

Chapter 4

Nailfold Capillaroscopy

Michael Hughes and Ariane L. Herrick

Abstract Microvascular abnormalities are a key feature of systemic sclerosis and typically occur early in the disease course. Nailfold capillaroscopy is a noninvasive clinically useful tool that can provide valuable information for the diagnosis and prognosis of primary Raynaud's disease and the scleroderma spectrum of autoimmune disorders. This chapter presents the diverse range of capillaroscopic abnormalities found in patients with SSc-spectrum disorders, and exemplifies the role of capillaroscopy in diagnosis and assessment.

Keywords Raynaud's phenomenon • Systemic sclerosis • Nailfold capillaroscopy • Videomicroscopy • Dermatoscope • Thermography

Introduction

Microvascular abnormalities are believed to be critical in the pathogenesis of systemic sclerosis (SSc), and occur early on in the disease course. These abnormalities can be visualized using the noninvasive technique of capillaroscopy, which may be considered a “window” into the microcirculation. Nailfold capillaroscopic abnormalities in SSc-spectrum disorders have been well described, the main abnormalities being dilated loops, areas of avascularity, hemorrhage, and distortion of the capillary architecture.

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Thus capillaroscopy is an invaluable investigation for the clinician to distinguish between primary and secondary Raynaud's phenomenon: normal capillaries are reassuring, whereas abnormal capillaries are suggestive of an underlying SSc-spectrum disorder. This is a critical distinction as both the management and prognosis of these patient groups is different.

Capillaroscopy can be performed using different techniques. Although most of the original work on capillaroscopy was performed using a widefield technique (magnification in the order of $\times 14$), advances in technology mean that more recently high magnification videocapillaroscopy (magnification in the order of $\times 200$) is being increasingly used. For clinicians without access to either of these methods, the nailfold capillaries can also be examined (albeit in less detail) using a dermatoscope or ophthalmoscope. This chapter will present the reader with a visually diverse range of capillaroscopic abnormalities found in patients with SSc-spectrum disorder, and exemplify the role of capillaroscopy in diagnosis and assessment. Images included were acquired using different methods: widefield capillaroscopy, videocapillaroscopy, and dermatoscopy. Clinical images (e.g., photographs and radiographs) and related investigations (e.g., thermograms) are also presented as appropriate to enrich the clinical scenarios.

Case 1

Scenario: A 17-year-old female with Raynaud's phenomenon and previous digital ulceration requiring several hospitalization for intravenous Iloprost (a prostacyclin vasodilator). She had a positive antinuclear antibody (ANA) of 1:1,000, no sclerodactyly and no proximal muscle weakness. Periungual erythema and visibly enlarged nailfold capillaries with hemorrhage were visible to the naked eye (Fig. 4.1).

Nailfold capillaroscopy (widefield technique) was abnormal with enlarged capillaries and multiple hemorrhages (Fig. 4.2), consistent with the diagnosis of SSc [1]. These appearances have been described as an "early" pattern ("early" = a small number of "giant" capillaries and hemorrhages, but no obvious loss of capillaries and relatively well-preserved capillary architecture [2]). The nailfold capillaroscopy appearances played a key role (in combination with her previous digital ulceration and positive ANA) in making the diagnosis of an SSc-spectrum disorder.

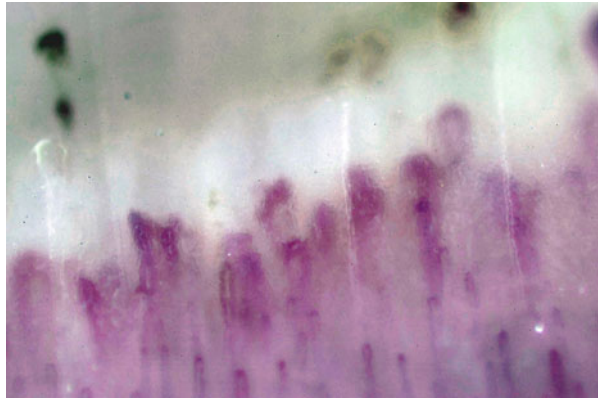
Case 2

Scenario: A 21-year-old female with an SSc-spectrum disorder (scleroderma, Raynaud's phenomenon, pulmonary interstitial fibrosis, anti-PM-Scl antibody, and elevated plasma creatinine kinase).

Fig. 4.1 Unmagnified view showing periungual erythema and visibly enlarged nailfold capillaries with hemorrhage [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.2 Abnormal nailfold capillaries using the widefield technique with enlarged capillaries and multiple hemorrhages. This is an early pattern with a small number of giant capillaries and hemorrhages but no obvious loss of capillaries and relatively well-preserved capillary architecture [Copyright Salford Royal NHS Foundation Trust]



Nailfold capillaroscopy (widefield technique) (Fig. 4.3) was abnormal with areas of angiogenesis (also described as “bushy,” “ramified,” “arborized” capillaries). These appearances are characteristic of patients with a myositic component to their disease [3]. Gottron’s papules (erythematous, raised papules over the metacarpal and interphalangeal joints) were seen on physical examination in keeping with an overlap with dermatomyositis (Fig. 4.4).

Case 3

Scenario: A 59-year-old female with limited cutaneous SSc (anti-centromere antibody) positive.

Videocapillaroscopy ($\times 300$ magnification) was abnormal with enlarged and giant capillaries (capillaries which are homogeneously enlarged, with a diameter of greater than $50 \mu\text{m}$) and areas of hemorrhage (Fig. 4.5). Videocapillaroscopy allows observers to measure capillary density and dimensions. An association



Fig. 4.3 Abnormal nailfold capillaries using the widefield technique demonstrating areas of angiogenesis (also described as “bushy,” “ramified,” “arborized” capillaries) which are characteristic of patients with a myositic component to their disease [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.4 Photograph of the hand of patient in Fig. 4.3 showing Gottron's papules: erythematous, raised papules over the metacarpal and interphalangeal joints [Copyright Salford Royal NHS Foundation Trust]

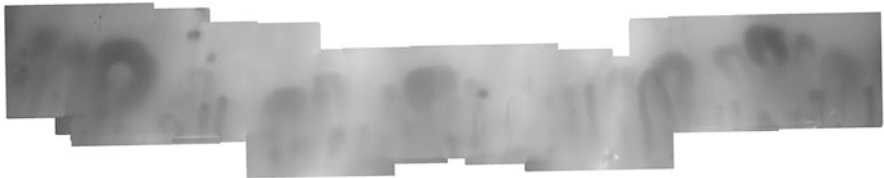


Fig. 4.5 Abnormal nailfold capillaries by videocapillaroscopy ($\times 300$ magnification) with enlarged and giant capillaries (capillaries which are homogenously enlarged, with a diameter of greater than $50 \mu\text{m}$) and areas of hemorrhage [Copyright Salford Royal NHS Foundation Trust]

Fig. 4.6 Abnormal nailfold capillaries by widefield microscopy showing giant capillaries, areas of hemorrhage, and areas of avascularity [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.7 The same patient as in Fig. 4.6 with finger and hand telangiectasias [Copyright Salford Royal NHS Foundation Trust]



between anti-centromere antibody positivity and the degree of capillary abnormality has been reported [4].

Case 4

Scenario: A 69-year-old female with limited cutaneous SSc (anti-centromere antibody positive) and a history of digital gangrene.

Nailfold capillaroscopy (widefield microscopy) (Fig. 4.6) showed giant capillaries, areas of hemorrhage, and areas of avascularity. She had widespread telangiectasias, including some on her fingers (Fig. 4.7), which are a very visible manifestation of the vasculopathy demonstrated on capillaroscopy. The degree of capillaroscopic abnormality has been associated with the severity of digital ischemia and telangiectasias, as well as with anti-centromere antibody [4], as well exemplified in this scenario.

Fig. 4.8 Abnormal capillaries with enlarged and giant capillary loops and areas of avascularity [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.9 Radiograph of the hand of the subject in Fig. 4.8 showing soft tissue calcinosis most obviously at the tip of the middle finger [Copyright Salford Royal NHS Foundation Trust]



Case 5

Scenario: A 65-year-old female with limited cutaneous SSc.

Capillaroscopy (Fig. 4.8) was abnormal with enlarged and giant capillary loops and areas of avascularity. Radiograph (Fig. 4.9) of the hands showed areas of

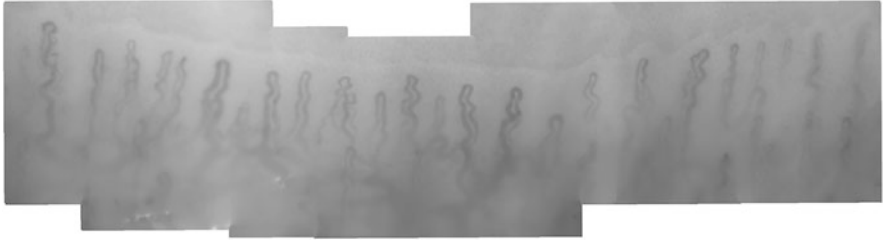


Fig. 4.10 Normal nailfold capillaries with regular “hair-pin” loops as seen by videocapillaroscopy ($\times 300$ magnification) [Copyright Salford Royal NHS Foundation Trust]

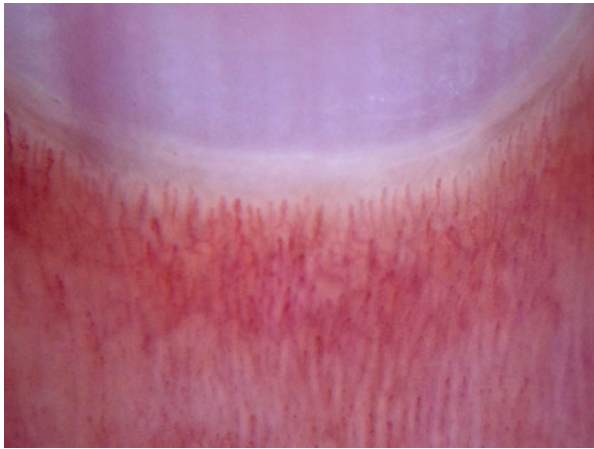


Fig. 4.11 Normal nailfold capillaries as demonstrated by dermoscopy ($\times 10$ magnification) [Copyright Salford Royal NHS Foundation Trust]

calcinosis (soft tissue calcification), most obviously at the tips of both middle fingers. An association between calcinosis and nailfold capillaroscopic changes has been reported [5], although this warrants further investigation.

Case 6

Scenario: A 35-year-old female with long-standing Raynaud’s phenomenon, being assessed for an underlying SSc-spectrum disorder. Her ANA was negative.

Nailfold capillaries were normal, with regular “hair-pin” loops, as demonstrated by both videocapillaroscopy ($\times 300$ magnification) (Fig. 4.10) and dermoscopy ($\times 10$ magnification) [6, 7] (Fig. 4.11). The combination of the negative ANA and the normal nailfold capillaroscopy made an SSc-spectrum disorder highly unlikely [8, 9]: she was therefore reassured, given lifestyle advice and offered oral vasodilator treatment.

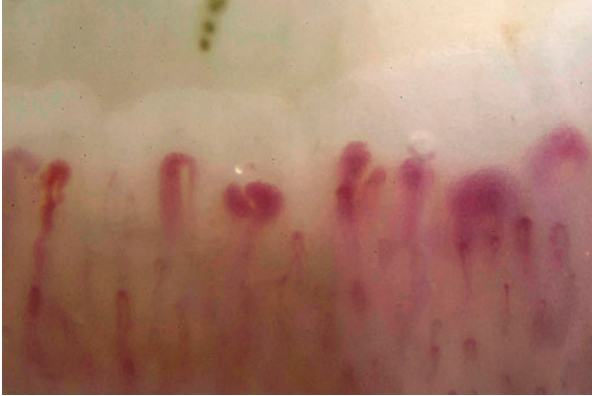


Fig. 4.12 Abnormal nailfold capillaries by widefield technique with dilated loops, areas of avascularity and some hemorrhages considered to represent an active phase of disease [Copyright Salford Royal NHS Foundation Trust]

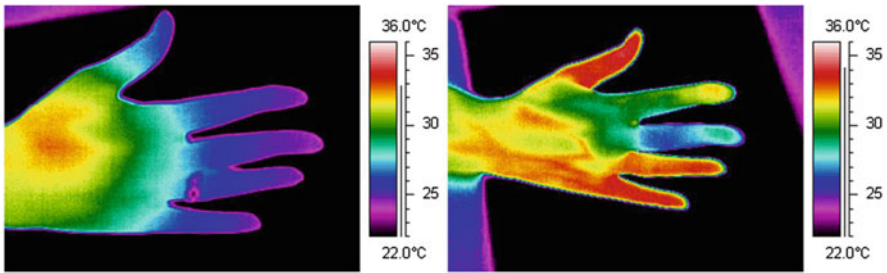


Fig. 4.13 Abnormal thermography of the hand in Fig. 4.12. The left image shows the fingers at 23 °C, the right image at 30 °C with persistence of the temperature gradient (>1 °C, fingertip cooler than dorsum) along the right middle finger. This persisting temperature gradient is consistent with the underlying structural vascular abnormality of SSc [Copyright Salford Royal NHS Foundation Trust]

Case 7

Scenario: A 46-year-old female with limited cutaneous SSc (Raynaud’s phenomenon and positive anti-centromere antibody).

Nailfold capillaroscopy (widefield technique) (Fig. 4.12) was abnormal with dilated loops, areas of avascularity and some hemorrhages. These appearances have been described as “active” (“active” = frequent giant capillaries and hemorrhages, some capillary loss, and some distortion of the capillary architecture) [2]. Thermography (which measures surface temperature) was abnormal (Fig. 4.13—left image shows the fingers at 23 °C, the right image at 30 °C). In contrast to the previous patient, even at a room temperature of 30 °C there was a persisting temperature gradient (>1 °C, fingertip cooler than dorsum) along the right middle finger. This

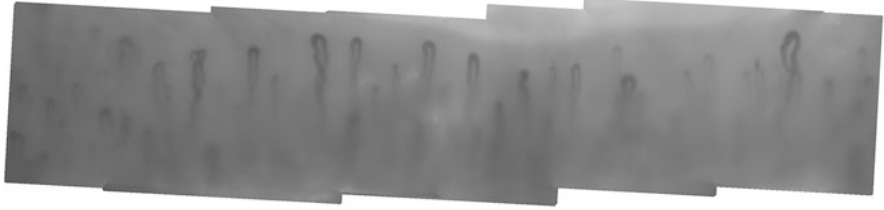


Fig. 4.14 Normal nailfold capillaries by videocapillaroscopy ($\times 300$ magnification) [Copyright Salford Royal NHS Foundation Trust]

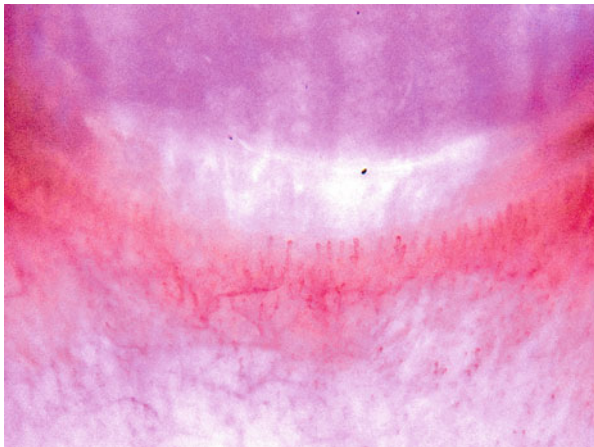


Fig. 4.15 Normal capillaries by dermoscopy ($\times 10$ magnification) [Copyright Salford Royal NHS Foundation Trust]

persisting temperature gradient (fingertip cooler) even at 30°C is consistent with the underlying structural vascular abnormality of SSc [10].

Case 8

Scenario: A 31-year-old female with primary Raynaud's phenomenon (ANA negative).

Videocapillaroscopy (magnification $\times 300$) (Fig. 4.14) and dermoscopy (magnification $\times 10$) (Fig. 4.15) were normal which, combined with the negative ANA, were consistent with a diagnosis of primary Raynaud's phenomenon. Thermography (Fig. 4.16—left image shows the fingers at 23°C , the right image at 30°C), which measures surface temperature, was also consistent with primary Raynaud's phenomenon, showing complete reversal of the vasospastic response at 30°C [10].

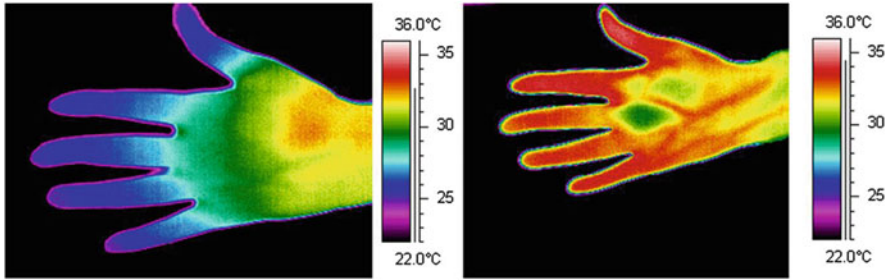


Fig. 4.16 The left image shows thermography of the fingers at 23 °C and the right image at 30 °C demonstrating complete reversal of the vasospastic response [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.17 Photograph of the upper limb demonstrating morphea [Copyright Salford Royal NHS Foundation Trust]

Case 9

Scenario: A 40-year-old male with a long history of Raynaud's phenomenon (ANA negative) and morphea of the upper limb (Fig. 4.17). The concern was that there might be underlying SSc.

Capillaroscopy (Fig. 4.18) was normal (widefield technique). This made the diagnosis of SSc unlikely, and the patient was reassured that his scleroderma was localized.

Case 10

Scenario: A 79-year-old female with limited cutaneous SSc (anti-centromere antibody-positive).

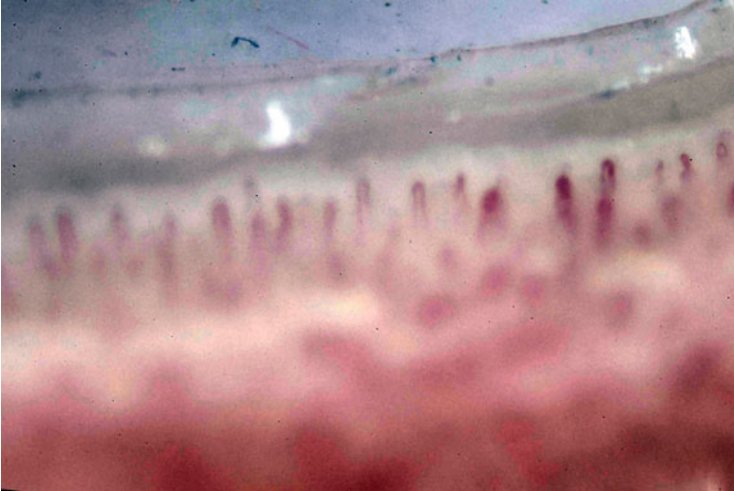


Fig. 4.18 Normal nailfold capillaroscopy using a widefield technique in the patient in Fig. 4.17 [Copyright Salford Royal NHS Foundation Trust]

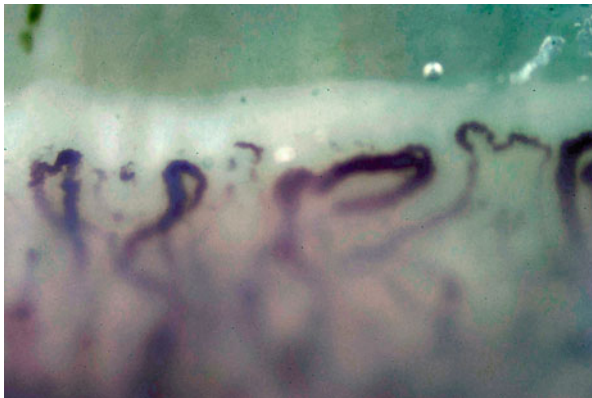


Fig. 4.19 Grossly abnormal capillaries utilizing the widefield technique with major disorganization of the capillary architecture and reduced capillary density, consistent with the “late” pattern of abnormality (“late” = giant capillaries and hemorrhages almost absent [although admittedly there were some hemorrhages in this case], severe capillary loss/avascularity, ramified/bushy capillaries, and distortion of the normal capillary architecture) [Copyright Salford Royal NHS Foundation Trust]

Capillaroscopy (widefield technique) (Fig. 4.19) was grossly abnormal with a major disorganization of the capillary architecture and reduced capillary density, consistent with the “late” pattern of abnormality (“late” = giant capillaries and hemorrhages almost absent [although admittedly there were some hemorrhages in this case], severe capillary loss/avascularity, ramified/bushy capillaries, and distortion of the normal capillary architecture) [2].

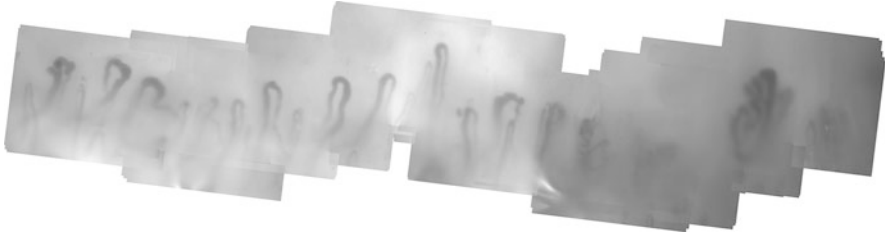


Fig. 4.20 Abnormal capillaries by videocapillaroscopy ($\times 300$ magnification) with areas of avascularity, some distortion of the normal capillary architecture and one angiogenic (“bushy”) capillary [Copyright Salford Royal NHS Foundation Trust]



Fig. 4.21 Photograph of the hand from the subject in Fig. 4.20 showing flexion deformities of the fingers and healing ulcers resulting in impairment in hand function [Copyright Salford Royal NHS Foundation Trust]

Case 11

Scenario: A 39-year-old female with diffuse cutaneous SSc and severe digital vasculopathy with recurrent digital ulceration (ANA of 1:1,000 with a positive anti Scl-70 antibody).

Videocapillaroscopy ($\times 300$ magnification) (Fig. 4.20) was abnormal with areas of avascularity, some distortion of the normal capillary architecture and one angiogenic (“bushy”) capillary. On physical examination, there were flexion deformities of the fingers and healing ulcers resulting in impairment in hand function (Fig. 4.21). The severity of nailfold capillary abnormality may be a predictor of digital ulceration [11, 12].

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References

1. Maricq HR, LeRoy EC. Patterns of finger capillary abnormalities in connective tissue disease by 'wide-field' microscopy. *Arthritis Rheum.* 1973;16(5):619–28.
2. Cutolo M, Sulli A, Smith V. Assessing microvascular changes in systemic sclerosis diagnosis and management. *Nat Rev Rheumatol.* 2010;6(10):578–87.
3. Mercer LK, Moore TL, Chinoy H, Murray AK, Cooper RG, Herrick AL. Quantitative nailfold video capillaroscopy in patients with idiopathic inflammatory myopathies. *Rheumatology (Oxford).* 2010;49(9):1699–705.
4. Herrick AL, Moore TL, Murray AK, Whidby N, Manning J, Bhushan M, et al. Nailfold capillary abnormalities are associated with anticentromere antibody and severity of digital ischaemia. *Rheumatology (Oxford).* 2010;49(9):1776–82.
5. Vayssairat M, Hidouche D, Abdoucheli-Baudot N, Gaitz JP. Clinical significance of subcutaneous calcinosis in patients with systemic sclerosis. Does diltiazem induce its regression? *Ann Rheum Dis.* 1998;57(4):252–4.
6. Bergman R, Sharony L, Shapira D, Nahir MA, Balbir-Gurman A. The handheld dermatoscope as a nail-fold capillaroscopic instrument. *Arch Dermatol.* 2003;139(8):1027–30.
7. Moore TL, Roberts C, Murray AK, Helbling I, Herrick AL. Reliability of dermoscopy in the assessment of patients with Raynaud's phenomenon. *Rheumatology (Oxford).* 2010;49(3):542–7.
8. Koenig M, Joyal F, Fritzler MJ, Roussin A, Abrahamowicz M, Boire G, et al. Autoantibodies and microvascular damage are independent predictive factors for the progression of Raynaud's phenomenon to systemic sclerosis: a twenty-year prospective study of 586 patients, with validation of proposed criteria for early systemic sclerosis. *Arthritis Rheum.* 2008;58(12):3902–12.
9. Herrick AL, Cutolo M. Clinical implications from capillaroscopic analysis in patients with Raynaud's phenomenon and systemic sclerosis. *Arthritis Rheum.* 2010;62(9):2595–604.
10. Anderson ME, Moore TL, Lunt M, Herrick AL. The 'distal-dorsal difference': a thermographic parameter by which to differentiate between primary and secondary Raynaud's phenomenon. *Rheumatology (Oxford).* 2007;46(3):533–8.
11. Sebastiani M, Manfredi A, Colaci M, D'amico R, Malagoli V, Giuggioli D, et al. Capillaroscopic skin ulcer risk index: a new prognostic tool for digital skin ulcer development in systemic sclerosis patients. *Arthritis Rheum.* 2009;61(5):688–94.
12. Smith V, De Keyser F, Pizzorni C, Van Praet JT, Decuman S, Sulli A, et al. Nailfold capillaroscopy for day-to-day clinical use: construction of a simple scoring modality as a clinical prognostic index for digital trophic lesions. *Ann Rheum Dis.* 2011;70(1):180–3.