Trichoscopic Signs in Dermatomyositis, Systemic Lupus Erythematosus, and Systemic Sclerosis: A Comparative Study of 150 Patients

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Keywords

Alopecia · Connective tissue diseases · Dermoscopy · Scleroderma · Systemic lupus erythematosus

Abstract

Background: Hair and scalp involvement is prevalent in connective tissue diseases (CTDs). Trichoscopic features may provide a diagnostic implementation and enable differentiation among CTDs; however, a direct comparison of these signs among CTD patients is lacking. **Objectives:** To compare trichoscopic findings in dermatomyositis (DM), systemic lupus erythematosus (SLE), and systemic sclerosis (SSc) as well as determine their distinctive features and associations with disease activity. **Methods:** Trichoscopic photographs were taken from DM, SLE, and SSc patients and further evaluated for hair shaft and scalp surface abnormalities. Data regarding patients' clinical manifestations, laboratory results, and disease activity were analyzed. **Results:** One hundred fifty participants, consisting of 30 DM, 60 SLE, and 60 SSc patients, were included. Perifollicular red-brown pigmentation, brown scattered pigmentation, and white patches were exclusive findings in DM, SLE, and SSc, respectively ($p < 0.001$). A multinomial logistic regression analysis revealed that DM demonstrated higher odds for having microaneurysmal blood vessels than SLE and SSc (odds ratio [OR] =

22.22, 95% confidence interval [CI] = 1.73–285.13, $p = 0.017$, and OR = 15.34, 95% CI = 1.36–177.59, $p = 0.029$, respectively). Polymorphic vessels forming a telangiectatic network suggested SSc over SLE (OR = 12.83, 95% CI = 1.35–121.98, $p = 0.026$), while avascular areas were more pronounced in SSc than DM and SLE (OR = 43.24, 95% CI = 5.17–361.67, $p = 0.001$, and OR = 0.03, 95% CI = 0.01–0.24, $p = 0.001$, respectively). In a quantile regression analysis, perifollicular red-brown pigmentation, reduction in hair diameter, and the absence of thin arborizing vessels were linked to higher disease activity in DM, SLE, and SSc, respectively (all $p < 0.05$). **Conclusions:** Trichoscopy is a valuable tool possessing diagnostic and prognostic values for CTDs. Specific trichoscopic features allow adequate distinction between DM, SLE, and SSc and may help identify active disease.

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Introduction

Hair and scalp changes are common in patients with connective tissue diseases (CTDs) and negatively impact the patients' quality of life, yet they remain largely unrecognized [1, 2]. Scalp abnormalities in dermatomyositis (DM) have variable frequency (28–82%), with scaly erythematous pruritic eruption being the most common

manifestation [3–7]. Alopecia in systemic lupus erythematosus (SLE) can be scarring or nonscarring with prevalence ranging from 17 to 85% [5, 8–11]. Localized scleroderma (e.g., morphea) involving the scalp has been well described; however, information on scalp abnormalities for the generalized form is sparse [1].

The distinction among CTDs can be difficult in patients with skin-predominant disease and has been anchored on the presence of pathognomonic features. However, widely recognized pathognomonic/characteristic cutaneous findings in DM, SLE, and systemic sclerosis (SSc) have been documented in approximately one third to three fourths of these cases [12–15]. Trichoscopy is a noninvasive device widely used on various hair and scalp disorders [16–18]. Trichoscopic abnormalities can be presented in CTD patients even without visible signs; therefore, information on their distinctive features may be of great value for those with a diagnostic dilemma.

Although trichoscopy may provide diagnostic clues for CTDs, only a few studies have exhibited this information [7, 19, 20]. A direct comparison of the trichoscopic findings among the most common CTDs, namely DM, SLE, and SSc, and their relations to the disease activity is lacking. This study aims to evaluate and compare trichoscopic findings among DM, SLE, and SSc patients without noticeable scalp lesions, as well as determine their association with the disease activity.

Materials and Methods

Study Design

This is a cross-sectional, analytic study approved by the Mahidol University Institutional Review Board for Ethics in Human Research (MURA2018/589). The study was conducted following the Helsinki Declaration, and written informed consent was obtained from patients before enrollment.

Study Participants

We enrolled patients from Rheumatology and Dermatology Clinics, Ramathibodi Hospital, Bangkok, Thailand. The inclusion criteria were patients aged ≥ 18 years with the diagnosis of DM according to the classification of Bohan and Peter [21] and/or Sontheimer [22] and/or the European League against Rheumatism (EULAR)/American College of Rheumatology (ACR) 2017 classification criteria for adult and juvenile idiopathic inflammatory myopathies [23], or SLE defined by the Systemic Lupus International Collaborating Clinics 2012 Criteria [24] and/or the EULAR/ACR 2019 criteria [25], or SSc as stated according to the ACR/EULAR 2013 classification criteria for SSc [26]. Exclusion criteria were overlapping autoimmune diseases, scarring alopecia, other hair and scalp disorders, systemic conditions or using medications affecting hair growth cycle/color, and hair dying in the past month.

Data Collection

Baseline patient characteristics (i.e., age, disease onset/duration, gender, cutaneous and extracutaneous manifestations) and laboratory results were recorded. The disease activity was assessed by using physician global activity, Cutaneous Assessment Tool-Binary Method (CAT-BM) activity score [27], and Manual Muscle Test (MMT) for DM [28]. The SLE Disease Activity Index 2000 (SLEDAI-2K) score was used for SLE [29], and the modified Rodnan Skin Score (mRSS) was applied for SSc [30].

We performed trichoscopic examination using a DermLite DL4 dermoscope (3Gen Inc., San Juan Capistrano, CA, USA) with minimal pressure, and photographs were taken from multiple areas of the scalp by one investigator. Trichoscopic evaluation was made on two aspects comprising the hair shaft and scalp surface. Hair shaft changes included decreased hair number (single-hair follicles $>20\%$ of follicles), decreased hair diameter (diameter diversity $>20\%$ of hair), and hair shaft hypopigmentation (hypopigmentation $\geq 20\%$ of hair) [7, 31]. Scalp changes comprising black dots, yellow dots, white dots, white patches, brown honeycomb pigmentation, brown scattered pigmentation, peripilar sign, follicular red dots, follicular red-brown pigmentation (red-brown macule around the hair follicle), and blue-gray pigmentation (speckled or target pattern), were noted. Scales were identified as perifollicular and/or interfollicular scales.

We further assessed for vascular abnormalities using a videodermoscope (Dino-Lite Pro; AnMo Electronics Corp., New Taipei City, Taiwan). Characteristics of arborizing vessels were described as thin arborizing blood vessels (vessel diameter thinner than that of terminal hair shafts), prominent arborizing blood vessels (thin vessels forming a vascular network), and thick arborizing blood vessels (vessel diameter larger than that of terminal hair shafts) [19, 32, 33]. Other distinctive vascular patterns, including microaneurysmal blood vessel (linear, serpentine, or tortuous dilated capillary with an ectatic portion resembling an aneurysm), dotted vessels, hairpin vessels, and polymorphic vessels forming a telangiectatic network (PVTN; different pattern of vessels forming a network of telangiectasia), were documented [20, 32]. Finally, avascular areas (whitish areas of fibrosis with the absence of blood vessels) were evaluated [20]. All trichoscopic photographs taken were assessed by one blinded hair specialist.

Statistical Analysis

Data analyses were performed using Stata 14.0 (Stata Corp. LLC, College Station, TX, USA). The sample size was estimated based on data from previous studies regarding trichoscopy of CTDs, and a minimum of 26 subjects per group was required [7, 19, 20]. Categorical variables were expressed as counts and percentages. Continuous variables were demonstrated in mean $\pm$ standard deviation (SD) or median (interquartile range, IQR). Analysis of variance, χ^2 , and Fisher's exact tests were used to compare variables between groups as appropriate. Multinomial logistic regression analysis was applied to estimate odds ratios (ORs) of having a disease of interest and their corresponding 95% confidence intervals (CIs). Quantile regression analysis was performed to determine the association between trichoscopic signs and disease activity. A p value <0.05 was considered statistically significant.

Table 1. Demographic data and comparison of trichoscopic findings among patients with dermatomyositis, systemic lupus erythematosus, and systemic sclerosis

Variables	DM (n = 30)	SLE (n = 60)	SSc (n = 60)	p value
Age (mean $\pm$ SD), years	52.0 $\pm$ 16.2	36.7 $\pm$ 14.4	53.8 $\pm$ 12.8	n.a.
Sex, n (%)				n.a.
Male	8 (26.7)	2 (3.3)	10 (16.7)	
Female	22 (73.3)	58 (96.7)	50 (83.3)	
Age of disease onset (mean $\pm$ SD), years	48.2 $\pm$ 15.8	27.0 $\pm$ 12.9	45.0 $\pm$ 13.9	n.a.
Median duration of disease (IQR), months	36 (7–60)	90 (24–204)	96 (36–144)	n.a.
Trichoscopic findings, n (%)				
Hair shaft findings				
Decrease in number	9 (30)	20 (33.3)	25 (41.7)	0.475
Decrease in diameter	1 (3.3)	10 (16.7)	10 (16.7)	0.101
Hair shaft hypopigmentation	3 (10)	18 (30.0)	0 (0)	<0.001*
Follicular opening and dots				
Black dots	2 (6.7)	2 (3.3)	1 (1.7)	0.487
White dots	17 (56.7)	29 (48.3)	45 (75.0)	0.009*
Perifollicular and interfollicular scalp surface				
Brown peripilar sign	5 (16.7)	1 (1.7)	0 (0)	0.001*
Perifollicular red-brown pigmentation	10 (33.3)	0 (0)	0 (0)	<0.001*
Brown honeycomb pigmentation	24 (80.0)	46 (76.7)	51 (85.0)	0.506
Brown scattered pigmentation	0 (0)	9 (15.0)	0 (0)	<0.001*
Blue-gray speckled pigmentation	12 (40.0)	17 (28.3)	2 (3.3)	0.014*
Salt and pepper appearance	0 (0)	0 (0)	3 (5.0)	0.061
White patches	0 (0)	0 (0)	25 (41.7)	<0.001*
Perifollicular scales	20 (66.7)	23 (38.3)	18 (30.0)	0.004*
Interfollicular scales	13 (43.3)	20 (33.3)	11 (18.3)	0.031*
Vascular findings				
Dotted vessels	8 (26.7)	13 (21.7)	0 (0)	<0.001*
Thin arborizing vessels	29 (96.7)	60 (100)	55 (91.7)	0.027*
Prominent arborizing vessels	7 (23.3)	31 (51.7)	22 (36.7)	0.026*
Thick arborizing vessels	16 (53.3)	22 (36.7)	31 (51.7)	0.169
Microaneurysmal blood vessels	5 (16.7)	0 (0)	0 (0)	<0.001*
Polymorphic vessels forming a telangiectatic network	0 (0)	0 (0)	12 (20.0)	<0.001*
Perifollicular location of aberrant vessels	4 (13.3)	1 (1.7)	0 (0)	0.006*
Interfollicular location of aberrant vessels	27 (90.0)	60 (100)	54 (90.0)	0.008*
Avascular areas	0 (0)	0 (0)	32 (53.3)	<0.001*

DM, dermatomyositis; IQR, interquartile range; n.a., not applicable; SD, standard deviation; SLE, systemic lupus erythematosus; SSc, systemic sclerosis. * Statistically significant at $p < 0.05$.

Results

Comparison of Trichoscopic Features among CTDs

One hundred fifty participants, comprising 30 DM, 60 SLE, and 60 SSc patients, were included. Their demographics are demonstrated in Table 1. Characteristic trichoscopic changes of DM, SLE, and SSc are illustrated in Figures 1–3, respectively. Hair shaft hypopigmentation was observed in both DM and SLE, but not in SSc, with a significant difference in favor of SLE ($p < 0.001$). Perifollicular red-brown pigmentation, brown scattered pigmentation, and white patches were exclusive findings in DM, SLE, and SSc, respectively (all $p < 0.001$). Blue-gray

speckled pigmentation was found more frequently in both DM and SLE than SSc ($p = 0.014$). Perifollicular and interfollicular scales were seen more often in DM compared to both SLE and SSc ($p = 0.004$ and $p = 0.031$, respectively).

Microaneurysmal vessels were exclusive for DM, while the PVTN and avascular areas were distinctive signs of SSc patients. Dotted vessels were more predominant in both DM and SLE than SSc ($p < 0.001$). Thin arborizing vessels forming prominent arborized vascular networks were prevalent in SLE ($p = 0.026$). Any vascular abnormalities located interfollicularly were more prominent in SLE ($p = 0.008$), while perifollicular changes favored DM ($p = 0.006$). Trichoscopic findings of all groups are summarized in Table 1.

Fig. 1. Trichoscopic features of patients with dermatomyositis. **a** Perifollicular red-brown pigmentation and scales. $\times 40$. **b** High magnification of perifollicular red-brown pigmentation showing tortuous blood vessels and brown macules at perifollicular areas.

$\times 120$. **c** Dilated aberrant blood vessels. $\times 20$. **d** Aneurysmal blood vessels defined as linear, serpentine, or tortuous dilated capillary with an ectatic portion resembling an aneurysm. $\times 200$.

Diagnostic Value of Trichoscopic Features for CTDs

Table 2 demonstrates the diagnostic value of trichoscopy among the three CTDs determined by multinomial logistic regression analysis. For hair shaft features, DM had lower odds for decreased hair diameter than both SLE and SSc (OR = 0.06, 95% CI = 0.01–0.72, $p = 0.027$, and OR = 0.08, 95% CI = 0.01–0.82, $p = 0.034$, respectively). Hair shaft hypopigmentation revealed lower odds for both DM and SSc than SLE (OR = 0.15, 95% CI = 0.02–0.93, $p = 0.042$, and OR = 0.04, 95% CI = 0.01–0.33, $p = 0.003$, respectively).

Scalp surface features revealed higher odds of perifollicular red-brown pigmentation for DM over SLE and SSc (OR = 20.61, 95% CI = 1.71–249.16, $p = 0.017$, and OR = 26.41, 95% CI = 2.68–259.86, $p = 0.005$, respectively). Brown scattered pigmentation favored SLE over SSc (OR = 0.05, 95% CI = 0.01–0.66, $p = 0.023$). Blue-gray

speckled pigmentation supported both DM and SLE over SSc (OR = 3.59, 95% CI = 1.16–11.11, $p = 0.026$, and OR = 0.22, 95% CI = 0.06–0.71, $p = 0.012$, respectively). White patch demonstrated a stronger association for SSc compared to other CTDs (OR = 0.04, 95% CI = 0.01–0.35, $p = 0.004$, and OR = 25.73, 95% CI = 3.02–218.98, $p = 0.003$, respectively). The presence of scales favored DM over both SLE and SSc. While perifollicular scales were more predominant in DM than both SLE and SSc (OR = 3.50, 95% CI = 1.09–11.22, $p = 0.032$, and OR = 4.70, 95% CI = 1.67–13.24, $p = 0.003$, respectively), interfollicular scales possessed higher odds for DM than SSc only (OR = 4.35, 95% CI = 1.46–12.94, $p = 0.008$).

Regarding microvascular abnormalities, DM demonstrated higher odds for microaneurysmal blood vessels than SLE and SSc (OR = 22.22, 95% CI = 1.73–285.13, $p = 0.017$, and OR = 15.34, 95% CI = 1.36–177.59, $p =$

Fig. 2. Trichoscopic features of patients with systemic lupus erythematosus. **a** Hair shaft changes including decreased hair number, decreased diameter, and hypopigmented hair shafts. $\times 20$. **b** Scalp changes consisting of black and white dots, brown scattered

pigmentation, and blue-gray speckled pigmentation. $\times 20$. **c** Prominent arborizing blood vessels forming a vascular network at inter-follicular areas. $\times 120$. **d** Thick arborizing blood vessels. $\times 20$.

0.029, respectively). Dotted vessels favored both DM and SLE over SSc (OR = 15.50, 95% CI = 1.72–139.73, $p = 0.015$, and OR = 0.08, 95% CI = 0.01–0.74, $p = 0.027$, respectively). PVTN suggested SSc over SLE (OR = 12.83, 95% CI = 1.35–121.98, $p = 0.026$), while the presence of avascular areas was more predominant in SSc than DM and SLE (OR = 43.24, 95% CI = 5.17–361.67, $p = 0.001$, and OR = 0.03, 95% CI = 0.01–0.24, $p = 0.001$, respectively).

Association between Trichoscopic Features and Disease Activity

In quantile regression analysis, perifollicular red-brown pigmentation was linked to higher physician global activity (coefficient = 40, 95% CI = 10.40–69.60, $p = 0.01$) and CAT-BM activity (coefficient = 3, 95% CI = 0.04–5.96, $p = 0.047$) scores in DM patients; however, no

significant association was demonstrated in the MMT score. For SLE, decreased hair diameter was linked to a higher SLEDAI-2K score (coefficient = 5, 95% CI = 2.21–7.79, $p = 0.001$), while the absence of thin arborizing vessels was related to a higher mRSS score (coefficient = –11, 95% CI = –19.71 to 2.29, $p = 0.014$) in SSc (Table 3).

Discussion

The present study provides new insights into trichoscopic values of patients with DM, SLE, and SSc. To our knowledge, we are the first to compare trichoscopic features among these conditions. We have identified distinctive findings on the hair shaft and scalp surface that can adequately differentiate among them. A combination of findings may contribute to their distinction. Moreover,

Fig. 3. Trichoscopic features of patients with systemic sclerosis: variable hair shaft and scalp changes including decreased hair number and diameter, avascular areas (**a**), and white patches (**b**). $\times 40$. **c** Polymorphic vessels forming a telangiectatic network de-

finied as a different pattern of vessels forming a network of vascular telangiectasia. $\times 40$. **d** High magnification of polymorphic vessels forming a telangiectatic network. $\times 80$.

trichoscopic features may provide prognostic implementations. Table 4 displays trichoscopic signs that can be useful to determine the diagnosis and prognosis of DM, SLE, and SSc.

In DM, although hair shaft changes were subtle, many characteristic scalp surface features were predominant. Perifollicular red-brown macules were distinctive and exclusive for DM (Fig. 1a, b). Blue-gray speckled pigmentation was demonstrated in almost half of the patients. Scales were presented in nearly three fourths of the cases and the perifollicular location favored DM over other CTDs. Our findings were roughly in line with the literature [7]. Under the microscope, blue-gray speckled pigmentation signifies melanophages in the papillary dermis caused by the typical interface dermatitis. Vascular ectasia, endothelial damage, and perifollicular inflammation admixed with features of postinflammatory hyperpig-

mentation may represent the characteristic perifollicular red-brown pigmentation [6, 34]. Scalp DM shows changes in the stratum corneum (e.g., focal parakeratosis) accounting for the scales presented on trichoscopy [6]. Essentially, we have demonstrated that scalp DM possesses abnormalities outside the follicles and preferentially on the perifollicular areas. Our findings correspond to a recent histological study revealing that the follicular architecture is virtually preserved in DM. The minimal follicular insult may also explain minor hair shaft changes observed on trichoscopy in DM patients.

In SLE, Suchonwanit et al. [19] have documented that trichoscopy can provide diagnostic implementation, as their distinctive findings were absent or minimally presented in the normal scalp. The present study confirms the value of trichoscopy beyond that of SLE diagnosis and that characteristic features could be accounted for to dif-

Table 2. Multinomial logistic regression analysis of trichoscopic findings in patients with dermatomyositis, systemic lupus erythematosus, and systemic sclerosis

Trichoscopic findings	DM versus SLE ^a			SSc versus SLE ^a			DM versus SSc ^a		
	OR	95% CI	<i>p</i> value ^b	OR	95% CI	<i>p</i> value ^b	OR	95% CI	<i>p</i> value ^b
Hair shaft findings									
Decrease in number	0.41	0.12–1.38	0.152	0.72	0.28–1.83	0.492	0.57	0.20–1.62	0.293
Decrease in diameter	0.06	0.01–0.72	0.027*	0.72	0.20–2.56	0.617	0.08	0.01–0.82	0.034
Hair shaft hypopigmentation	0.15	0.02–0.93	0.042*	0.04	0.01–0.33	0.003*	4.15	0.37–45.46	0.244
Follicular opening and dots									
Black dots	1.06	0.08–13.48	0.963	0.28	0.01–4.97	0.385	3.80	0.31–45.79	0.294
White dots	0.82	0.27–2.47	0.730	2.28	0.91–5.64	0.076	0.36	0.13–0.99	0.049
Perifollicular and interfollicular scalp surface									
Brown peripilar sign	5.10	0.31–82.88	0.252	0.41	0.01–9.36	0.577	12.40	0.19–129.10	0.035
Perifollicular red-brown pigmentation	20.61	1.71–249.16	0.017	0.78	0.03–16.08	0.872	26.41	2.68–259.86	0.005
Brown honeycomb pigmentation	0.59	0.15–2.24	0.442	0.96	0.30–2.96	0.938	0.62	0.17–2.15	0.452
Brown scattered pigmentation	0.10	0.01–1.71	0.112	0.05	0.01–0.66	0.023	2.01	0.10–40.73	0.648
Blue-gray speckled pigmentation	0.79	0.23–2.66	0.705	0.22	0.06–0.71	0.012	3.59	1.16–11.11	0.026
Salt and pepper appearance	0.34	0.01–13.18	0.561	0.50	0.02–10.11	0.650	0.68	0.05–8.53	0.764
White patches	1.04	0.05–20.94	0.979	25.73	3.02–218.98	0.003	0.04	0.01–0.35	0.004
Perifollicular scales	3.50	1.09–11.22	0.032	0.74	0.28–1.95	0.548	4.70	1.67–13.24	0.003
Interfollicular scales	2.23	0.69–7.13	0.176	0.51	0.17–1.46	0.213	4.35	1.46–12.94	0.008
Vascular findings									
Dotted vessels	1.28	0.31–5.17	0.731	0.08	0.01–0.74	0.027	15.50	1.72–139.73	0.015
Thin arborizing vessels	0.54	0.02–12.12	0.701	0.16	0.01–1.74	0.131	3.49	0.35–33.97	0.282
Prominent arborizing vessels	0.33	0.10–1.05	0.063	0.57	0.23–1.38	0.215	0.58	0.20–1.66	0.311
Thick arborizing vessels	1.26	0.42–3.78	0.678	1.13	0.42–2.99	0.805	1.42	0.29–6.84	0.662
Microaneurysmal blood vessels	22.22	1.73–285.13	0.017	1.45	0.07–26.41	0.803	15.34	1.36–177.59	0.029
Polymorphic vessels forming a telangiectatic network	3.32	0.15–69.23	0.439	12.83	1.35–121.98	0.026	0.26	0.02–2.28	0.224
Avascular areas	1.22	0.06–23.88	0.898	43.24	5.17–361.67	0.001	0.03	0.01–0.24	0.001

CI, confidence interval; DM, dermatomyositis; OR, odds ratio; SLE, systemic lupus erythematosus; SSc, systemic sclerosis. Statistically significant at *p* < 0.05. ^a Reference category of pairwise comparison. ^b Adjusted for age, sex, age of disease onset, and duration of disease.

Table 3. Quantile regression analysis of trichoscopic findings in patients with dermatomyositis, systemic lupus erythematosus, and systemic sclerosis

Disease	Disease activity score	Correlations with disease activity		<i>p</i> value
		coefficient	95% CI	
DM	Physician global activity score			
	Perifollicular red-brown pigmentation	40	10.40–69.60	0.010
	CAT-BM activity score			
	Perifollicular red-brown pigmentation	3	0.04–5.96	0.047
SLE	SLEDAI-2K score			
	Decrease in hair diameter	5	2.21–7.79	0.001
SSc	mRSS score			
	Thin arborizing vessels	–11	–19.71 to –2.29	0.014

CAT-BM, Cutaneous Assessment Tool – Binary Method; CI, confidence interval; DM, dermatomyositis; IQR, interquartile range; mRSS, modified Rodnan Skin Score; OR, odds ratio; SLEDAI-2K, Systemic Lupus Erythematosus Disease Activity Index 2000; SLE, systemic lupus erythematosus; SSc, systemic sclerosis. Statistically significant at *p* < 0.05.

Table 4. Comparison of trichoscopic clues for the diagnosis of dermatomyositis, systemic lupus erythematosus, and systemic sclerosis

Trichoscopic findings	DM	SLE	SSc
Hair shaft findings	Decreased hair density and diameter	Prominent hair shaft hypopigmentation ^a Decreased hair density and diameter	Decreased hair density and diameter
Scalp surface findings	Perifollicular red-brown pigmentation ^a Blue-gray speckled pigmentation Prominent perifollicular scales Prominent interfollicular scales	Brown scattered pigmentation ^a Blue-gray speckled pigmentation	White patches ^a
Vascular findings	Microaneurysmal blood vessels ^a Thick arborizing vessels Perifollicular location of aberrant vessels	Prominent arborizing blood vessels Thick arborizing vessels Interfollicular location of aberrant vessels	Polymorphic vessels forming a telangiectatic network ^a Avascular area ^a Thick arborizing vessels
Features related to higher disease activity	Perifollicular red-brown pigmentation	Decreased hair diameter	Absence of thin arborizing vessels

DM, dermatomyositis; SLE, systemic lupus erythematosus; SSc, systemic sclerosis. ^a The most specific sign in differentiating from the others.

ferentiate SLE from its mimickers. Typical trichoscopic findings for SLE were hair shaft changes (decreased hair density/diameter, and hair shaft hypopigmentation) (Fig. 2a) and scalp changes (brown scattered and blue-gray speckled pigmentation) (Fig. 2b). Unlike DM, pathology involving follicular architecture (decrement of follicular counts and terminal-to-vellus hair ratio) is remarkable in SLE [35]. Hair shaft alterations could indicate damaged hair matrix cells resulting in defective hair shaft formation and melanogenesis [8, 19, 36]. SLE commonly involves nonfollicular structures as well. Histologically, nonscarring alopecia in SLE demonstrates epidermal atrophy and interface dermatitis along the dermoepidermal junction/follicular epithelium which correspond to brown scattered and blue-gray speckled pigmentation on trichoscopy, respectively [10, 35].

SSc involves complex interrelations between the immunological, vascular, and fibrotic elements, resulting in chronic and progressive tissue fibrosis [37]. SSc has long been considered to have no specific scalp and/or trichoscopic changes [38]. However, our study has demonstrated several trichoscopic abnormalities that corresponded well to SSc pathophysiology and were highly suggestive of SSc. Thick homogenized sclerotic collagen bundles in the dermis may compromise the follicular architecture leading to hair size reduction and diffuse hair loss (Fig. 3a) [38]. White patches located between normally arranged follicular units are a visible sign of fibrosis and microcirculation insufficiency in SSc (Fig. 3b) [20]. Unlike DM and SLE, SSc does not possess melanophages as a consequence of interface changes; therefore, the absence of blue-gray speckled pigmentation was anticipated.

The scalp is a well-vascularized structure, and microvascular injury plays a role in the pathophysiology of CTDs. Therefore, vascular abnormalities were universally observed on trichoscopy in over 90% of all three conditions. Disease-specific microvascular pathology may lead to pattern-specific findings and enables trichoscopic distinction among CTDs. In DM, microvascular pathology is mediated by the humeral process, leading to vascular depletion, hypoxia, and myofiber necrosis. Subsequently, local angiogenesis occurs as a compensation process [34, 39, 40]. Angiogenic factors (e.g., vascular endothelial growth factor and angiogenin) may involve in the pathogenesis of DM and correspond to thick arborizing and microaneurysmal blood vessels presented on trichoscopy (Fig. 1c, d) [34, 39–41]. Moreover, the perifollicular location of these aberrant vessels favors DM over both SLE and SSc. In SLE, arborizing blood vessels of the scalp were mostly located interfollicularly and were prominent in size (Fig. 2c, d). Angiogenesis in SLE is induced by raised circulating angiogenic cytokines as well [42]. Despite the shared angiogenic process, different levels of microvascular injury may lead to phenotypic variation between DM and SLE. Crowson and Magro [34] demonstrated that, compared to SLE, DM lesions showed greater endothelial injury, vascular ectasia, and vascular fibrin deposit. Likewise, we have observed that trichoscopic microvascular features were more aberrant in patients with DM than SLE.

Endothelial injury is the initial vascular insult in SSc, remarkably demonstrating endothelial cell apoptosis, vasoconstriction, and vasculopathy [43]. Tissue hypoxia and fibrosis may parallel the predominant avascular areas and the absence/decrement of normal trichoscopic vas-

cular structures. Angiogenesis also appears in SSc as compensation to chronic hypoxia, but the process may be defective and dysregulated and could evolve towards various forms of neovascularization. The characteristic trichoscopic finding, the PVTN (Fig. 3c, d), has also been described by Jasso-Olivares et al. [7] and may be a consequence of defective angiogenesis in SSc. Nevertheless, future studies on pathomechanism, biomarkers, and their effects on different morphology and pattern of vascular abnormalities in CTDs are warranted.

We are the first to identify the association between trichoscopic features and validated tools in measuring disease activity in DM and SSc. Our data affirm that decreased hair diameter paralleled a higher SLEDAI-2K score and may be related to an inflammatory process damaging the hair matrix cells in patients with SLE [19]. The presence of perifollicular red-brown macules indicated higher physician global activity and CAT-BM scores in DM, reflecting both microvascular changes and scalp inflammation. Increased levels of type 1 interferon, a group of cytokines accountable for inflammatory responses and vascular changes, were associated with higher disease activity in both DM and SLE [44–49]. We have also demonstrated that the absence of thin arborizing blood vessels was linked to a higher mRSS score in SSc. As a well-vascularized structure, thin arborizing vessels are a common trichoscopic finding in the normal scalp [19]; once progressive rarefaction of microvessels occurs in SSc, extensive tissue fibrosis becomes apparent. Loss of vascular structures can be further linked to progressive skin thickening measured via the mRSS score [15]. Nevertheless, further large prospective studies are required to verify these findings.

The limitation of our study includes its cross-sectional, single-center nature, which allowed no follow-up period and restricted the study population to Southeast Asians. Additionally, our sample size was relatively small.

Conclusion

Careful attention to specific trichoscopic features enables distinction between DM, SLE, and SSc. Decreased hair diameter was suggestive for SLE and SSc, while hair shaft hypopigmentation indicated SLE. Perifollicular red-brown macules, brown scattered pigmentation, and white patches were exclusive for DM, SLE, and SSc, respectively. Blue-gray speckled pigmentation supported DM and SLE, while scales favored DM. Microaneurysmal vessels and avascular areas were restricted to DM and SSc, re-

spectively. Certain trichoscopic changes hold prognostic values for CTDs. Perifollicular red-brown pigmentation, reduction in hair diameter, and the absence of thin arborizing vessels were linked to higher disease activity in DM, SLE, and SSc, respectively.

Key Message

Trichoscopic examination provides diagnostic and prognostic values for dermatomyositis, systemic lupus erythematosus, and systemic sclerosis.

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Statement of Ethics

This study protocol was reviewed and approved by the Mahidol University Institutional Review Board for Ethics in Human Research (MURA2018/589). The study was conducted following the Helsinki Declaration, and written informed consent was obtained from each patient before enrollment to participate in the study and to publish their clinical data and images.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

K. Chanprapaph and P. Suchonwanit designed and conceptualized the study. K. Chanprapaph, P. Limtong, and P. Suchonwanit performed the data collection. K. Chanprapaph, P. Limtong, P. Ngamjanyaporn, and P. Suchonwanit contributed to the analysis and interpretation of the results. K. Chanprapaph, P. Limtong, and P. Suchonwanit contributed to manuscript writing.

Data Availability Statement

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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