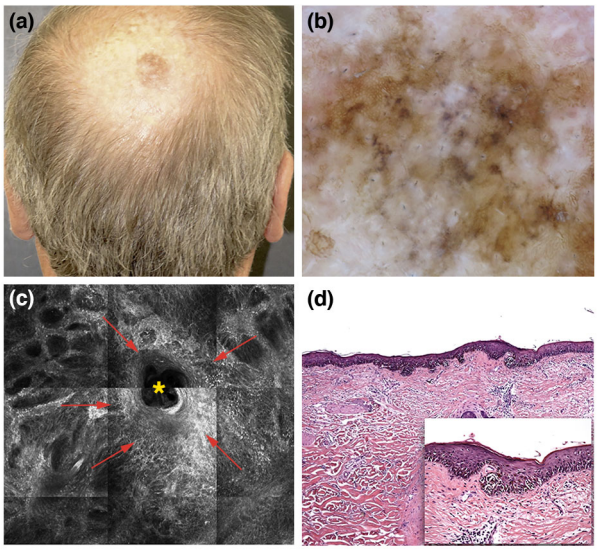

Figure 1 Lentigo maligna of the vertex region in a bald man. (a) Dermoscopic features of lentigo maligna (b) including atypical pseudo-network, annular–granular pattern, grey colour and rhomboidal structures. (20× magnification). Reflectance confocal microscopy reveals the presence of many dendritic cells (red arrows) at the dermoepidermal junction, with folliculotropism. (yellow asterisk within follicle) (c). Histological slide (H&E staining); melanoma *in situ* with lentigo maligna pattern of growth. At high power, melanoma cells grow mainly at the base of the epidermis and are singularly dispersed.

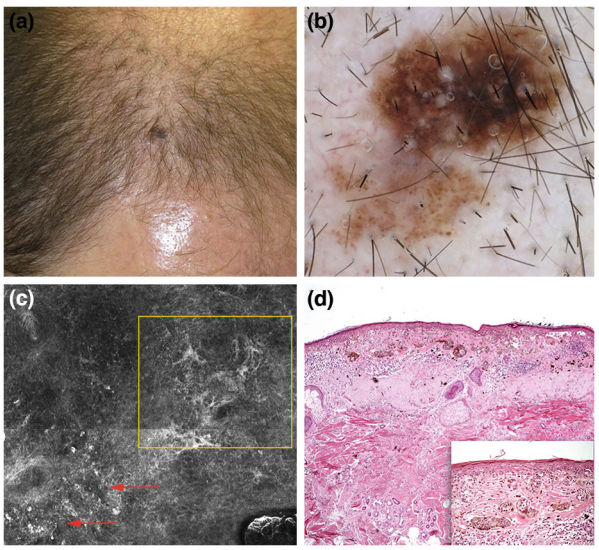

Figure 2 Superficial spreading melanoma of the parietal region of the scalp in a man with thinning hairs. (a) Dermoscopic features (b), asymmetric lesion with globular pattern in the lower part, white veil in the intermedium portion, atypical network, globules and multiple colours in the upper part. (20× magnification) Reflectance confocal microscopy shows pagetoid spreading of roundish (red arrows) and dendritic cells (yellow square) in the superficial layer. (c) Histological slide (H&E staining); superficial spreading melanoma with some infiltrating neoplastic aggregates in the dermis. The pattern of growth in depth is nested, and it is associated with an evident epidermotropism.

subtype was more frequently *in situ* (LM) and located on the vertex.

Discussion

This study reveals that scalp LM/LMM subtype is associated with sun damaged and is predominantly located on the vertex, characterized on dermoscopy by classic facial LM features and on RCM by classic melanoma features plus folliculotropism. Scalp SSM is mostly located on the frontal and temporal areas and is characterized by typical dermoscopy and RCM features of SSM in other body areas. Nevi were also mainly located on the frontal and temporal areas; RCM features of nevi were reassuring although a subset of them revealed cytologic atypia (pagetoid cells or atypical melanocytes at dermal-epidermal junction) on RCM.

The study confirms the common risk factors of baldness, male sex and chronic sun damage for scalp melanoma,[19,21,22,45] in particular with LM/LMM diagnoses.[17] We observed that 50% of LM/LMMs were located on the vertex, whereas SSMs were more frequently seen on the temporal and frontal areas. These data can be explained by the different pattern of UV exposure of these areas; the vertex is more chronically exposed in bald individuals, while the frontal-temporal area is more at risk of intermittent sun exposure.[17] Interestingly, nevi share a similar distribution pattern as SSMs, which suggest a common pathogenetic background that is less susceptible to UV radiation compared to LM/LMM type.

In our study population, most of the melanomas were *in situ*, which may be due to earlier diagnosis performed at our tertiary referral centres, utilizing both dermoscopy and RCM in routine clinical practice. Benati *et al*.[4] published a small cohort of scalp melanoma only, with a higher number of invasive melanomas, which may partially be explained by the majority of melanomas included being SSMs.

In accordance with previous data, bluish-white veil, pigmented blotches, atypical pigmented network and regression were dermoscopic criteria associated with scalp melanoma diagnoses. Stanganelli *et al*.[29] observed that blue-white veil and pigmented blotches are more frequent observed in thick melanomas (≥1 mm) while atypical pigmented network and regression occur more often in *in situ* and thin (≤1 mm) melanomas. The current study focused on thin melanoma, with the exclusion of nodular lesions. However, we demonstrated that all of the aforementioned dermoscopic criteria had a higher frequency in SSMs. Moreover, we found that other three criteria were significantly more observed among SSMs: atypical vascular pattern, irregular streaks and inverse network.

Table 4 Reflectance confocal microscopy criteria

Variables		Final diagnosis			Total	*P* values	
		Nevi	LM/LMM	SSM		LM/LMM vs. SSM	Nevi vs. melanoma
Pagetoid cells		17 (11.3%)	58 (90.6%)	29 (87.9%)	**104 (42.1%)**	**0.731***	**<0.001**
Pagetoid cells	Absent	133 (88.7%)	6 (9.4%)	4 (12.1%)	**143 (57.9%)**	**0.147**	**<0.001**
	Dendritic	14 (9.3%)	40 (62.5%)	14 (42.4%)	**68 (27.5%)**		
	Round	2 (1.3%)	4 (6.3%)	1 (3.0%)	**7 (2.8%)**		
	Both	1 (0.7%)	14 (21.9%)	14 (42.4%)	**29 (11.7%)**		
Atypical junctional cells		18 (12.0%)	56 (87.5%)	29 (87.9%)	**103 (41.7%)**	**>0.99***	**<0.001**
Atypical junctional cells	Absent	132 (88.0%)	8 (12.5%)	4 (12.1%)	**144 (58.3%)**	**0.174**	**<0.001**
	Dendritic	12 (8.0%)	36 (56.3%)	12 (36.4%)	**60 (24.3%)**		
	Round	4 (2.7%)	3 (4.7%)	1 (3.0%)	**8 (3.2%)**		
	Both	2 (1.3%)	17 (26.6%)	16 (48.5%)	**35 (14.2%)**		
Folliculotropism		6 (4.0%)	44 (68.8%)	14 (42.4%)	**64 (25.9%)**	**0.012**	**<0.001**
Medusa-like structures		1 (0.7%)	9 (14.1%)	4 (12.1%)	**14 (5.7%)**	**>0.99***	**<0.001**
Dermal atypia		0 (0.0%)	6 (9.4%)	4 (12.1%)	**10 (4.0%)**	**0.731***	**<0.001***
Main RCM architecture						**0.096**	**<0.001**
	Aspecific	39 (26.0%)	37 (57.8%)	13 (39.4%)	**89 (36.0%)**		
	Ringed	34 (22.7%)	3 (4.7%)	3 (9.1%)	**40 (16.2%)**		
	Meshwork	38 (25.3%)	24 (37.5%)	15 (45.5%)	**77 (31.2%)**		
	Clod	39 (26.0%)	0 (0.0%)	2 (6.1%)	**41 (16.6%)**		
Total		**150**	**64**	**33**	**247**		

The SSM groups also include *in situ* non-LM melanomas.
LM/LMM, lentigo maligna and lentigo maligna melanoma; SSM, superficial spreading melanoma.
*Fisher's exact test.

Table 5 Multivariable logistic regression analysis

Variables		OR	95% CI for OR		*P* value
			Lower	Upper	
Dermoscopy	Blue-white veil	9.9	1.7	56.5	0.009
	Atypical vascular pattern	5.4	0.8	34.9	0.073
	Inverse network	13.3	0.7	234.4	0.077
Scalp site	Vertex	ref.			0.01
	Parietal	2.5	0.3	18.2	0.357
	Temporal	55.8	6.1	506.9	<0.001
	Occipital	5.1	0	1568.6	0.578
	Frontal	10.5	1.6	70.2	0.015
Stage (*in situ* vs. invasive)		10.1	2.5	40.9	0.001

Factors independently associated with the diagnosis of lentigo maligna / lentigo maligna melanoma: LM/LMM groups vs. *in situ* non-LM / superficial spreading melanoma: SSM group. Variables entered at step 1: Atypical pigment network, Bluish-white veil, Atypical vascular pattern, Irregular streaks, Irregular pigmented blotches, Inverse network, Regression, Atypical pseudo-network, Scalp site, Stage (*in situ* vs. invasive), Folliculotropism.
CI, confidence interval; OR, odds ratio.

Concerning LM/LMM subtype, we confirmed that classic dermoscopic features described for LM on the face[28,38,46] were also observed in LM of the scalp.

The dermoscopic homogeneous/structureless patterns predominantly observed in the nevi included in the current study were in accordance with those observed by Zalaudek *et al.*,[44] despite a different nevus cohort with a more prevalent representation of blue nevi included in the current study.

Many authors have already described the useful application of *in vivo* RCM in detecting melanoma.[33,35–37] In line with previously published papers, most melanoma in the current study had atypical melanocytes at the dermoepidermal junction or in the epidermis (pagetoid spread).

We observed a higher number of dendritic pagetoid cells in the epidermis of LM as compared to SSM. However, SSM lesions more frequently exhibited pagetoid cells (dendritic and roundish

shape), compared to mostly dendritic cells in LM/LMM. Moreover, the presence of atypical cells at the dermal-epidermal junction and the presence of atypia in the dermis were statistically associated with melanoma diagnosis.

In accordance with Borsari *et al*,[47] pagetoid spreading in the epidermis and atypical cells at the dermal-epidermal junction are RCM-positive predictors for thin melanoma diagnosis. When considering the presence of dendritic cells in the epidermis only, a differential diagnosis between nevus and melanoma is more difficult than in the presence of atypia in the DEJ or in case of roundish or dendritic shaped cells, which are more reliable markers of malignancy.[40] Although different types of cell shape have been described for SSM and LM/LMM, establishing the specific melanoma subtype based only on cell morphology seems to not be possible.

Folliculotropism, already described as a specific feature of facial LM/LMM, was also found to be specific for LM/LMM scalp lesions.[34,38,48,49] Further, medusae-like structures, an RCM feature suggestive of folluculotropism,[38] were associated with malignancy and observed in 14% of LM/LMM and 12% of SSM.

In our series, the most frequently observed invasive melanoma subtype was invasive SSM. Although it is rather difficult to interpret these data, a possible explanation could be related to a more accurate/early diagnosis of LM before the lesion progressed into an invasive lesion, or it may reflect the intrinsic relationship to a biologic, slow-growing attitude of LM.

The main limitations of this study were the retrospective design of the study, and the inclusion of a selected group of highly suspicious melanocytic nevi, sent for second level, *in vivo* assessment with RCM. Moreover, this study included a relatively small number of evaluators.

This study highlights that sun-damaged skin, lesion location on the scalp are specifically correlated with melanoma subtype. Notably, dermoscopy and RCM features commonly associated with melanoma or nevi diagnoses in other body areas can be applied to highly suspicious lesions of the scalp. These revelations should assist clinicians in identifying thin melanomas on this special body site, which may assist in early diagnoses and improved prognoses.

Acknowledgement

The patients in this manuscript have given written informed consent to the publication of their case details.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

Table S1. Univariate logistic regression analysis.