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ORIGINAL ARTICLE

Dermoscopy of scalp tumours: a multi-centre study conducted by the international dermoscopy society

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Abstract

Background Little is known about the dermoscopic features of scalp tumours.

Objective To determine the dermoscopic features of scalp tumours.

Methods Retrospective analysis of dermoscopic images of histopathologically diagnosed scalp tumours from International Dermoscopy Society members.

Results A total of 323 tumours of the scalp from 315 patients (mean age: 52 years; range 3–88 years) were analysed. Scalp nevi were significantly associated with young age (<30 years) and exhibited a globular or network pattern with central or perifollicular hypopigmentation. Melanoma and non-melanoma skin cancer were associated with male gender, androgenetic alopecia, age >65 years and sun damage. Atypical network and regression were predictive for thin (≤1 mm) melanomas, whereas advanced melanomas (tumour thickness > 1 mm) revealed blue white veil, unspecific patterns and irregular black blotches or dots.

Conclusions The data collected provide a new knowledge regarding the clinical and dermoscopy features of pigmented scalp tumours.

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Conflict of interest

None declared.

Introduction

Dermoscopic examination has become a standard procedure in the management of skin tumours, because of its ability to improve a clinician's diagnostic confidence and accuracy. Dermoscopic criteria have been formulated for most skin tumours. However, the dermoscopic characteristics of melanocytic and non-melanocytic scalp tumours have not yet been described in detail.[1–6]

The International Dermoscopy Society (IDS) conducted a retrospective study of excised and histopathologically diagnosed scalp tumours based on evaluation of dermoscopic images and patient data contributed by participating IDS members. The aims of the study were: (i) to assess the distribution and prevalence of scalp tumours according to patient demographics, anatomic location on the scalp, and Breslow thickness (melanomas only); and (ii) to analyse the prevalence of global and local dermoscopic criteria of pigmented melanocytic and non-melanocytic scalp tumours.

Subjects and methods

Study design

We conducted a retrospective analysis of patient characteristics and dermoscopic patterns of excised and histopathologically diagnosed scalp tumours. The study was first proposed at an IDS meeting in 2005, with a request for patient data and dermoscopic images relevant to cases of pigmented scalp tumours to be sent via internet to the study coordinator (I.Z.). Study participation was solicited by e-mail requests to IDS members, by a notice on the IDS website (http://www.dermoscopy-ids.org) and by announcements at dermatology/dermoscopy meetings.

For each lesion, a patient documentation form and digital dermoscopic and clinical images in high-definition JPG format were required. We included the digital images irrespective whether they were taken with polarized, non-contact or non-polarized, contact dermoscopic devices. The documentation form collected the following data: (i) age; (ii) sex; (iii) presence of androgenetic alopecia; (iv) signs of sun damage such as actinic keratoses or solar freckles; (v) personal history of skin cancer; (vi) reported history of changes; (vii) histopathological diagnosis including Breslow thickness for melanoma; and (viii) anatomic sub-site of the lesion on the scalp (i.e. front, temporal, parietal, vertex, occipital and nuchal; Fig. 1). Records were stripped of identifying information before they were transmitted by e-mail to the study coordinator, who assigned numbers to the cases.

The initial request was for pigmented scalp lesions; however, we amended the study design to include the small number of cases of

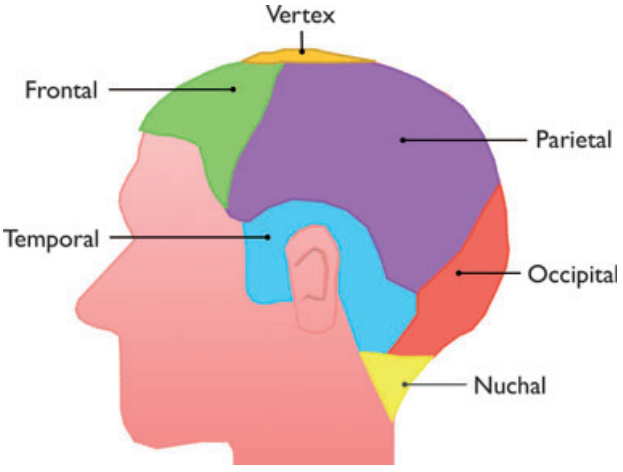

Figure 1 Anatomic regions of the scalp.

non-pigmented scalp lesions that were transmitted. We included all cases irrespective whether lesions were entirely or only partially photographed. The only requirement was that the image quality be sufficient to allow reliable recognition of pigmented dermoscopic structures and colours. We relied on the histopathological diagnoses that were made at the referring clinics, as logistical problems prevented the implementation of a consensus histopathological evaluation of the collected cases.

Dermoscopic analysis

The digital images were reviewed by two of us (I.Z; G.A) blinded to the original histopathologic diagnosis. Each lesion was scored for global and local dermoscopic patterns using pattern analysis. If a lesion lacked specific patterns of a melanocytic or non-melanocytic tumour, the pattern was defined as unspecific. Site-related patterns were classified as typical or atypical pseudonetwork.[7] Typical pseudonetwork was characterized by the presence of thickened, brown pigmented lines around the hair follicles, with the lines resembling a network but lacking additional features of asymmetric pigmented hair follicles, rhomboidal structures or annular–granular structures. Atypical pseudonetwork was defined as described by Schiffner *et al.*[8] for the diagnosis of facial melanoma as the presence of asymmetric pigmented hair follicular openings, rhomboidal structures, annular–granular structures, black dots within the hair follicle or destruction of the hair follicles. The evaluation also included areas of hypopigmentation, defined as areas that were lighter than the pigmentation of a lesion. If vessels were apparent in a lesion, they were scored as present; in a separate analysis, vessels were further classified as: (i) comma; (ii) dotted-glomerular; (iii) linear-irregular; (iv) hairpin; or (v) arborizing vessels. After the dermoscopic evaluation, the evaluator selected one of the following diagnostic options: (i) common nevus; (ii) blue nevus; (iii) equivocal lesion to be excised; (iv) melanoma; (v) basal cell carcinoma (BCC); (vi) seborrheic keratosis (SK); or (vii) other.

The two evaluators achieved a consensus diagnosis; if no consensus could be reached, a consensus diagnosis of 'equivocal lesion to be excised' was selected. The consensus dermoscopic diagnosis was then compared with the histopathological diagnosis to assess the accuracy of dermoscopic patterns for the diagnosis of different types of scalp tumours.

Statistical analysis

The prevalence of the global and local dermoscopic criteria was compared between benign and malignant melanocytic lesions

Table 1 Patients characteristic and localization of 193 melanocytic scalp tumours. Significant values are highlighted in bold

Clinical data		Nevus (*n* = 78)		Blue nevus (*n* = 27)		MM (*n* = 75)		MM-Mets (*n* = 13)		Nevi vs. MM	Blue nevi vs. MM-Mets
		n	%	*n*	%	*n*	%	*n*	%	*P*-value*	*P*-value*
Sex	Female	32	41.9	15	55.6	17	22.7	7	53.8	**0.015**	1.000
	Male	46	59.1	12	44.4	58	77.3	6	46.2		
Age (years)	3–39	51	65.3	11	40.8	12	16.0	3	23.1	**<0.001**	**0.025**
	40–55	12	15.4	9	33.3	16	21.3	4	30.8		
	56–65	12	15.4	5	18.5	14	18.7	0	0.0		
	66–88	3	3.9	2	7.4	33	44.0	6	46.1		
Alopecia	No	65	85.5	24	88.9	45	60.8	9	69.2	**0.001**	0.125
	Yes	11	14.5	3	11.1	29	39.2	4	30.8		
Sun-damage	No	61	82.4	22	88.0	42	58.3	3	23.1	**0.001**	**<0.001**
	Yes	13	17.6	3	12.0	30	41.7	10	76.9		
Skin cancer previous	No	46	80.7	23	95.8	48	81.4	0	0.0	0.928	
	Yes	11	19.3	1	4.2	11	18.6	13	100.0		
	n.a.	21		3		16					
Changes	No	23	56.1	9	60.0	11	23.9	5	45.5		
	Yes	18	43.9	6	40.0	35	76.1	6	54.5	**0.002**	**0.462**
	n.a.	37		12		29		2			
Localization	Frontal	16	21.9	2	7.4	11	14.7	1	11.1		
	Temporal	17	23.3	6	22.2	10	13.3	3	33.3		
	Parietal	16	21.9	10	37.1	22	29.4	3	33.3		
	Vertex	11	15.1	3	11.1	13	17.3	0	0.0		
	Occipital	10	13.7	4	14.8	19	25.3	1	11.1		
	Nuchal	3	4.1	2	7.4	0	0.0	1	11.1	0.087	0.895
	n.a	5						4			

*P-values from chi-squared or Fisher exact test when appropriate.

MM, melanoma; MM-Mets, melanoma metastases; n.a., not available.

using the chi-squared test or the Fisher exact test if appropriate. These tests were also used for evaluating the differences in the distribution by age, sex, history of sun damage or skin cancer, androgenetic alopecia, and localization among benign vs. malignant melanocytic tumours and benign vs. malignant non-melanocytic lesions.

For cases of melanoma, the chi-squared test was used to assess differences in the prevalence of dermoscopic criteria (sensitivity) according to patient age, sex, history of sun damage, androgenetic alopecia, localization, and thickness in mm according to Breslow. The agreement between the histopathological and dermoscopic diagnosis for all tumour was assessed using the kappa statistics. On each lesion group the sensitivity of the dermoscopic diagnosis was also calculated.

Results

Patient demographics and clinical characteristics

A total of 323 cases of scalp tumours excised from 315 patients were collected from researchers at 35 pigmented lesion clinics in 13 countries (Argentina, Australia, Austria, Brazil, China, France, Germany, Italy, New Zealand, Slovenia, Spain, Turkey and United States). Based on histopathologic diagnosis, 193 (59.8%) tumours were classified as melanocytic tumours and 130 (40.2%) as non-melanocytic tumours. Forty-five (13.9%) of the submitted cases were scalp tumours without significant pigmentation. Four cases of melanoma and nine cases of non-melanocytic tumours including three BCC, two SK, two squamous cell carcinoma (SCC) and two viral warts were excluded

Table 2 Absolute number and frequencies (in percentage) of dermoscopic patterns associated with 189 evaluated melanocytic tumours. Significant values are highlighted in bold

Dermoscopic patterns	Histopathologic diagnosis								Overall comparison	Nevi vs. MM	Blue nevi vs. MM-Mets
	Nevus (*n* = 78)		Blue nevus (*n* = 27)		MM (*n* = 71)		MM-Mets (*n* = 13)		*P*-value**	*P*-value*	*P*-value*
	n	%	*n*	%	*n*	%	*n*	%			
Pigment network	27	34.6	1	3.7	25	35.2	0	0.0	**<0.001**	1.000	†
Typical	18	17.1	0	0.0	2	2.8	0	0.0	**<0.001**	**<0.001**	†
Atypical	9	11.5	1	3.7	23	32.4	0	0.0	**<0.001**	0.002	†
Pseudonetwork	6	5.7	0	0.0	23	32.4	0	0.0	**<0.001**	**<0.001**	†
Typical	6	5.7	0	0.0	0	0.0	0	0.0	0.044		
Atypical	0	0.0	0	0.0	23	32.4	0	0.0	**<0.001**	**<0.001**	†
Aggregated globules	29	27.6	0	0.0	9	12.7	3	23.1	**<0.001**	0.001	0.029
Regular	22	20.9	0	0.0	2	2.8	2	15.4	**<0.001**	**<0.001**	†
Irregular	7	6.7	0	0.0	7	9.9	1	7.7	0.371		
Streaks	6	7.7	1	3.7	8	11.3	1	7.7	0.736		
Regular	2	2.7	1	3.7	2	2.8	0	0.0	1.000		
Irregular	4	3.8	0	0.0	6	8.5	1	7.7	0.396		
Structureless blue	5	6.4	24	89.0	2	2.8	5	38.5	**<0.001**	0.446	0.002
Structureless brown	15	19.2	1	3.7	9	12.7	1	7.7	0.202		
Regression	3	3.9	1	3.7	37	51.1	1	7.7	**<0.001**	**<0.001**	†
Blue-white veil	2	1.9	0	0.0	26	36.6	4	30.8	**<0.001**	**<0.001**	0.008
Hypopigmentation	38	48.7	13	48.2	26	36.6	2	15.4	0.088		
Central	14	18.0	0	0.0	1	1.4	0	0.0	**0.001**	0.001	†
Perifolllicular	15	19.2	2	7.4	5	7.0	1	7.7	0.125		
Diffuse/multifocal	7	9.0	11	40.7	17	23.9	1	7.7	**0.001**	0.015	0.053
Eccentric	3	3.9	0	0.0	3	4.2	0	0.0	1.000		
Blotches	12	15.4	1	3.7	36	50.7	5	38.5	**<0.001**	**<0.001**	0.010
Central	9	11.6	1	3.7	16	22.5	3	23.1	0.055		
Irregular	3	3.9	0	0.0	20	28.2	2	15.4	**<0.001**	**<0.001**	†
Vessels	16	20.5	10	37.0	8	11.3	1	7.7	0.027		
Unspecific	4	5.1	1	3.7	13	18.3	4	30.8	0.005		

**P*-values from chi-squared or Fisher exact test when appropriate.

***P*-values from Fisher exact test.

†Test not performed given the low prevalence of dermoscopic pattern among blue nevus and MM-Mets.

MM, melanoma (MM); MM-Mets, melanoma metastases.

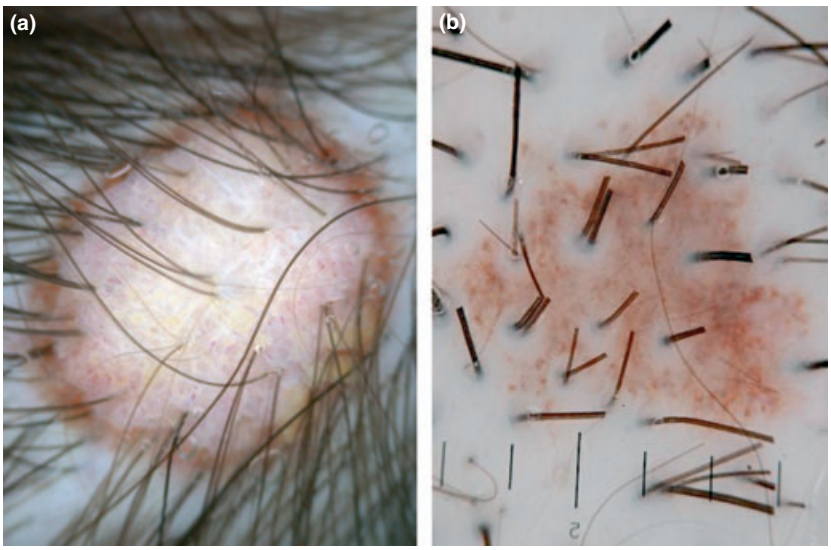

Figure 2 Stereotypical appearance of scalp nevi showing central hypopigmentation (eclipse nevus) (a) and perifollicular hypopigmentation (b).

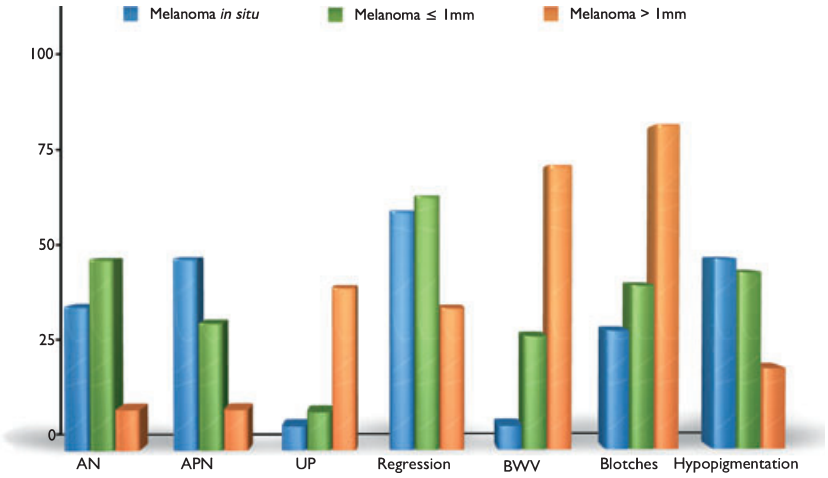

Figure 3 Prevalence (given as percentage) of dermoscopic patterns among melanomas with different tumour thickness. AN, atypical network; APN, atypical pseudonetwork; BWV, blue white veil; UP, unspecific pattern.

from further dermoscopic evaluation because of insufficient image quality.

The mean age of the patients was 52 years (range: 3–88 years) and the majority of patients (212/315; 67.3%) were male. Data were classified into four groups based on patient age (3–39, 40–55, 56–65 and 66–88 years) with a similar distribution of patients in each age group (data not shown).

Fifty-six (17.8%) patients had reported a personal history of skin cancer, as follows: BCC, 10 patients (including two who also reported previous melanoma); melanoma, four patients; xeroderma pigmentosum, three patients; SCC, two patients; and cutaneous lymphoma, one patient. For the remaining patients with previous skin cancer, a specific diagnosis was not available. Four patients (including two with a history of melanoma) had cutaneous scalp metastases from previous melanoma. Data about the primary melanoma were available for only three of these patients. In one case, the primary melanoma was on the scalp, with a tumour thickness of 0.78 mm at excision. In the second case, the primary melanoma was on the trunk, with a tumour thickness of 2 mm. The third case was a patient who had a metastatic primary scalp melanoma with a tumour thickness of 4.1 mm.

The most common locations for scalp tumours were the parietal (n = 84; 26.0%), temporal (n = 69; 21.4%) or frontal (n = 63; 19.5%) area of the scalp, followed by the occipital area (n = 46; 14.2%) and vertex (n = 44; 13.6%). Only six (1.9%) scalp tumours involved the nuchal region. For 11 (3.4%) scalp tumours, the location was not recorded.

In 210 cases, tumour size could be assessed from the clinical images. Seventy-one scalp tumours had a diameter >2 cm. Of these, 56 (78.9%) were melanomas, nine (12.7%) were SK and six (8.5%) were BCC.

Histopathologic diagnosis of scalp tumours

The 193 melanocytic tumours consisted of 66 (34.2%) common nevi, 27 (14.0%) blue nevi, 12 (6.2%) atypical nevi, 75 (38.9%) primary melanomas and 13 (6.7%) melanoma metastases. For two melanomas, tumour thickness was not reported. The median tumour thickness for the remaining melanomas was 1.6 mm (range: 0.12–12 mm). Seventeen (22.7%) melanomas were *in situ* melanoma, 34 (45.3%) melanomas had a tumour thickness ≤1 mm and 22 (29.3%) melanomas had a tumour thickness >1 mm.

Histopathologic classification of the 75 primary melanomas revealed 19 (25.3%) cases of the lentigo maligna type, 24 (32%) cases of the superficial spreading type, four (5.3%) cases of nodular type, one (1.3%) case of malignant blue nevus and one (1.3%) case of nevoid melanoma. For the remaining 26 (34.6%) cases of melanoma, no further information of the histopathologic subtype was available.

By histopathologic diagnosis the 130 non-melanocytic scalp tumours were classified as follows: BCC, 65 (50.0%) cases; SK, 38 (29.2%) cases; and other, 27 (20.8%) cases. The latter category consisted of SCC ($n = 15$), angioma ($n = 3$), lichen planus-like keratosis ($n = 3$), viral wart ($n = 2$), dermatofibroma ($n = 1$), neurofibroma ($n = 1$), pilomatrixoma ($n = 1$) and nevus sebaceus ($n = 1$). Included in the 15 cases of SCC were two cases of pigmented actinic keratoses (AK) and two cases of non-pigmented AK.

The 45 scalp tumours without significant pigmentation consisted of 19 (42.2%) BCC, 13 (24.4%) SCC, 7 (15.5%) dermal nevi, 2 (4.4%) viral warts and one case each of SK, dermatofibroma, neurofibroma and nevus sebaceous.

Patient demographics and clinical dermoscopic patterns of melanocytic scalp tumours

The patient demographics and clinical characteristics of the 193 melanocytic scalp tumours are summarized in Table 1. Compared with patients with nevi, those with melanomas were significantly more likely to be male ($P = 0.015$) and to be older ($P < 0.001$). Patients with melanomas also had a higher prevalence of androgenetic alopecia ($P = 0.001$), signs of sun-damage ($P = 0.001$) and history of changes ($P = 0.002$), compared with patients with nevi (Table 1).

Patients with dermal nevi lacking pigmentation were older than those with pigmented non-blue scalp nevi (mean 51.3 years vs. mean 32.2 years, respectively; data not shown).

Table 2 shows the frequency of dermoscopic features among nevi, melanomas and cutaneous metastases. Given the high number of tests performed, the overall comparison was made using Bonferroni with a confidence level set to $\alpha = 0.0019 = 0.05/26$ (26 number of tests performed according to the different types of melanocytic tumours). Further comparisons according to nevi vs. melanoma and blue nevi vs. melanoma metastases groups were performed only for those dermoscopic criteria that showed a significant prevalence on overall comparison.

Nevi exhibited a significant higher prevalence of regular network, regular globules and structureless blue pigmentation (i.e. blue nevi) compared with melanoma. Instead, melanomas were significantly associated with atypical network, atypical pseudonetwork, blue-white structures and irregular black blotches ($P < 0.001$). Areas of hypopigmentation were common in nevi and melanomas, but in nevi hypopigmentation was predominantly seen in the centre or perifollicular (Fig. 2), whereas melanomas were prone of diffuse/multifocal areas of hypopigmentation.

For the 71 scalp melanomas, the prevalence of patterns according to Breslow thickness subdivided into *in situ*; ≤1 mm, >1 mm was additionally calculated (Fig. 3). Atypical pseudonetwork ($P = 0.043$) and diffuse-multifocal areas of hypopigmentation ($P = 0.162$) were more prevalent in melanoma *in situ*.

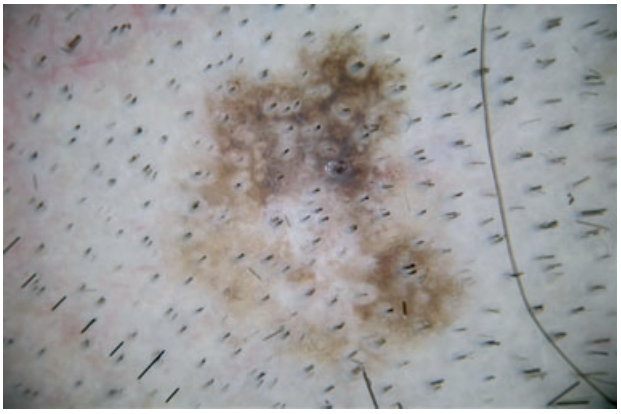

Figure 4 Dermoscopic image of early invasive melanoma (tumour thickness 0.3 mm) located on the parietal area of the scalp of a 34-year-old man, showing an atypical pseudonetwork and diffuse areas of regression.

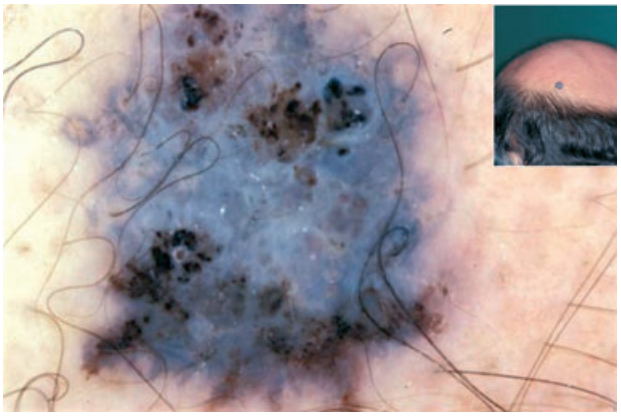

Figure 5 Dermoscopic image of a thick melanoma (tumour thickness > 2 mm) located on the parietal area of the scalp, showing structureless blue pigmentation intermingled with irregularly distributed black blotches or dots.

Atypical network/pseudonetwork ($P = 0.023$) and regression ($P = 0.136$) occurred likewise in melanoma *in situ* and melanomas ≤1 mm (Fig. 4). In striking contrast, thick melanomas showed unspecific patterns ($P = 0.006$), blue white veil ($P < 0.001$) and irregular black blotches and dots ($P = 0.055$) (Fig. 5). Neither dermoscopic pattern nor melanoma thickness showed any correlation with androgenetic alopecia or anatomic location.

Patient demographics and clinical dermoscopic patterns of non-melanocytic scalp tumours

A total of 121 non-melanocytic tumours were available for further dermoscopic analysis. Among those, 75 (62.0%) cases were non-melanoma skin cancer (62 BCC and 13 SCC). The risk profile for non-melanoma skin cancer of the scalp was similar as for scalp melanomas: age >65 years, signs of sun-damage, androgenetic alopecia and history of skin cancer (Table 3).

The dermoscopic patterns of the 121 cases of non-melanocytic skin tumours are summarized in Table 4. In BCC there was high prevalence (66.1%) of blue-grey or brown-grey ovoid/globular structures. Notably, 19 (52.8%) and four (30.8%) cases of SK and SCC, respectively displayed criteria overlapping with melanocytic tumours.

Vascular pattern among melanocytic and non-melanocytic scalp tumours

Table 5 summarizes the vascular patterns among melanocytic and non-melanocytic scalp tumours. Vessels were generally infrequent among melanocytic skin tumours with the exception of blue nevi, in which linear irregular vessels appeared in eight (29.6%) cases (Fig. 6). The seven dermal nevi lacking significant pigmentation showed linear-irregular vessels ($n = 3$), comma-vessels ($n = 2$) and one case revealed arborizing vessels.

Among the non-melanocytic tumours, arborizing vessels were seen in 26 of 62 cases of BCC (41.9%), including all 19 cases of non-pigmented BCC. Linear-irregular vessels were the most common type of vessels in SCC, appearing in five of 13 cases (38.5%).

Diagnostic concordance of the dermoscopic evaluation

The agreement between the histopathological and dermoscopic diagnosis was 76.9% for all tumours ($\kappa = 0.720$; 0.651,769) with

Table 3 Patients characteristic and localization of 130 non-melanocytic scalp tumours. Significant values are highlighted in bold

Clinical data		BCC ($n = 65$)		SK ($n = 38$)		SCC ($n = 15$)		Others benign ($n = 12$)		BCC + SCC vs. SK and others
		n	%	*n*	%	*n*	%	*N*	%	*P*-value*
Sex	Female	24	36.9	10	26.3	0	0.0	3	25.0	0.623
	Male	41	63.1	28	73.7	15	100.0	9	75.0	
Age (years)	3–39	2	3.1	1	2.7	0	0.0	3	25.0	0.074
	40–55	19	29.2	12	32.4	3	20.0	4	33.4	
	56–65	14	21.5	13	35.1	4	26.7	3	25.0	
	66–88	30	46.2	11	29.7	8	53.4	2	16.7	
Alopecia	No	33	50.8	25	65.8	0	0.0	8	72.7	**0.004**
	Yes	32	49.2	13	34.2	15	100.0	3	27.3	
Sun-damage	No	31	47.7	29	76.3	1	6.7	9	81.8	**<0.001**
	Yes	34	52.3	9	23.7	14	93.3	2	18.2	
Skin cancer previous	No	39	65.0	28	96.6	10	71.4	7	87.5	**0.001**
	Yes	21	35.0	1	3.4	4	28.6	1	12.5	
	n.a.	5		9		1		4		
Changes	No	9	20.4	10	47.6	3	36.4	4	50.0	**0.023**
	Yes	35	79.6	11	52.4	8	63.6	4	50.0	
	n.a.	21		17		4		4		
Localization	Frontal	18	28.1	6	15.8	6	40.0	3	27.3	**0.033**
	Temporal	13	20.3	15	39.5	3	20.0	2	18.2	
	Parietal	14	21.9	12	31.6	3	20.0	4	36.4	
	Vertex	8	12.5	4	10.5	3	20.0	2	18.2	
	Occipital	11	17.2	1	2.6	0	0.0	0	0.0	
	Nuchal	0	0.0	0	0.0	0	0.0	0	0.0	
	n.a.	1		0	0.0	0	0.0	1		

*P-values from chi-squared or Fisher exact test when appropriate.

BCC, basal cell carcinoma;SCC, squamous cell carcinoma; SK, seborrheic keratosis.

Table 4 Absolute numbers and frequency (in percentage) of dermoscopic patterns among non-melanocytic skin tumours. Numbers in brackets in column 6 refer to the cases of actinic keratoses included in the group of squamous cell carcinoma

Dermoscopic patterns	Histopathologic diagnosis							
	BCC (*n* = 62)		SK (*n* = 36)		SCC (*n* = 13)		Others (*n* = 10)	
	n	%	*n*	%	*n*	%	*n*	%
Criteria of BCC	53	85.5	1	2.8	1 (0)	7.7	2	20.0
Leaf-like structures	18	29.0	0	0.0	0	0.0	0	0.0
Blue-grey Ovoid/globular Structures	41	66.1	1	2.8	0	0.0	2	20.0
Spoke wheel	7	11.3	0	0.0	0	0.0	0	0.0
Arborizing	26	41.9	0	0.0	1 (0)	7.7	1	10.0
Ulceration	23	37.1	0	0.0	2 (0)	15.4	0	0.0
Multiple erosions	7	11.3	0	0.0	0	0.0	0	0.0
Criteria of SK	2	3.2	28	77.8	4 (2)	30.8	2	20.0
Multiple milia	1	1.6	17	47.2	1 (0)	7.7	1	10.0
Comedo-like Openings	1	1.6	22	61.1	0	0.0	0	0.0
Brain-like Structures	0	0.0	4	11.1	2 (1)	15.4	0	0.0
Sharp demarcation	0	0.0	2	5.6	1 (0)	7.7	0	0.0
Fingerprint/fat Fingers	0	0.0	5	13.9	0	0.0	1	10.0
Criteria of vascular tumour	0	0.0	0	0.0	0	0.0	3	30.0
Red-purple lacunas	0	0.0	0	0.0	0	0.0	3	30.0
Criteria overlapping with melanocytic tumour	10	16.1	19	52.8	4 (3)	30.8	1	10.0
Structureless blue	2	3.2	1	2.8	0	0.0	1	10.0
Blue-white veil	2	3.2	2	5.6	0	0.0	0	0.0
Regression	4	6.4	7	19.4	2 (2)	15.4	1	10.0
Blotches	5	8.1	5	13.9	1 (1)	7.7	0	0.0
Central	2	3.2	1	2.8	1 (1)	7.7	0	0.0
Irregular	3	4.8	4	11.1	0	0.0	0	0.0
Hypopigmentation	3	4.8	12	33.3	2 (1)	15.4	1	10.0
Central	0	0.0	1	2.8	0	0.0	0	0.0
Perifolllicular	0	0.0	4	11.1	0	0.0	0	0.0
Diffuse-multifocal	3	4.8	4	11.1	1 (0)	7.7	1	10.0
Eccentric	0	0.0	3	8.3	1 (1)	7.7	0	0.0
Unspecific	2	3.2	2	5.6	1 (1)	7.7	0	0.0

BCC, basal cell carcinoma; SCC, squamous cell carcinoma; SK, seborrheic keratosis.

highest concordances observed on blue nevi (88.9%), BCC (85.5%) and melanoma (81.7%). The specificity was 77.8% for SK and 74.4% for nevi. Melanoma was correctly diagnosed in 58/71 (81.7%). In five other cases, the diagnosis 'nevus to be excised' was made; thus, 63/71 (88.7%) of all melanomas in the study would have received appropriate management (Table 6).

Seven melanomas with a thickness of <1 mm were classified as regressing SK (including four cases of SK and three cases classified as other with a histopathologic diagnosis of lichen planus like keratosis) because of the presence of fingerprint-like structures (four cases; Fig. 7), few comedo-like openings (two cases), single milia-like cysts (one case) and large areas of regression (all seven cases). In addition, one melanoma was classified as pigmented AK. From a total of 78 nevi, including 12 histopathologically atypical nevi, 58 were correctly identified. The remaining 20 nevi were classified as melanoma in eight cases, blue nevus ($n = 4$), BCC ($n = 4$), SK ($n = 1$), and in three cases of nevi lacking significant pigmentation, SCC ($n = 2$) or other ($n = 1$) diagnosis was suggested.

Discussion

Our analysis of more than 300 melanocytic and non-melanocytic scalp tumours revealed significant differences between various skin tumours at this special body site with respect to their clinical and dermoscopic features. We paid particular attention to the features associated with scalp melanoma to establish criteria that may aid in the early diagnosis of this 'invisible' killer.[9]

Consistent with previous clinical studies, our results showed melanoma and non-melanoma skin cancer of the scalp to occur most frequently in bald men, in those aged over 65 years and in those with chronic sun-damage or history of skin cancer.[1–3,10,11] These data support the view that UV-irradiation plays a role in

Table 5 Prevalence of vessels among melanocytic and non-melanocytic tumours. Numbers in brackets in column 6 refer to the cases of actinic keratoses included in the group of squamous cell carcinoma

Dermoscopic vascular pattern	Non-melanocytic tumours							
	BCC (*n* = 62)		SK (*n* = 36)		SCC (*n* = 13)		Others (*n* = 10)	
	n	%	*N*	%	*n*	%	*n*	%
Vessels								
Comma-vessels	0	0.0	1	2.8	0	0.0	0	0.0
Linear irregular	2	3.2	0	0.0	5 (0)	38.5	2	20.0
Hairpin	2	3.2	5	13.9	1 (0)	7.7	1	10.0
Dotted	0	0.0	3	13.9	1 (0)	7.7	2	20.0
Arborizing	26	41.9	0	0.0	1 (0)	7.7	1	10.0
Dermoscopic vascular pattern	**Melanocytic skin tumours**							
	Nevi (*n* = 78)		Blue nevi (*n* = 27)		MM (*n* = 71)		MM-Mets (*n* = 13)	
	n	%	*n*	%	*n*	%	*n*	%
Vessels								
Comma	4	5.1	1	3.7	1	1.4	0	0.0
Linear irregular	5	6.4	8	29.6	3	4.2	1	7.7
Hairpin	1	1.3	1	3.7	2	2.8	0	0.0
Dotted	7	6.7	2	7.4	2	2.8	0	0.0
Arborizing	1	1.3	1	3.7	0	0.0	1	7.7

BCC, basal cell carcinoma; MM, melanoma; MM-Mets, melanoma metastases; SCC, squamous cell carcinoma;. SK, seborrheic keratosis.

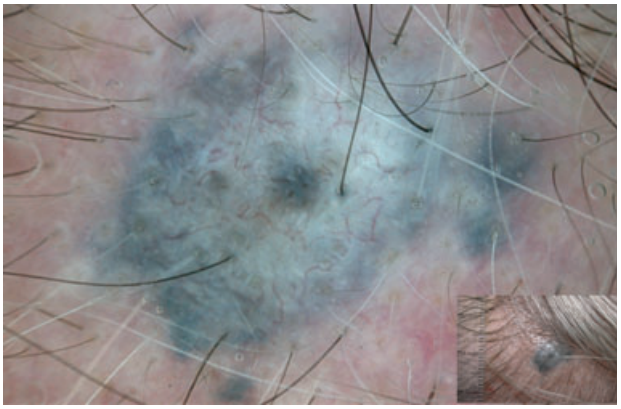

Figure 6 Clinical (inset) and dermoscopic image showing a blue nevus on the scalp. Diffuse, structureless blue and white areas and linear-irregular vessels are apparent.

the pathogenesis of skin cancer.[10,11] The relatively high incidence of melanoma among bald men is especially noteworthy given the hypothesis that the poor prognosis of scalp melanoma might be a consequence of delayed detection due to concealment of the lesion from hair coverage, rather than a consequence of a more rapid change from horizontal to vertical growth of scalp melanoma compared with melanoma on other body sites.[3,9,10] However, 56 of 75 melanomas (74.7%) in our series had a diameter >2 cm. It remains, therefore, to be determined whether these lesions perhaps represent a subset of melanomas that can grow horizontally for several years before acquiring the potential to invade the dermis, as recently proposed.[12–14]

In contrast to melanoma, most of the melanocytic nevi of the scalp occurred in the youngest age group in our series (i.e. less than 30 years). Melanocytic nevi were not significantly associated with androgenetic alopecia or with sun-damage. Similar observations were made in an earlier study investigating the prevalence and distribution of scalp nevi in a large cohort of individuals, suggesting that sun exposure plays a negligible role in development of these nevi.[15]

Besides these epidemiological differences, nevi and melanomas on the scalp showed striking differences in dermoscopic patterns. The two most common dermoscopic features of non-blue nevi were globular patterns and network patterns. Network patterns were frequently associated with central hypopigmentation (i.e. eclipse nevus; Fig. 2a) or perifollicular hypopigmentation (Fig. 2b).

Eclipse nevi on the scalp often appear in children and teenagers,[16,17] although some scalp nevi in teenagers reveal atypical histopathological features.[4,5] Eclipse nevi have been associated with a greater than average total nevus count, a condition that is a strong risk factor for cutaneous melanoma in adulthood.[18] Both eclipse nevi and nevi with perifollicular hypopigmentation on the scalp are benign lesions, with no documented risk of progression and can be conservatively managed, particularly when detected in children or teenagers.[17,18] However, because scalp nevi in children or teenagers may indicate a tendency to develop multiple nevi, we suggest performing regular total body skin examinations of those individuals.[15,18–20]

Table 6 Diagnostic concordance between the dermoscopic and histopathologic diagnosis of scalp tumours

Dermoscopic diagnosis	Histopathological diagnosis								
	Blue nevus	Nevus	MM	MM-Mets	BCC	SK	SCC	Other	Total
Blue nevus	2 8.9	4 5.1	0 0.0	3 22.1	2 3.2	1 2.8	0 0.0	1 10.0	35 11.3
Nevus	1 3.7	58 74.4	5 7.0	3 23.1	0 0.0	2 5.6	0 0.0	0 0.0	69 22.3
MM	1 3.7	8 10.3	58 81.7	5 38.7	6 9.7	2 5.6	0 0.0	1 10.0	81 26.1
BCC	1 3.7	4 5.1	0 0.0	2 15.4	53 85.5	1 2.8	0 0.0	2 20.0	63 20.3
SK	0 0.0	1 1.3	4 5.6	0 0.0	1 1.6	28 77.8	1 7.7	1 10.0	36 11.6
SCC	0 0.0	1 1.3	1 1.4	0 0.0	0 0.0	1 2.8	11 84.6	0 0.0	14 4.5
Other	0 0.0	2 2.6	3* 4.2	0 0.0	0 0.0	1 2.8	1 7.7	5 50.0	12 3.9
Total	27 100	78 100	71 100	13 100	62 100	36 100	13 100	10 100	310 100

*Refers to three cases of lichen planus like keratosis.

BCC, basal cell carcinoma; MM, melanoma; MM-Mets, melanoma metastases; SCC, squamous cell carcinoma; SK, seborrheic keratosis.

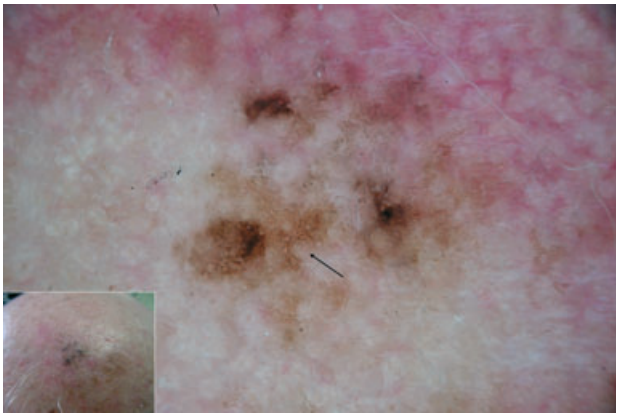

Figure 7 Dermoscopic image of an early invasive melanoma (tumour thickness < 0.3 mm) located on the vertex of the bald scalp misclassified as regressing seborrheic keratosis because of the presence of fingerprint-like structures (arrow), moth eaten border and large areas of regression.

Approximately one-fourth of all nevi in this study (27 of 105; 25.7%) were blue nevi. Most of them (89%) revealed a structureless blue pigmentation by dermoscopy. Approximately half of the blue nevi in this study (13 of 27; 48.2%) showed additional areas of hypopigmentation. Although such patterns are well-established features of blue nevi,[21] we also noted a high frequency (eight of 27; 29.6%) of atypical vascular pattern (i.e. linear-irregular vessels) among our sample of blue nevi of the scalp (Fig. 6).

Structureless blue-white pigmentation and atypical vessels as seen in our series of scalp blue nevi may be also the only dermoscopic features of thick nodular melanoma and cutaneous metastases.[22,23] Unlike blue nevi, advanced melanomas are characterized by rapid growth; consequently, diagnosis of blue nevus should be confirmed by a 'convincing' subjective history of an unchanged, stable lesion.[23] However, patients are often unaware of scalp tumours and may be unable to provide a reliable history. In such cases, blue lesions or changing nodular lesions should be excised immediately, regardless of the patient's age. Monitoring the lesion is not a reasonable option, as a diagnostic delay of even a few months may potentially worsen the prognosis of a rapidly growing melanoma.[24] A subtle clue for advanced melanoma might be the presence of irregular black blotches or dots over a blue background; in 26 of 27 blue nevi in this study, this feature was absent (Figs 5 and 6).

Although thick melanomas often displayed unspecific patterns, dermoscopy of thin melanomas revealed melanoma-specific criteria such as atypical pseudonetwork or atypical network pattern (Fig. 4), as reported previously.[25,26] Many of the thin (≤1 mm) melanomas in this study (32 of 49; 65.3%) revealed also areas of regression or diffuse hypopigmentation; by contrast, areas of regression were seen in only four of 105 nevi (3.8%) in this study.

Scalp tumours showing areas of regression should be biopsied even in the absence of melanoma-specific criteria. This recommendation is supported by the finding that seven melanomas in this study were misclassified as regressing SK (Fig. 7). As it can be difficult to distinguish regressing melanoma from regressing SK or pigmented AK,[24,27–30] we suggest performing a biopsy to confirm the diagnosis of melanoma before complete excision, especially for large, flat scalp tumours. This approach should avoid over-treatment of otherwise benign scalp tumours.

Finally, our evaluation of BCCs, SKs and angiomas suggests that their dermoscopic patterns do not differ significantly from the

patterns in those types of lesions appearing on the trunk. Thus, established criteria should allow their diagnosis with confidence.[7] The vascular patterns associated with SCC in our study highlight the general management rule to excise non-pigmented tumours showing dotted or linear-irregular vessels.[22,31,32]

This study has limitations, the most evident being the inclusion of large tumours that are only partially documented. Although multiple dermoscopic images showing different areas of the tumour were submitted for most large tumours, we cannot guarantee that all parts of the tumour were documented. Another limitation is that we evaluated only a small subset of non-pigmented tumours ($n = 45$) and cannot make definitive conclusions from such a small sample. Furthermore, as all lesions in this study were excised in routine clinical practice, it is likely that our sample is over-represented by clinically equivocal lesions.

Given the unfavourable prognosis of scalp melanoma, early detection and prompt treatment appear to be the best approach for improving the survival of patients with scalp melanoma. Particularly for adult men, a full body examination including an inspection of the scalp should be performed during general dermatologic visits.

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