BJD
British Journal of Dermatology

Dermoscopy of pyogenic granuloma: a morphological study

P. Zaballos, M. Carulla,* F. Ozdemir,† I. Zalaudek,‡ J. Bañuls,§ Á. Llambrich,¶ S. Puig,** G. Argenziano†† and J. Malvehy**

*Departments of Dermatology and *Epidemiology, Hospital Sant Pau i Santa Tecla, 43003 Tarragona, Spain*
†Department of Dermatology, Ege University Medical Faculty, Izmir, Turkey
‡Department of Dermatology, Medical University of Graz, Graz, Austria
§Department of Dermatology, Hospital Universitario de Alicante, Alicante, Spain
¶Department of Dermatology, Hospital de Son Llatzer, Palma de Mallorca, Spain
***Department of Dermatology, Hospital Clinic of Barcelona, Barcelona, Spain*
††Department of Dermatology, Second University of Naples, Naples, Italy

Summary

Background Pyogenic granuloma is a common, benign, vascular lesion of the skin and mucous membranes which is a simulator of amelanotic/hypomelanotic melanoma and other tumours.

Objectives To determine the diagnostic significance of dermoscopic structures and patterns associated with pyogenic granulomas in a large series of cases.

Methods Digital dermoscopic images of histopathologically proven cases of 122 pyogenic granulomas and 140 other tumours (28 amelanotic melanomas, seven melanoma metastases, 22 basal cell carcinomas and 83 other tumours) were collected from university hospitals in Spain, Italy, Austria and Turkey. The frequency, sensitivity, specificity, positive predictive value, negative predictive value, intraobserver agreement and interobserver agreement of the dermoscopic structures and patterns associated with pyogenic granulomas were calculated.

Results Vascular structures were observed in 45% of pyogenic granulomas (sensitivity of 45·1% and specificity of 17·9%; both $P < 0·001$). Seven exclusive patterns were made up from the combination of the structures 'reddish homogeneous area' (RHA), 'white collarette' (WC), 'white rail lines' (WRL) and 'vascular structures' (VS). The pattern composed of RHA, WC and WRL showed the highest sensitivity (22·1%; $P < 0·001$) and a specificity of 100% ($P < 0·001$) for pyogenic granulomas. Two other patterns (RHA + WC and RHA + WC + WRL + VS) showed 100% specificity when compared with melanoma ($P < 0·001$ and $P < 0·05$, respectively).

Conclusions Even though some dermoscopic patterns are useful in the recognition of pyogenic granulomas, dermoscopy is not a substitute for histology, mostly when vessels are present, as melanoma cannot be ruled out.

Correspondence
Pedro Zaballos Diego.
E-mail: pzaballos@aedv.es

Accepted for publication
3 September 2010

Funding sources
None.

Conflicts of interest
None declared.

DOI 10.1111/j.1365-2133.2010.10040.x

Pyogenic granuloma is a common, benign, acquired, vascular lesion of the skin and mucous membranes. It usually presents as a solitary, rapidly growing, papule or polyp that bleeds easily after minor trauma. Pyogenic granuloma mainly affects the fingers, hands, face, lips and oral mucous membranes although it has been described at all parts of the skin and mucous membranes.[1–3] In most cases, patient history and clinical appearance provide adequate information to make the correct preoperative diagnosis; however, there are common benign and malignant tumours that may be clinically confused with pyogenic granuloma.[1–5] In 38% of one case series,[5] the clinical diagnosis of pyogenic granuloma proved to be wrong. Misdiagnoses documented in the medical literature include keratoacanthoma, squamous cell carcinoma, basal cell carcinoma, inflamed seborrhoeic keratosis, common wart, melanocytic naevus, Spitz naevus, amelanotic melanoma, metastatic carcinoma, Kaposi sarcoma and true haemangioma.[1–6]

Dermoscopy is a noninvasive technique which has greatly improved the diagnostic accuracy of pigmented and vascular skin lesions. However, apart from sporadic case reports,[7] analysis of the dermoscopic features of pyogenic granulomas has

been performed in only one case series in a previous study that included a relatively small number of patients.[8] As pyogenic granuloma is a frequent benign tumour that may mimic other skin tumours including amelanotic malignant melanoma, the precise definition of the dermoscopic findings and patterns for this lesion is of major interest.

The aim of this study was to analyse the dermoscopic features and patterns of pyogenic granulomas in a large series of cases.

Materials and methods

Dermoscopic images of 122 histopathologically proven cases of pyogenic granuloma, collected at pigmented lesion clinics in Spain, Italy, Austria and Turkey, were evaluated for the presence of dermoscopic features. Dermoscopic images of each lesion were obtained using DermLite Foto (3Gen, LLC, Dana Point, CA, U.S.A.) mounted on a digital camera or Dermaphot (Heine Optotechnik, Herrsching, Germany), at 10-fold magnification. No pressure was used, to avoid the collapse of the vessels seen in the lesion. Clinical data were obtained for each patient, including age, sex and anatomical location. The lesions were obtained from 72 women (59%) and 50 men (41%), age range 10–76 years (median 32·1). Fifty-nine of 122 lesions were located on the upper extremities (48%), mainly on the fingers, 31 on the trunk (25%), 21 on the head or neck (17%) and 11 on the lower extremities (9%). A list of dermoscopic criteria established by the Consensus Net Meeting on Dermoscopy,[9] used in the study of vascular structures described by Argenziano *et al.*[10] and used in the dermoscopic description of pyogenic granulomas performed in some case series,[7,8] was evaluated by one of the contributing investigators experienced in dermoscopy (P.Z.). These criteria and their frequency in pyogenic granulomas are shown in Table 1. The dermoscopic structures most commonly found in pyogenic granulomas were used to build up seven global exclusive patterns (Fig. 1) and all pyogenic granulomas were evaluated for the presence of these patterns (Table 1).

In the second part of the study, dermoscopic images of 140 reddish or pinkish tumours that may be included in the differential diagnoses of pyogenic granulomas were similarly obtained and evaluated for the presence of the same dermoscopic structures and patterns seen in pyogenic granulomas. These 140 lesions comprised 28 amelanotic melanomas, seven melanoma metastases, 22 basal cell carcinomas, 38 vascular lesions (19 angiomas, three of them thrombosed ones, 11 solitary angiokeratomas and eight lesions of Kaposi sarcoma) and 45 other tumours (13 Spitz/Reed naevi, six clear cell acanthomas, four keratoacanthomas, three squamous cell carcinomas, three inflamed seborrhoeic keratoses, three pilomatrixomas, three cutaneous leishmaniases, two poromas, two skin metastases, two nodular hidradenomas, one glomangioma, one inverted follicular keratosis, one irritated intradermal naevus and one neurofibroma).

Based on these evaluations, we have determined the diagnostic significance of different dermoscopic structures and

Table 1 Frequencies of the dermoscopic structures and patterns in pyogenic granulomas and other tumours

	Pyogenic granulomas (n = 122), n (%)	Melanomas (n = 35), n (%)	Basal cell carcinomas (n = 22), n (%)	Other vascular lesions (n = 38), n (%)	Other nonvascular lesions (n = 45), n (%)
Reddish homogeneous area	118 (97)	31 (89)	11 (50)	22 (58)	24 (53)
White collarette	90 (74)	4 (11)	1 (5)	4 (11)	4 (9)
White rail lines	55 (45)	8 (23)	3 (14)	13 (34)	2 (4)
Ulceration	56 (46)	23 (66)	9 (41)	9 (24)	16 (36)
Vascular structures	55 (45)	35 (100)	22 (100)	13 (34)	45 (100)
Dotted vessels	13 (11)	23 (66)	3 (14)	2 (5)	20 (44)
Comma vessels	0	1 (3)	0	0	1 (2)
Hairpin vessels	12 (10)	16 (46)	3 (14)	2 (5)	13 (29)
Glomerular vessels	0	0	0	0	8 (18)
Telangiectasias	15 (12)	1 (3)	15 (68)	0	1 (2)
Linear-irregular vessels	38 (31)	29 (83)	9 (41)	12 (32)	27 (60)
Polymorphous/atypical vessels	16 (13)	30 (86)	9 (41)	5 (13)	25 (56)
Patterns					
P1 (RHA and WC)	23 (19)	0	0	1 (3)	0
P2 (RHA and WRL)	7 (6)	0	0	2 (5)	0
P3 (RHA and VS)	11 (9)	19 (54)	8 (36)	8 (21)	21 (47)
P4 (RHA, WC and WRL)	27 (22)	0	0	0	0
P5 (RHA, WC and VS)	23 (19)	4 (11)	0	2 (5)	1 (2)
P6 (RHA, WRL and VS)	7 (6)	8 (23)	2 (9)	2 (5)	2 (4)
P7 (RHA, WC, WRL and VS)	14 (11)	0	1 (5)	1 (3)	0

RHA, reddish homogeneous area, WC, white collarette; WRL, white rail lines; VS, vascular structures.

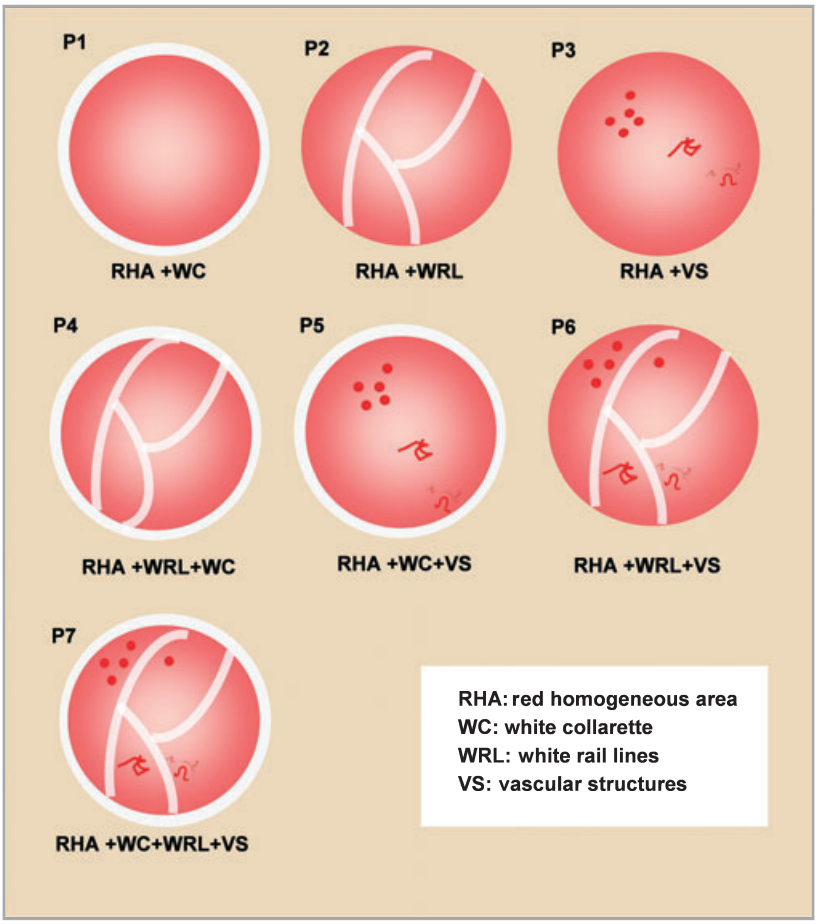

Fig 1. Schematics of the exclusive dermoscopic patterns in pyogenic granulomas. Pattern P1, pyogenic granulomas with reddish homogeneous area and white collarete; P2, reddish homogeneous area and white rail lines; P3, reddish homogeneous area and vascular structures; P4, reddish homogeneous area, white collarette and white rail lines; P5, reddish homogeneous area, white collarette and vascular structures; P6, reddish homogeneous area, white rail lines and vascular structures; P7, reddish homogeneous area, white collarette, white rail lines and vascular structures.

patterns associated with pyogenic granulomas. Criteria for calculating diagnostic variables of each dermoscopic structure or pattern in pyogenic granulomas were defined as follows: true positive (TP) lesions were pyogenic granulomas showing the dermoscopic structure or pattern being tested, true negative (TN) lesions were nonpyogenic granulomas where the dermoscopic structure or pattern was not detected, false negative (FN) lesions were pyogenic granulomas not showing the dermoscopic structure or pattern being tested, and false positive (FP) lesions were nonpyogenic granulomas but which revealed the dermoscopic structure or pattern being tested. Sensitivity was the fraction of pyogenic granuloma lesions showing the dermoscopic structure or pattern under investigation among all lesions of pyogenic granuloma and was calculated as TP/(TP + FN). Specificity was the fraction of lesions other than pyogenic granulomas not showing the dermoscopic structure or pattern among all nonpyogenic granuloma lesions and was calculated as TN/(TN + FP). The positive predictive value (PPV) was the fraction of pyogenic granuloma lesions showing the dermoscopic structure or pattern among all lesions showing that dermoscopic structure or pattern and was calculated as TP/(TP + FP). The negative predictive value (NPV) was the fraction of nonpyogenic granuloma lesions not showing the dermoscopic structure or pattern among all lesions not showing that dermoscopic structure or pattern and was calculated as TN/(TN + FN). Data analysis was performed using the SPSS statistical software, version 17.0 (SPSS Inc., Chicago, IL, U.S.A.) for data management, giving 2×2 contingency tables, and the differences were analysed by the χ^2 test or Fisher's exact test.

All the lesions in this study were evaluated for the presence of dermoscopic structures and patterns by one of the contributing authors (P.Z.). The interobserver and intraobserver reproducibility were assessed for each dermoscopic structure and pattern evaluated for 30 lesions, randomly selected from the 262 included in the study. Regarding intraobserver reproducibility, one observer (P.Z.) evaluated each structure and pattern and re-evaluated them 3 months later. Regarding interobserver reproducibility, two experienced observers (I.Z., F.O.) evaluated the same lesions as evaluated by P.Z. and the results were compared. Data analysis was performed using the SPSS statistical software, version 17.0 for data management. Reproducibility was assessed using kappa statistics (κ) with approximate significance. With regard to the interpretation of κ values, a value of 1 indicates perfect agreement, values $> 0{\cdot}8$ are considered excellent, values between 0·6 and 0·8 are good, values between 0·4 and 0·6 are fair and values $< 0{\cdot}4$ are poor.

The study protocol was approved by the Local Research Ethics Committee of the Hospital Universitari de Sant Joan/Faculty of Medicine, Reus, Spain. All participants gave oral informed consent.

Results

A careful dermoscopic examination of the pyogenic granulomas allowed the observation of the following features: (i) 'reddish or red-whitish homogeneous area', a structureless zone whose colour varied from completely red to red with whitish zones, was present in the majority of the lesion in 118 of 122 pyogenic granulomas (97%); (ii) 'white collarette', a ring-shaped or arcuate squamous structure that is usually located at the periphery of the lesions, was identified at the periphery of 90 of 122 pyogenic granulomas (74%); (iii) 'white rail' lines, white streaks that intersect the lesion, were observed in 55 of 122 pyogenic granulomas (45%); (iv) 'ulceration' was present in 56 of 122 pyogenic granulomas (46%); and (v) 'vascular structures' were observed in 55 of 122 lesions (45%). The breakdown of vascular structures is shown in Table 1. We found linear-irregular vessels in 38 (31%) cases and polymorphous/atypical vessels in 16 (13%) cases. In all the pyogenic granulomas included in the study, specific criteria for melanocytic or nonmelanocytic tumours previously described in the literature[8] were absent except for the presence of lacunae in six cases (5%), blue homogeneous area in six cases (5%) and remnants of pigment in one case (1%). From the combination of the dermoscopic structures 'reddish homogeneous area' (RHA), present in all patterns because it is the most common structure, 'white collarette' (WC), 'white rail lines' (WRL) and 'vascular structures' (VS), we built up seven exclusive patterns (Fig. 1): pattern 1 (RHA and WC), pattern 2 (RHA and WRL), pattern 3 (RHA and VS), pattern 4 (RHA, WC and WRL), pattern 5 (RHA, WC and VS), pattern 6 (RHA, WRL and VS) and pattern 7 (RHA, WC, WRL and VS). We ruled out the structure 'ulceration' because it was present in < 50% of pyogenic granulomas and is a common structure in other tumours such as melanomas and basal cell carcinomas. Frequency of patterns and schematics illustrating these findings are seen in Figure 1 and Table 1. The three most common patterns found were, in order of frequency, pattern 4 (22% of pyogenic granulomas) and patterns 1 and 5 (19% of cases each).

Concerning the other cutaneous tumours (Table 1), 'reddish homogeneous area', 'ulceration' and 'vascular structures' were observed relatively frequently, above all in melanomas (89%, 66% and 100%, respectively) and basal cell carcinomas (50%, 41% and 100%, respectively). The other two structures ('white collarette' and 'white rail lines') were found less frequently (11% and 23% in melanomas; 5% and 14% in basal cell carcinomas, respectively). Concerning the dermoscopic patterns, pattern 4 was observed only in pyogenic granulomas, patterns 1 and 2 were also seen in other vascular lesions (3% and 5%, respectively), pattern 7 was also found in 5% of basal cell carcinomas and in 3% of other vascular lesions, and patterns 3, 5 and 6 were observed relatively frequently in other tumours.

Table 2 summarizes the statistical analysis including sensitivity, specificity (including specificities of pyogenic granuloma in reference to amelanotic melanoma and basal cell carcinoma), PPV and NPV, intraobserver agreement (κ intra) and interobserver agreement (κ inter) for pyogenic granulomas. Important dermoscopic findings related to structures and patterns, as follows.

Structures

The structure 'reddish homogeneous area' exhibited the highest sensitivity (96·7%; $P < 0·001$) but showed low specificity.

Table 2 Diagnostic significance and reproducibility of dermoscopic structures and patterns in pyogenic granulomas*

Structures and patterns	Sensitivity, %	Specificity, %	S (MM), %	S (BCC), %	PPV, %	NPV, %	κ intra	κ inter
Reddish homogeneous area	96·7	37·1	11·4‡	50	57·3	92·9	1·00	1·00
White collarette	73·8	90·7	88·6	95·5	87·4	79·8	0·81	0·67
White rail lines	45·1	81·4	77·1†	86·4	67·9	62·9	0·93	0·61
Ulceration	45·9‡	59·3‡	34·2‡	59·1‡	49·5‡	55·7‡	0·93	0·73
Vascular structures	45·1	17·9	0	0	32·4	27·2	0·79	0·67
P1 (RHA and WC)	18·9	99·3	100	100†	95·9	58·4	0·78	0·84
P2 (RHA and WRL)	5·7	98·6	100‡	100‡	77·8	54·6	0·65	0·00‡
P3 (RHA and VS)	9·1	60	45·7	63·6	16·4	43·1	0·78	0·00‡
P4 (RHA, WC and WRL)	22·1	100	100	100	100	59·6	0·79	0·66
P5 (RHA, WC and VS)	18·9	95	88·6‡	100	76·7	57·3	1·00	0·64
P6 (RHA, WRL and VS)	5·7‡	90‡	77·1	90·9‡	33·3‡	52·3‡	0·65	0·00‡
P7 (RHA, WC, WRL and VS)	11·5	98·6	100†	95·5‡	87·5	56·1	0·67	0·54

S (MM), specificity of pyogenic granulomas in reference to melanoma; S (BCC), specificity of pyogenic granulomas in reference to basal cell carcinoma; PPV, positive predictive value; NPV, negative predictive value; κ intra, intraobserver agreement; κ inter, interobserver agreement; RHA, reddish homogeneous area, WC, white collarette; WRL, white rail lines; VS, vascular structures. *$P < 0·01$ for all comparisons except †$P < 0·05$ and ‡not significant.

This structure showed an NPV of 92·9% ($P < 0·001$) and a PPV of 57·3% ($P < 0·001$). The intraobserver and interobserver agreement was perfect ($\kappa = 1$; $P < 0·001$).

The structure 'white collarette' showed a high specificity (90·7%; $P < 0·001$) but a sensitivity of 73·8% ($P < 0·001$). This structure exhibited specificities of 88·6% and 95·5% compared with melanoma and basal cell carcinoma, respectively ($P < 0·01$ for both). It showed a PPV of 87·4% ($P < 0·001$) and an NPV of 79·8% ($P < 0·001$). The intraobserver agreement was excellent ($\kappa = 0·81$; $P < 0·001$) and interobserver agreement was good ($\kappa = 0·67$; $P < 0·001$).

The structure 'white rail lines' showed a good specificity (81·4%; $P < 0·001$) and a low sensitivity (45·1%; $P < 0·001$). The specificities compared with melanoma (77·1%; $P < 0·05$) and basal cell carcinoma (86·4%; $P < 0·001$) were lower than those shown by the structure 'white collarette'. The data on PPV and NPV were not relevant. The intraobserver agreement was excellent ($\kappa = 0·93$; $P < 0·001$) and interobserver agreement was good ($\kappa = 0·61$; $P < 0·001$).

The dermoscopic criteria 'ulceration' and 'vascular structures' exhibited low sensitivity, specificity, PPV and NPV.

Patterns

Pattern 4 (RHA + WC + WRL) (Fig. 2) showed the highest sensitivity (22·1%; $P < 0·001$) and a specificity of 100% ($P < 0·001$). This pattern exhibited specificities of 100% ($P < 0·001$) when compared with the two malignant tumours (amelanotic melanoma and basal cell carcinoma) and a PPV of 100% ($P < 0·001$). The intraobserver agreement was good ($\kappa = 0·79$; $P < 0·001$) and interobserver agreement was also good ($\kappa = 0·66$; $P < 0·001$).

Pattern 1 (RHA + WC) (Fig. 3) showed a sensitivity of 18·9% ($P < 0·001$) and a specificity of 99·3% ($P < 0·001$), with a specificity of 100% when compared with the two malignant tumours [melanoma ($P < 0·001$) and basal cell carcinoma ($P < 0·05$)]. It showed a PPV of 95·9% ($P < 0·001$). The intraobserver agreement was good ($\kappa = 0·78$; $P < 0·001$) and interobserver agreement was excellent ($\kappa = 0·84$; $P < 0·001$).

Pattern 7 (RHA + WC + WRL + VS) (Fig. 4) exhibited a low sensitivity (11·5%; $P < 0·001$) and a high specificity (98·6%; $P < 0·001$) with a specificity of 100% ($P < 0·05$) when compared with melanoma. It showed a PPV of 87·5% ($P < 0·001$). The intraobserver agreement was good ($\kappa = 0·67$; $P < 0·001$) and interobserver agreement was fair ($\kappa = 0·54$; $P < 0·001$).

The other four patterns (Fig. 5) showed lower sensitivity and specificity or nonsignificant data.

Of the pyogenic granulomas 92% showed one of the seven described dermoscopic patterns. The remaining 8% of cases presented none of the previous patterns and were considered unclassified. It is important to emphasize those cases with bluish homogeneous structures that may be clinically and dermoscopically misdiagnosed as melanomas which were observed in 5% of cases (Fig. 6).

Discussion

None of the dermoscopic structures evaluated in the study was demonstrated to be 100% specific for pyogenic granulomas as an isolated criterion. A 'reddish homogeneous area', a homogeneous zone whose colour varied from completely red to red with whitish zones, was present in the majority of the

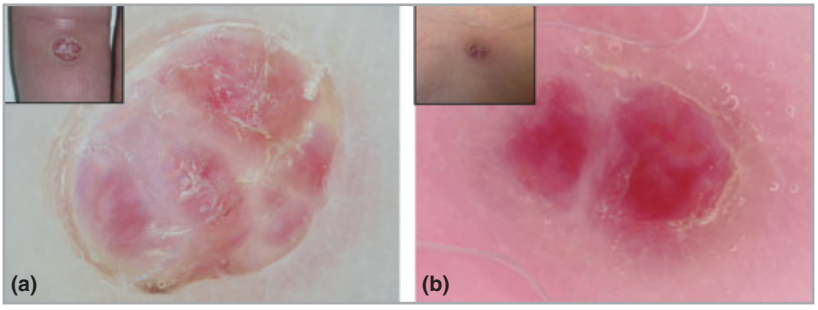

Fig 2. Pattern composed of the presence of reddish homogeneous area, white collarette and white rail lines and the absence of vascular structures (Pattern 4 in Fig. 1) (DermLite Foto; 3Gen, LLC; original magnification × 10). (a) Pyogenic granuloma located on the finger of an 18-year-old man. (b) Pyogenic granuloma located on the palm of the hand of a 24-year-old woman.

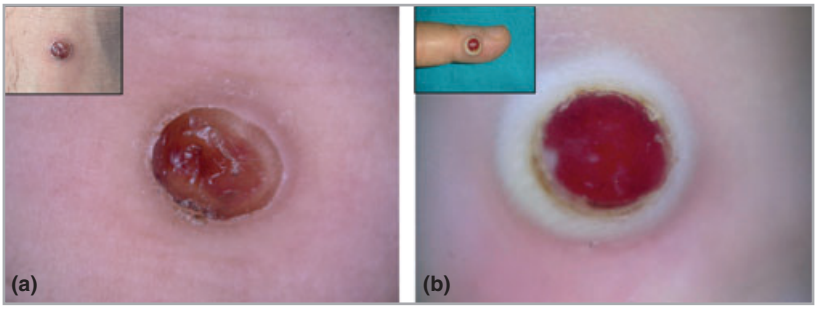

Fig 3. Pattern composed of the presence of reddish homogeneous area and white collarette and the absence of white rail lines and vascular structures (Pattern 1 in Fig. 1) (DermLite Foto; 3Gen, LLC; original magnification × 10). (a) Pyogenic granuloma located on the leg of a 53-year-old man. (b) Pyogenic granuloma located on a finger of a 30-year-old woman.

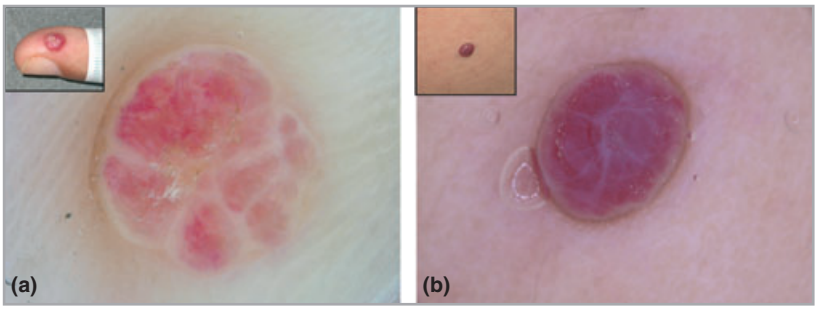

Fig 4. Pattern composed of the presence of reddish homogeneous area, white collarette, white rail lines and vascular structures (Pattern 7 in Fig. 1) (DermLite Foto; 3Gen, LLC; original magnification × 10). (a) Pyogenic granuloma located on the finger of a 21-year-old man. (b) Pyogenic granuloma located on the back of a 31-year-old man.

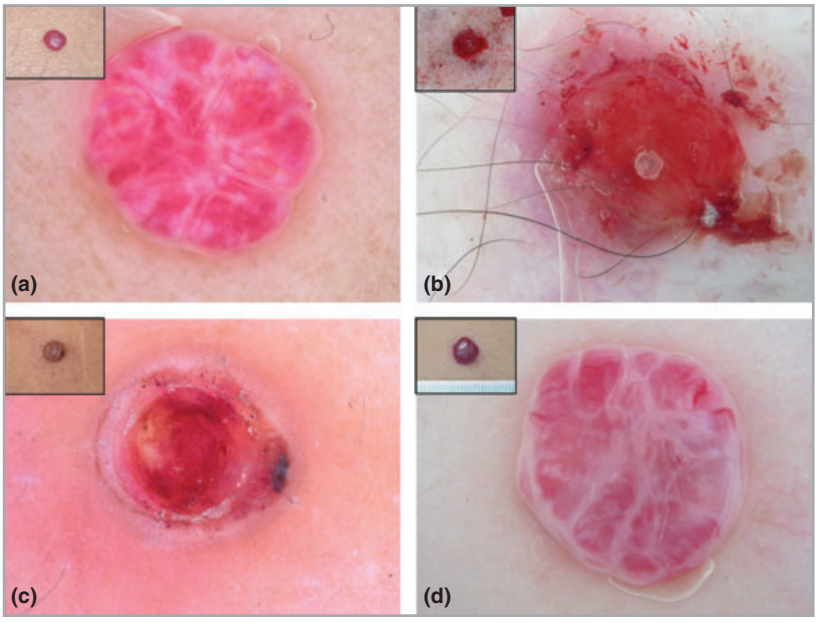

Fig 5. The remaining dermoscopic patterns of pyogenic granulomas. (a) Pyogenic granuloma dermoscopically composed of reddish homogeneous area and white rail lines (Pattern 2 in Fig. 1) located on the arm of a 29-year-old man; (b) pyogenic granuloma composed of reddish homogeneous area and vascular structures (Pattern 3 in Fig. 1) located on the thorax of a 15-year-old boy; (c) reddish homogeneous area, white collarette and vascular structures (Pattern 5 in Fig. 1) in a pyogenic granuloma located on the leg of a 35-year-old woman; (d) pyogenic granuloma located on the back of a 22-year-old woman which shows reddish homogeneous area, white rail lines and vascular structures (Pattern 6 in Fig. 1) (DermLite Foto; 3Gen, LLC; original magnification × 10).

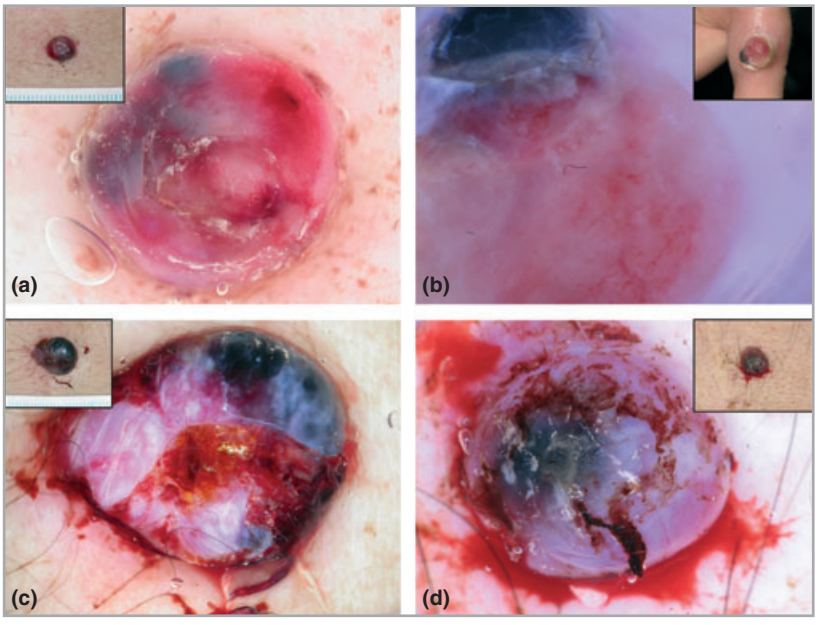

Fig 6. Atypical cases of pyogenic granulomas which show blue homogeneous areas under dermoscopy. (a) Pyogenic granuloma located on the back of a 35-year-old man; (b) pyogenic granuloma located on the finger of a 50-year-old woman; (c) pyogenic granuloma located on the thorax of a 18-year-old man; (d) pyogenic granuloma located on the thorax of a 79-year-old man (DermLite Foto; 3Gen, LLC; original magnification × 10).

lesions.[7,8] The histopathological correlation of the reddish homogeneous area may be attributed to the presence of numerous small capillaries or proliferating vessels that are set in a myxoid stroma of pyogenic granulomas. This was demonstrated to be the most frequent dermoscopic structure associated with pyogenic granulomas (96·7% sensitivity and 92·9% NPV). However, it is a nonspecific structure for pyogenic granuloma because it is commonly found in other tumours, especially amelanotic melanomas (89% of cases). Pizzichetta *et al.*[11] found a similar structure, called milky red areas, in 93% of thick amelanotic/hypomelanotic melanomas. Milky red areas exhibited a 71·2% specificity for amelanotic/hypomelanotic melanomas in the study of Menzies *et al.*[12] and the odds ratio for melanoma was 2·5 ($P < 0·001$) for lesions with this structure.

The 'white collarette' is a ring-shaped or arcuate squamous structure that is usually located at the periphery of the lesions. It corresponds to the hyperplastic adnexal epithelium that partially or totally embraces the lesion at the periphery of most pyogenic granulomas.[8] The white collarette was demonstrated to be the most specific structure for pyogenic granulomas, with a 90·7% specificity. This structure also exhibited a 73·8% sensitivity and a 87·4% PPV for this vascular lesion. In the medical literature, it has been observed in pyogenic granulomas and clear cell acanthomas.[13] However, in our study it was also seen in other lesions including four amelanotic melanomas, one basal cell carcinoma, three Kaposi sarcomas, one solitary angiokeratoma and one Spitz naevus.

The 'white rail lines' are defined as whitish streaks or bands that intersect the pyogenic granulomas and may correspond histologically to the fibrous septa that surround the capillary tufts or lobules in more advanced cases.[8] These structures exhibited quite good specificity (81·4%) but low sensitivity, PPV and NPV for pyogenic granulomas. Agero *et al.*[14] and Zaballos *et al.*[15] observed similar structures in dermatofibromas and Bories *et al.*[16] observed similar structures in fully regressive melanomas when polarized contact dermoscopy was used, although the authors did not specify if these structures intersect the lesion or not. Anyway, we found these structures in 23% of amelanotic melanomas, 14% of basal cell carcinomas and 34% of other vascular lesions.

Pyogenic granulomas are frequently eroded and crusted, and may bleed very easily. This feature may explain the haemorrhagic crusts or ulceration that was seen in 46% of cases. As expected, the significance of this dermoscopic structure was very low because it is a relatively common finding in other tumours and it was not used in building up the patterns.

A surprising finding was the presence of vascular structures in 45% of pyogenic granulomas as Zaballos *et al.*[8] did not find vascular structures in the pyogenic granulomas of their series. The most common vascular structures seen in our cases, excluding reddish homogeneous area, were 'linear-irregular vessels' which were observed in 31% of pyogenic granulomas. In the study of Argenziano *et al.*,[10] linear-irregular vessels were the most common vascular structure observed in melanomas (33%) and showed a PPV for melanoma of 67·6%. Moreover, Argenziano *et al.* found that linear-irregular vessels exhibited 81·1% PPV for malignancy. It is important to note that Argenziano *et al.* included pigmented and nonpigmented lesions in their study. However, linear-irregular vessels were not found at a significantly different rate in melanomas vs. nonmelanoma lesions in the exhaustive study of Menzies *et al.*,[12] although they did not include any pyogenic granulomas in the group of nonmelanocytic lesions. Only the presence of 'linear irregular vessels as predominant vessel type' exhibited a specificity of 79·8% for amelanotic/hypomelanotic melanomas (odds ratio 2·1; $P = 0·002$) in the study of Menzies *et al.*[12] In our study, we observed linear-irregular vessels in 83% of papular or nodular amelanotic melanomas and melanoma metastases. The second most frequently observed vascular structures were polymorphous/atypical vessels (13% of pyogenic granulomas) which are defined as any combination of two or more different types of vascular structures. The most frequent combination in pyogenic granulomas was that of linear-irregular and dotted vessels (52%). Argenziano *et al.*[10] also observed this combination as the most frequent one in their series of melanocytic and nonmelanocytic skin tumours. Most importantly, Zalaudek *et al.*[6] found this combination as the most frequent dermoscopic finding in amelanotic and hypopigmented melanomas, especially when associated with a white to red veil that can be assimilated in the reddish homogeneous area of our study. Pizzichetta *et al.*[11] also found the combination of dotted and linear-irregular vessels to be the most common vascular pattern in thick amelanotic/hypomelanotic melanomas, observing this pattern in 27% of cases. This combination of vessels was significantly different among the nonmelanoma group compared with amelanotic/hypomelanotic melanomas in the study of Menzies *et al.*,[12] with a 84·7% specificity (odds ratio 2·3; $P = 0·001$) for melanoma. We found this combination in 61% of amelanotic melanomas of our series and in 43% of melanoma metastases. Dotted vessels are defined as tiny red dots densely aligned next to each other in a more or less regular fashion, and we observed this kind of vessel in 11% of pyogenic granulomas. In the study of Argenziano *et al.*,[10] dotted vessels showed a PPV for a melanocytic lesion of 90%, and the probability of a lesion with dotted vessels being a melanoma was 37·8%. Pizzichetta *et al.*[11] found dotted vessels in 20% of their thick amelanotic/hypomelanotic melanomas. However, in the study of Menzies *et al.*,[12] dotted vessels were not significantly different among the melanoma vs. the nonmelanoma group. Other types of vascular structures observed in pyogenic granulomas in our study were telangiectasias in 12% of cases and hairpin vessels, defined as vascular loops, sometimes twisted and bending, in 10%. Kreusch and Koch[17] observed this vascular structure in many lesions, mainly melanomas and Spitz naevi and, when surrounded by a whitish halo, in keratinizing tumours. However, in the study of Argenziano *et al.*,[10] hairpin vessels were not found

in any melanomas and were significantly associated with seborrhoeic keratosis (51%) and less frequently with squamous cell carcinoma (29%). However, Menzies *et al.*[12] found hairpin vessels as the second most positive predictor of melanoma, regarding vascular structures, with a 90·6% specificity (odds ratio 2·5; $P = 0·001$) for amelanotic/hypomelanotic melanoma. Finally, Menzies *et al.*[12] found the presence of predominant central vessels as the most positive vascular-related predictor of amelanotic/hypomelanotic melanoma, and we found this feature in only 5% of pyogenic granulomas with vascular structures (data not shown).

Regarding the patterns, the pattern composed of RHA, WC and WRL in the absence of VS has been demonstrated to be 100% specific for pyogenic granulomas. None of the lesions in the nonpyogenic granulomas group exhibited this pattern and therefore the specificity and PPV were 100% ($P < 0·001$). This pattern also showed the highest sensitivity (22·1%; $P < 0·001$) and good figures for intraobserver and interobserver agreement. Therefore this pattern has been demonstrated to be the most significant finding associated with pyogenic granulomas. The same pattern but without WRL showed a very high specificity (99·3%; $P < 0·001$) and PPV (95·9%; $P < 0·001$) for pyogenic granulomas and, most importantly, we did not find this pattern in any malignant tumour (melanoma, basal cell carcinoma or Kaposi sarcoma). The intraobserver and interobserver agreements for this pattern were good to excellent. Finally, the pattern composed of all structures (RHW, WC, WRL and VS) also exhibited an excellent specificity (98·6%; $P < 0·001$), with a specificity of 100% ($P < 0·05$) when compared with amelanotic/hypomelanotic melanoma. This is the only pattern with vascular structures that has been demonstrated to be quite specific for pyogenic granuloma in the study. These three patterns together add up to 52% of all pyogenic granulomas.

In conclusion, important messages to be gleaned from this series of cases are:

1 In our study, 52% of pyogenic granulomas showed one of three dermoscopic patterns which are not found in any amelanotic/hypomelanotic melanoma. These patterns are composed of RHA + WC + WRL − VS, RHA + WC − WRL − VS and RHA + WC + WRL + VS. The first pattern exhibited 100% specificity and PPV for pyogenic granulomas and was not found in other nonpyogenic granuloma lesions.

2 Be careful when vascular structures are observed in lesions clinically diagnosed as pyogenic granulomas. In our study, only in cases where we observed WC and WRL in the same tumour was the lesion not a melanoma. However, we found melanomas with WC or WRL, and a melanoma with all structures could be possible.

3 Dermoscopy has been shown to be a very useful tool to evaluate pyogenic granulomas. However, we are in favour of removing all pyogenic granulomas to study them histopathologically because this tumour is a simulator of amelanotic/hypomelanotic melanoma on clinical and dermoscopic examination.[18]

What's already known about this topic?

- The most common dermoscopic structures associated with pyogenic granulomas are reddish homogeneous area, white collarette, 'white rail' lines and ulceration.
- The presence of a red or red-whitish homogeneous area surrounded by a white collarette was the most frequent dermoscopic pattern in pyogenic granulomas.

What does this study add?

- The pattern composed of reddish homogeneous area, white collarette and white rail lines showed a specificity of 100% for pyogenic granulomas.
- The authors have found vascular structures in 45% of pyogenic granulomas.
- The presence of vascular structures in a red tumour resembling a pyogenic granuloma indicates that a melanoma should not be ruled out.

References

1 Mooney MA, Janninger CK. Pyogenic granuloma. *Cutis* 1995; **55**:133–6.

2 Pagliai KA, Cohen BA. Pyogenic granuloma in children. *Pediatr Dermatol* 2004; **21**:10–13.

3 Requena L, Sangueza OP. Cutaneous vascular proliferation. Part II. Hyperplasias and benign neoplasms. *J Am Acad Dermatol* 1997; **37**:887–919.

4 Elmets CA, Ceilley RI. Amelanotic melanoma as a pyogenic granuloma. *Cutis* 1980; **25**:164–7.

5 Rowe L. Granuloma pyogenicum. *AMA Arch Derm* 1958; **78**:341–7.

6 Zalaudek I, Argenziano G, Kerl H *et al.* Amelanotic/hypomelanotic melanoma – is dermoscopy useful for diagnosis? *J Dtsch Dermatol Ges* 2003; **1**:369–73.

7 Zaballos P, Salsench E, Puig S, Malvehy J. Dermoscopy of pyogenic granulomas. *Arch Dermatol* 2007; **143**:824.

8 Zaballos P, Llambrich A, Cuellar F *et al.* Dermoscopic findings in pyogenic granuloma. *Br J Dermatol* 2006; **154**:1108–11.

9 Argenziano G, Soyer HP, Chimenti S *et al.* Dermoscopy of pigmented skin lesions: results of a consensus meeting via the internet. *J Am Acad Dermatol* 2003; **48**:679–93.

10 Argenziano G, Zalaudek I, Corona R *et al.* Vascular structures in skin tumors. A dermoscopy study. *Arch Dermatol* 2004; **140**:1485–9.

11 Pizzichetta MA, Talamini R, Stanganelli I *et al.* Amelanotic/hypomelanotic melanoma: clinical and dermoscopic features. *Br J Dermatol* 2004; **150**:1117–24.

12 Menzies SW, Kreusch J, Byth K *et al.* Dermoscopic evaluation of amelanotic and hypomelanotic melanoma. *Arch Dermatol* 2008; **144**:1120–7.

13 Bugatti L, Filosa G, Broganelli P, Tomasini C. Psoriasis-like dermoscopic pattern of clear cell acanthoma. *J Eur Acad Dermatol Venereol* 2003; **17**:452–5.

14 Agero AL, Taliercio S, Disza SW *et al.* Conventional and polarized dermoscopy features of dermatofibroma. *Arch Dermatol* 2006; **142**:1431–7.

15 Zaballos P, Llambrich A, Ara M *et al.* Dermoscopic findings of haemosiderotic and aneurysmal dermatofibroma: report of six patients. *Br J Dermatol* 2006; **154**:244–50.
16 Bories N, Dalle S, Debardieux S *et al.* Dermoscopy of fully regressive cutaneous melanoma. *Br J Dermatol* 2008; **158**:1124–9.
17 Kreusch J, Koch F. Auflichmikroskopische Charakterisierung von Gefäßmustern in Hauttumoren. *Hautarzt* 1996; **47**:264–72.
18 Puig S, Argenziano G, Zalaudek I *et al.* Melanomas that failed dermoscopic detection: a combined clinicodermoscopic approach for not missing melanoma. *Dermatol Surg* 2007; **33**:1262–73.