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Exploring sarcoidosis via nailfold capillaroscopy: A window into the disease's microvascular landscape

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Abstract. *Background and aim:* Sarcoidosis is a systemic granulomatous inflammatory disease that can affect virtually any organ, with a predilection for the lungs. It may present vasculitic features involving small, medium, or large vessels. Microvascular alterations in sarcoidosis can be assessed using nailfold videocapillaroscopy (NVC), a tool widely applied in the diagnosis and monitoring of systemic sclerosis, among other conditions. The aim of our study was to detect microcirculatory changes in patients with sarcoidosis and investigate their potential correlation with organ involvement. *Methods:* We conducted a single-center, retrospective case-control study involving three groups: 51 patients diagnosed with sarcoidosis, 51 healthy volunteers serving as controls, and 51 patients with systemic sclerosis. The groups were similar in sex and age. All participants underwent nailfold videocapillaroscopy (NVC) to assess microvascular changes. *Results:* This study confirmed the presence of non-specific microcirculatory abnormalities in patients with sarcoidosis, particularly in terms of reduced capillary density, the presence of angiogenesis, and slowed capillary flow. Although these alterations do not currently appear to correlate with specific clinical aspects of the disease, (e.g. the presence of autoantibodies, laboratory parameters and variables of lung function). *Conclusions:* Our findings confirm the presence of non-specific microvascular abnormalities in sarcoidosis. However, the identification of these capillaroscopic alterations as specific to sarcoidosis requires further confirmation. Ongoing studies aim to explore the potential role of NVC as a diagnostic marker and to investigate its correlation with the clinical manifestations of sarcoidosis.

Key words: sarcoidosis; endothelial damage; interstitial lung disease

Introduction

Sarcoidosis is a multisystem inflammatory granulomatous disease of unknown etiology that most commonly affects the lungs, though it can involve virtually any organ in the body. Its clinical presentation is highly heterogeneous, ranging from asymptomatic or acute, self-limiting forms to chronic, multi-organ involvement that may lead to organ failure or severe fibrosis (1-3). The diagnosis and management of sarcoidosis remain challenging for clinicians, partly due to the incomplete understanding of its pathogenesis and triggering factors, and partly because treatment can be complex, particularly in cases that respond poorly to standard therapies (4).

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It is well established that the pathogenesis of sarcoidosis involves a dysregulated immune response to environmental or occupational exposures, specific substances, or microbial agents in genetically predisposed individuals. Nevertheless, many aspects of the disease remain unclear. Sarcoidosis is a complex, multi-organ condition, and therapeutic decisions must consider the extent of organ involvement, clinical manifestations, and disease progression. The primary goals of treatment are to control inflammation, prevent irreversible organ damage, and manage symptoms and therapeutic approach varies depending on the organs affected and the severity of the disease (5).

Several biomarkers are used to monitor disease activity, therapeutic response, and progression in sarcoidosis. Although no single ideal marker exists, a combination of clinical parameters, laboratory tests, and imaging techniques is typically employed to evaluate disease status (6).

Angiotensin-converting enzyme (ACE) is one of the most commonly used biomarkers; it is produced by granulomas (7), and elevated levels may be detected in patients with active disease. However, ACE has significant limitations, as levels can be normal in active sarcoidosis and elevated in other conditions. It is neither sensitive nor specific for sarcoidosis and may be influenced by genetic polymorphisms or therapies such as ACE inhibitors (8).

Serum levels of soluble interleukin-2 receptor (sIL-2R) are considered markers of immune and T-cell activation. Elevated sIL-2R levels correlate with active granulomatous inflammation and disease severity, making this biomarker potentially useful for monitoring disease activity and therapeutic response. Nonetheless, its clinical value requires further validation through larger, multinational studies (9).

Chitotriosidase, an enzyme produced by activated macrophages within granulomas, is another potential marker. Although not specific to sarcoidosis, its levels have been associated with active granulomatous disease and may reflect disease activity (10).

Currently, no single biomarker is sufficient for monitoring disease reactivation, progression, or therapeutic response in sarcoidosis. However, an integrated approach combining clinical assessment, laboratory biomarkers, and imaging—such as PET/CT—provides a more comprehensive evaluation. Among the most useful markers for tracking disease activity and treatment response are ACE, sIL-2R, and PET/CT findings.

Vascular involvement in sarcoidosis has been previously reported. Macrovascular damage may present as accelerated atherosclerosis, evidenced by altered lipid profiles and atherosclerotic lesions identified via ultrasound. Although rare, vasculitic lesions have also been described, potentially affecting vessels of any size (11–13).

Conversely, microvascular damage has been supported by both histological findings and serological markers indicative of endothelial injury, reinforcing the concept that microcirculatory involvement may be a relevant component of sarcoidosis pathophysiology (14,15). The use of magnifying probes to study the capillaries of the nailfold is a simple, non-invasive technique that dates back to the early 20th century and has been employed since the 1930s to investigate microcirculation in Raynaud's phenomenon, both with and without associated systemic sclerosis (16). Over time, the technique has evolved, but it was not until the 2000s that specific capillaroscopic patterns were identified by Cutolo et al., which are now incorporated into the classification criteria for systemic sclerosis (17, 18).

Nailfold videocapillaroscopy (NVC) has proven to be a fundamental tool not only in the diagnosis of systemic sclerosis but also in its management, follow-up, and in assessing therapeutic efficacy (19–22).

This promising technique has since been extended to various rheumatologic conditions. The nailfold microcirculation has been studied in patients with rheumatoid arthritis, dermatomyositis, psoriasis, psoriatic arthritis, and systemic lupus erythematosus (23). NVC has also been applied in non-rheumatologic diseases characterized by microvascular involvement, such as diabetes mellitus, arterial hypertension, and neurological disorders including amyotrophic lateral sclerosis and multiple sclerosis (24).

In recent years, NVC has also been introduced in intensive care units and intraoperative settings, demonstrating its versatility as a non-invasive method that can be performed at the patient's bedside (25, 26). Finally, this technique has also been employed to analyze microcirculation in pulmonary diseases such as chronic obstructive pulmonary disease, pulmonary hypertension, interstitial lung diseases, and SARS-CoV-2 pneumonia (27–30). More

recently, attention has turned toward microvascular involvement in patients with sarcoidosis, particularly in those exhibiting autoimmune features in blood tests (31–43); to date, only two studies in the literature have investigated microcirculatory alterations in patients with sarcoidosis, both involving small patient cohorts-understandable given the disease's epidemiology (44–50).

The aim of our study is to determine whether microcirculatory alterations are present in patients with sarcoidosis and whether such changes differ significantly from those in healthy subjects and in systemic sclerosis patients, using NVC as a diagnostic tool. A secondary objective is to evaluate whether microvascular abnormalities correlate with specific clinical features of sarcoidosis, in order to explore the potential diagnostic, therapeutic, and follow-up applications of this technique.

Materials and Methods

Patients

We conducted a single-center, cross-sectional, case-control study involving 51 retrospectively selected patients followed at our European Reference Network Pneumological Unit with a diagnosis of sarcoidosis. Diagnosis was confirmed by histological examination and based on the criteria of the American Thoracic Society (34), as detailed in Figure 1. The control group consisted of 51 healthy volunteers and 51 systemic sclerosis patients (SSc), the diagnosis was based on the 2013 classification criteria for systemic sclerosis of the American college of rheumatology/European league against rheumatism (52). All SSc patients presented an early scleroderma pattern at NVC evaluation, as defined by Cutolo (36, 44–50).

Exclusion criteria for the three groups included: age under 18 years, underlying malignancies, untreated systemic infections, heart failure, coronary artery disease, pulmonary hypertension, hypoxia (so Chronic Obstructive Pulmonary Disease, Sleep Apnea Syndrome for example), and comorbidities that could potentially bias microvascular assessment by NVC. These comorbidities included idiopathic inflammatory myopathies, systemic lupus erythematosus, undifferentiated connective tissue diseases, Sjögren's syndrome, rheumatoid arthritis, Hashimoto's thyroiditis, primary biliary cholangitis, diabetes mellitus, severe uncontrolled systemic hypertension, and peripheral atherosclerotic diseases. Furthermore, the presence of Raynaud phenomenon was an exclusion criterion for both the sarcoidosis and healthy volunteer groups. All participants provided informed consent. The study was approved by the Ethics Committee of the University of Trieste for research and publication during meeting No. 9, held on 29 October 2024.

Capillaroscopy was performed by two trained operators using a 200× magnifying probe connected to image analysis software (Videocap ©, DS Medica Srl). All images were acquired using the same device and subsequently reviewed by both operators. Prior to the examination, patients were instructed to refrain from smoking or consuming coffee and were asked to rest in a room maintained at 22–25 °C for at least 15 minutes, in accordance with standard examination protocols.

The capillaroscopic parameters assessed included capillary density, defined as the number of capillaries per linear millimeter and considered reduced if <7 capillaries/mm; the presence of morphological abnormalities—specifically tortuous, crossed, or branched capillaries; microhemorrhages; ecstatic capillaries, defined as those with a loop diameter of 20–50 μm; and giant capillaries, with loop diameters exceeding 50 μm (17). Tortuosity and crossed capillaries were considered significant when observed in more than 50% of the visual field, while the presence of branched capillaries was always recorded. Neoangiogenesis was identified by the presence of bushy or bizarrely shaped loops originating from a single, normally sized capillary (17).

Respiratory function tests performed at the time of capillaroscopy were conducted using the same equipment and interpreted by a single pulmonary specialist, in accordance with the ERS/ATS technical standards for interpretive strategies in routine lung function testing (35).

Statistical analysis

Categorical variables were expressed as counts and percentage. Continuous variables were expressed as mean (and relative SD) or median (and relative IQR), as appropriate. Comparison of categorical variables between groups were made by chi-square test or Fisher's exact test. In the case of continuous variables, t-test or Mann–Whitney U test were

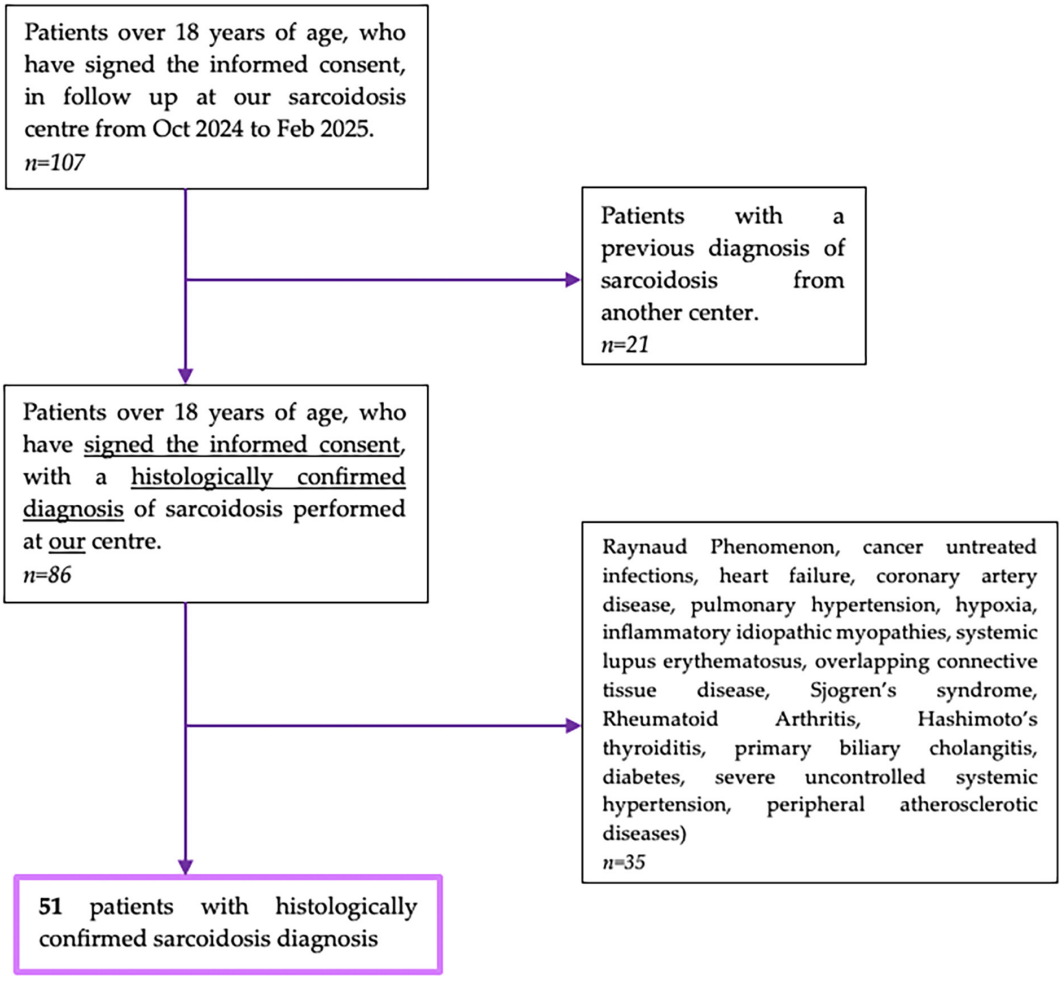

Figure 1. Prisma diagram showing the selection process of sarcoidosis patients from our centre involved in our study.

used, depending on the validity of assumptions. In the case/control comparison, to evaluate the effect of sex and age as potential confounding factors, a logistic regression model was estimated using the characteristic of interest as binary outcome and sex, age, case/control status as predictors. Any p-values equal or lower than 0.05 were considered statistically significant.

Results

We conducted a single-center cross-sectional case-control study of 51 retrospectively selected patients attending our European Reference Network Pneumological Unit with a diagnosis of sarcoidosis confirmed by histological examination and based on America Thoracic Society (ATS) criteria (35), 51 volunteers healthy subjects and 51 SSc patients, similar in sex and age. All patients underwent NVC, performed by two operators trained in the execution of the method, with a 200x magnifying probe connected with image analysis software (DS Medica Srl Videocap ©) (36-40).

Descriptive analysis

For the patients in the case group, data on age at diagnosis and time since diagnosis, spirometry data, blood test results and in particular the presence of anti-nuclear Antibodies (ANA) and antibody title, when performed, were recorded, extra-pulmonary involvement with particular attention to parenchymatous organ and heart involvement, high resolution computed tomography (HRTC) pattern and

in particular the presence of fibrosis (i.e. Scadding stage IV) and presence of comorbidities, including sleep apnea syndrome, as shown in Table 1.

In the group of patients with sarcoidosis, 7 patients (14%) had their capillaroscopic examination performed at the time of diagnosis. Globally 38 patients (74%) showed non-specific microcirculatory abnormalities at capillaroscopy summarized in Table 2. We also assessed microcirculatory alterations in relation to spirometry results. No correlation was found between capillary density and forced vital capacity (FVC) (p=0.07), nor between forced expiratory volume in one second (FEV_1) (p=0.06) and the presence of crossed capillaries.

Subsequently, we analysed the microcirculatory abnormalities and the frequency with which they occurred in sarcoidosis patients with cardiac involvement, obstructive sleep apnea (OSA), scadding stage and finally in patients who had a capillaroscopic examination at the time of diagnosis of sarcoidosis, the results are displayed in Tables 3 and 4.

Sarcoidosis/controls comparison

In the comparison between healthy subjects and patients with sarcoidosis, the microcirculation abnormalities detected in the second group were statistically significant, as shown in Figure 2 and Table 5.

When sex and age were included as covariates on the logistic model, for the sarcoidosis and healthy subjects' group, statistically significant results were found with regard to reduced density (p=0.03), presence of angiogenesis (p<0.001). As expected, the giant capillary, defined as homogeneously enlarged loops with diameter ≥50 μm, where observed only in the SSc group. Furthermore, the SSc group shows a statistically significant increase in the presence of microemmorages compared to healthy subjects and sarcoidosis patients (p<0.001). Furthermore, when sex and age were included as covariates on the logistic model, for the sarcoidosis and SSc group, statistically significant results were found with regard to microemmorages (p=0.02).

The mean capillary density was also lower in the sarcoidosis group than in the healthy controls with p-value=0.0004, even in the linear model taking sex and age into account.

Table 1. Charateristic of our sarcoidosis study population

Case population, n=51	**n (%)**
Male	32 (62.75)
Age mean, (min, max) **SD**	58 (38, 86) 10
Time from diagnosis, month	24 (0, 25)
Smokers	19 (37.25)
Scadding stage	
I	4 (7.84)
II	36 (70.6)
III	0
IV	11 (21.57)
Organ involvment	
Lung	48 (94.12)
Nodes	51 (100)
Spleen	12 (23.53)
Liver	5 (9.8)
Heart	12 (23.53)
Skin	7 (13.73)
Joint and Bones	12 (23.53)
Comorbidities	
Obstructive Sleep apnea (OSA)	13 (25.49)
Obesity	11 (21.57)
PFR data	
FEV1, as % predicted, mean (SD)	90(6)
FVC, as % predicted, mean (SD)	94(7)
DLCO, as % predicted, mean (SD)	78(10)
HRTC patterns	
GGO	17 (33.33)
Nodules	44 (88.27)
Fibrosis	11 (21.57)
ANA+	12 (23.53)
Ongoing Therapy	
Steroid	33 (64.71)
Methotrexate	22 (43.14)
Mycophenolate	1 (1.96)
Anti-Tumor Necrosis Factor	4 (7.84)
Previous therapy	
Steroid	43 (84.31)
Methotrexate	31 (60.78)
Mycophenolate	6 (11.76)
Anti-Tumor Necrosis Factor	13 (25.49)

Legend. S.D.: Standard deviation, FEV1: Forced expiratory volume in the first second; FVC: Fored Vital Capacity; DLCO: Diffusion Lung Carbon Monoxide; HRTC: High Resolution Computed Thomography; GGO: Ground Glass Opacities; SUV: Standardized Uptake Value; PET: Positron emission tomography; ANA: Anti-Nuclear Antibodies.

Discussion

There are currently only two studies in the literature that have investigated microcirculatory changes in patients with sarcoidosis, both involving smaller sample sizes than our study. Cattelan et al. examined this phenomenon in 26 patients with sarcoidosis, comparing them with a group of 30 healthy controls and 30 patients with primary Raynaud's phenomenon (31). Acemoğlu et al. analyzed capillaroscopic changes in 42 patients with sarcoidosis, comparing the findings with those of patients with systemic sclerosis and healthy individuals (33). Our study, involving a larger cohort, demonstrated that capillaroscopic angiogenesis and reduced capillary density occur in patients with sarcoidosis in a statistically significant manner compared to healthy controls and systemic sclerosis. Furthermore, we identified a statistically significant slowing of capillary flow in our patient group, a feature not previously highlighted. No correlation was found between capillary abnormalities and lung function parameters, as previously reported.

Importantly, none of our sarcoidosis patients exhibited nailfold videocapillaroscopy (NVC) abnormalities typically observed in SSc patients with an early scleroderma pattern, as defined by Cutolo, such as giant capillaries (36,44–54). Our results confirm that microcirculatory abnormalities are indeed present in sarcoidosis when analyzed in a larger sample. Interesting, these alterations were statistically significant when compared to healthy controls, suggesting that microvascular involvement is a component of sarcoidosis pathophysiology.

The presence of microvascular abnormalities in sarcoidosis aligns with previous histopathological and serological evidence indicating endothelial damage and microcirculatory disruption in this disease (13,31,33). While macrovascular vasculitis is rare, microvascular damage appears more subtle yet potentially relevant, especially given the systemic

Table 2. Characteristics of microcirculation abnormalities detected in the sarcoidosis patients

	NVC-Abnormalities (n 38/51)	
	n	%
Low density	19	50
Avascular area	10	26,3
Tortuos	30	78
Crossed	31	81
Angiogenesis	29	76,32
Branching	24	63,16
Inverted apex	17	44,74
Microemorrages	4	10
Ectasic capillaries	24	63
Giant capillaries	0	0
Slow blood flow	16	42
Density (mean, min, max)	6.6 (4, 10)	

Table 3. Analysis of microcirculation abnormalities in the group of sarcoidosis patients divided according to comorbidities and sarcoidosis characteristics, including OSA, cardiac involvement, scadding stage IV and NVC performed at diagnosis

NVC parameters	OSA, microcirculation abnormalities (n=10) n(%)	Scadding IV, microcirculation abnormalities (n=8) n (%)	Heart, microcirculation abnormalities (n=10) n (%)	microcirculation abnormalities (n=6) n (%)
Slow blood flow	5(50)	4 (50)	7 (70)	4 (66.7)
Ectasic	5(50)	5 (62.5)	5 (50)	6 (100)
Microemorragies	0	1 (12.5)	2 (20)	1 (16.7)
Angiogenesis	10(100)	7 (87.5)	8 (80)	4 (66.7)
Branching	9(90)	6 (75)	6 (60)	3 (50)
Inverted apex	8(80)	6 (75)	4 (40)	1 (16.7)
Crossed	10(100)	6 (75)	9 (90)	6 (100)
Tortuos	9(90)	6 (75)	9 (90)	6 (100)
Low density	9(90)	4 (50)	5 (50)	3 (50)
Avascular areas	6(60)	3 (37.5)	4 (40)	0

nature of sarcoidosis and its capacity to affect multiple organs, including the lungs, heart, and skin. Our findings of reduced capillary density and slowed blood flow may reflect early endothelial dysfunction or injury, which could contribute to tissue hypoxia and fibrosis, particularly in pulmonary interstitial involvement (13,31,33).

Figure 3 illustrates representative capillaroscopic images from selected patients with sarcoidosis who were included in our study.

Table 4. Characteristics of patients with fibrosis and microcirculation abnormalities divided according to the presence or absence of pulmonary fibrosis associated with sarcoidosis (Scadding stage IV)

	Scadding IV (n=8) n (%)	Scadding I, II, III (n=30) n (%)	p-value
Slow blood flow	4 (50)	12 (40)	0.0133
Ectasic	5 (62.5)	19 (63)	<0.001
Microemorragies	1 (12.5)	3 (10)	0.4795
Angiogenesis	7 (87.5)	22 (73)	<0.001
Branching	6 (75)	18 (60)	0.0015
Inverted apex	6 (75)	11 (36)	0.1701
Crossed	6 (75)	25 (83)	<0.001
Tortuos	6 (75)	24 (80)	<0.001
Low density	4 (50)	15 (50)	0.0012
Avascular areas	3 (37.5)	7 (23)	0.1797
ANA+	2 (25)	4 (13)	0.5637

Interestingly, although microvascular abnormalities such as angiogenesis and tortuosity were prevalent in our sarcoidosis cohort, they did not demonstrate clear correlations with specific organ involvements, autoantibody presence and laboratory data, as shown in Table 6.

This suggests that microcirculatory changes might be a non-specific feature of sarcoidosis or possibly an epiphenomenon related to systemic immune activation rather than a direct marker of disease activity or severity. Nonetheless, the significant differences observed between sarcoidosis patients and healthy individuals support the potential utility of NVC as a supplementary tool in the overall evaluation of these patients.

When comparing sarcoidosis with systemic sclerosis (SSc), a disease known for its specific capillaroscopic patterns (36), our results reinforced the non-specific nature of the microvascular alterations in sarcoidosis. The microhemorrhages and giant capillaries characteristic of SSc (36,51-54) were absent in our sarcoidosis group, underscoring the lack of disease-specific capillaroscopic patterns in sarcoidosis at present. However, the lower capillary density and increased angiogenic features observed in sarcoidosis suggest some degree of microvascular remodeling resembling early or non-specific microvascular changes seen in other systemic inflammatory conditions.

The subgroup analyses further revealed that patients with cardiac involvement, obstructive

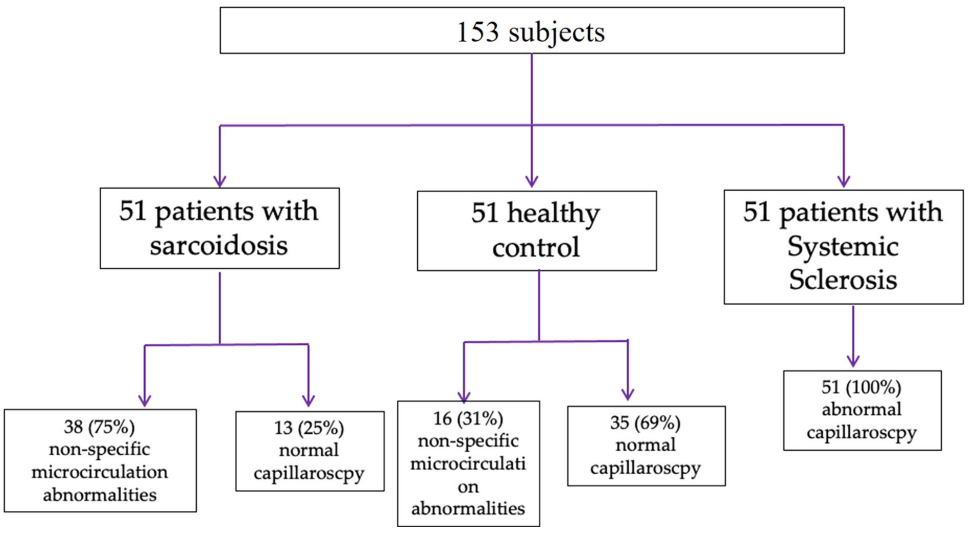

Figure 2. Results of our study on the three groups taken into consideration, i.e. patients affected by sarcoidosis (right), healthy subjects (centre) and patients with Systemic Sclerosis (left).

Table 5. Microcirculation abnormalities and statistical analysis between healthy population (HS), sarcoidosis (SA) and systemic sclerosis patients (SSc)

	HS (n=51)	SA (n=51)	SSc (n=51)	p-value HS vs SA	OR	95%CI	p-value SA vs SSc	OR	95%CI
Age, Median (Q1, Q3)	56 (52, 64)	50 (40, 60)	54 (45, 60)	0.07	-	-	0.06	-	-
Sex, Female n (%)	29 (59)	30 (58)	32 (62)	0.06	0.92	0.42, 2.03	0.06	0.85	0.38, 1.88
Smokers n (%)	19 (37.25)	21 (41)	7 (14)	0.839	0.85	0.38, 1.88	0.0039	4.40	1.66, 11.64
NVC									
Density median (Q1, Q3)	8 (7, 9)	7 (6, 8)	7 (6, 7)	<0.001			0.07		
Tortuos n (%)	23 (45)	36 (71)	27 (53)	0.016	2.19	0.91,5.39	0.06	1.51	0.67, 3.45
Crossed n (%)	28 (55)	39 (76)	25 (49)	0.06	2.4	0.97, 6.13	0.05	0.88	0.39, 1.97
Angiongenesis n (%)	3 (5.9)	29 (57)	2 (57)	<0.001	19.3	5.5, 96	<0.001	0.76	0.09, 4.93
Microemmorages n (%)	3 (5.9)	5 (9,8)	34 (67)	0.7	1.53	0.34, 8.05	<0.001	32.6	9.75, 154
Ectasic n (%)	15 (29)	25 (49)	24 (47)	0.06	1.75	0.74, 4.20	0.06	2.17	0.95, 5.10
Slow blood flow n (%)	5 (9.8)	21 (41)	32 (63)	0.0006	8.5	2.8, 30.9	0.06	16.9	5.94, 57.7

sleep apnea, or advanced Scadding stage IV fibrosis exhibited higher frequencies of certain microvascular abnormalities, such as angiogenesis and slow blood flow. These findings hint at a potential association between microvascular alterations and disease severity or specific organ involvement, although larger studies are warranted to confirm these observations.

From a clinical perspective, the non-invasive nature of NVC makes it an attractive adjunctive tool for monitoring microvascular involvement in sarcoidosis. While our data do not establish a direct correlation with disease activity or progression, the detection of microcirculatory alterations might serve as an early marker of endothelial dysfunction, potentially preceding overt clinical manifestations. Future longitudinal studies are needed to determine whether these microvascular changes predict disease progression, response to therapy, or organ-specific damage.

Limitations of our study include its retrospective design and single-center setting, which may limit the generalizability of the findings. The relatively small sample size, especially when subdividing patients based on organ involvement, also reduces the statistical power to detect meaningful correlations. Additionally, the cross-sectional nature of the study precludes assessment of microvascular changes over time or their relation to disease activity and treatment responses.

Prospective, multicenter studies with larger cohorts are essential to validate these preliminary observations. Future research should focus on correlating microvascular alterations with clinical activity scores, functional parameters, and response to therapy. Exploring the molecular mechanisms underlying microvascular changes in sarcoidosis may also unveil novel therapeutic targets aimed at endothelial protection and microcirculatory restoration.

In summary, our findings highlight the presence of non-specific microvascular alterations in sarcoidosis detectable by NVC. While these changes are not currently specific enough for diagnostic purposes, they open new avenues for understanding the vascular component of sarcoidosis and its potential role in disease pathogenesis and management.

Conclusion

In conclusion, our study confirms that microvascular abnormalities are present in sarcoidosis, albeit in a non-specific manner. The distinct capillaroscopic

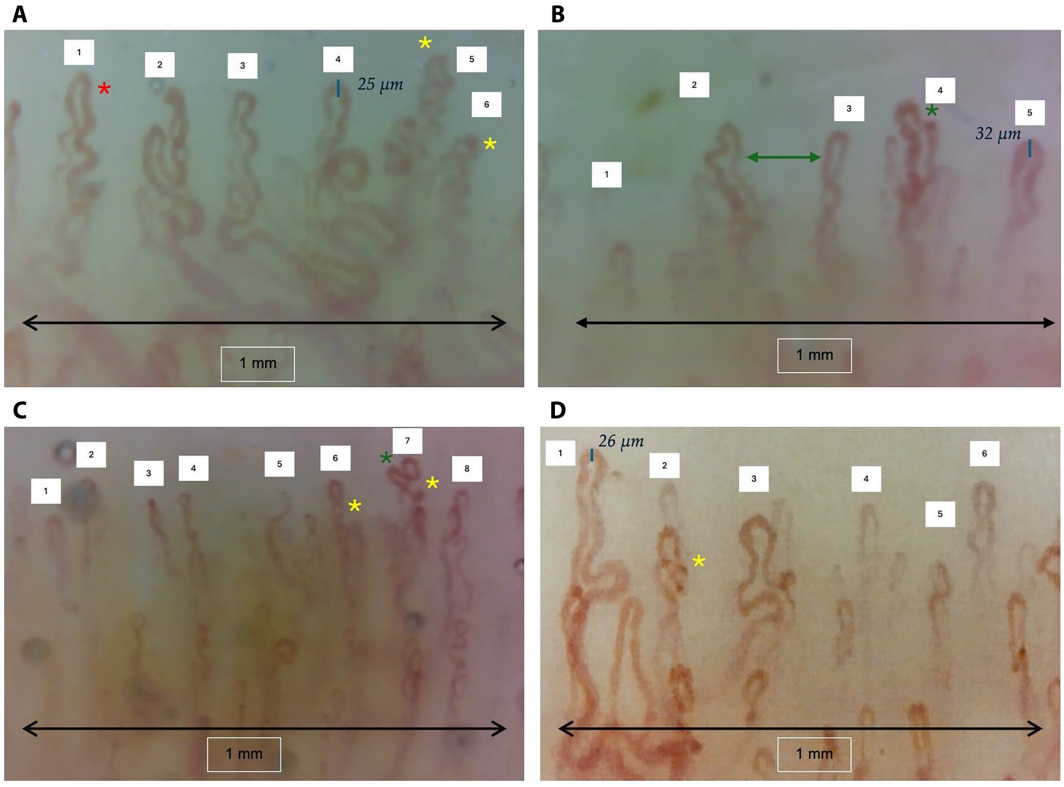

Figure 3. Representative capillaroscopic images of patients with sarcoidosis included in our study. In panel a, a reduced capillary density (6 capillaries/mm) is observed, with the presence of some crossing capillaries (yellow asterisk), tortuous capillaries (red asterisk), and ectasic capillaries (capillary in position 4). In panel b, a reduced capillary density (5 capillaries/mm) is evident, with avascular areas (green arrow), ectasic capillaries (position 5), and capillaries with downward concavity (green asterisk). Panel c shows edema; the capillary density is preserved, but an initial architectural disorganization is evident, with some crossing capillaries (yellow asterisk) and capillaries with downward concavity (green asterisk). Panel d highlights a reduced capillary density (5/mm), with ectasic capillaries (position 1) and crossing capillaries (yellow asterisk).

Table 6. Reports the statistical analysis data concerning sarcoidosis patients who exhibited angiogenesis on capillaroscopy, compared with sarcoidosis patients without evidence of angiogenesis on capillaroscopy

	Angiogenesis		
Subgroups	**no, n=22**	**yes, n=29**	***p-value***
ANA+	8 (36%)	4 (14%)	0.09
OSA	3 (14%)	10 (34%)	0.114
Scaddig St.IV	4 (18%)	7 (24%)	0.73
Heart involvment	4 (18%)	8 (28%)	0.5
Suv Max PET	7.2(4.5, 11.5)	9.5 (6.6, 12.7)	0.15
Time from diagnosis	9.5 (3, 14)	7 (2, 11)	0.149

patterns associated with systemic sclerosis are not observed in sarcoidosis, emphasizing the need for further research to elucidate the specificity and clinical significance of these findings. Incorporating NVC into a multimodal assessment framework could enhance our understanding of the microvascular component of sarcoidosis and potentially guide personalized management strategies.

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Conflict of Interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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