Nailfold videocapillaroscopic changes in patients with psoriatic arthritis: A systematic review

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Received February 11, 2025; Accepted May 23, 2025

DOI: 10.3892/br.2025.2008

Abstract. Nailfold videocapillaroscopy (NVC) is a non-invasive method for the visualization of nailfold capillaries. Recent advancements in imaging technology have enhanced the resolution and accuracy of capillaroscopic assessment, making nailfold capillaroscopy an essential tool for evaluating microvascular changes. Various alterations in the microcirculation have recently been described in psoriatic arthritis (PsA). In recent years, nailfold capillaroscopy has gained attention in dermatology and rheumatology. The present study provides a detailed description of the NVC changes associated with PsA. Initially, various medical databases were searched, a total of 97 articles were reviewed and 17 of them were included in the analysis. Subsequently, several parameters were assessed, including the total number of patients and controls; the presence of disorganized, long, tortuous, ramified, crossed, dilated and giant capillaries, the presence of neoangiogenesis, hemorrhages or hemosiderin deposits, low capillary density and avascular areas. Regarding the use of videocapillaroscopy in patients with PsA, the following key findings were observed: Disorganized and tortuous capillaries, along with a notable reduction in capillary density compared with that in individuals with psoriasis. Nailfold capillaroscopy has emerged as a valuable tool, offering insights into both microvascular lesions and structural abnormalities of the nail, thus aiding in the early diagnosis and monitoring of patients with PsA. Notably, capillaroscopic abnormalities in patients with PsA may be associated with disease severity and activity, thus providing a potential marker for monitoring disease progression and response to therapy. In conclusion, the insights gained from capillaroscopy offer valuable information regarding disease progression and highlight the importance of integrating innovative diagnostic methods into clinical practice.

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Key words: nailfold capillaroscopy, capillaries, psoriatic arthritis, psoriasis

Introduction

Psoriatic arthritis (PsA) is a chronic inflammatory rheumatic condition that can impact up to 30% of patients with psoriasis (PsO) (1). Timely detection and effective monitoring of PsA are essential, as prompt therapy can limit disease progression, prevent joint erosion, joint deformity and systemic complications, and improve quality of life. The present study explores the potential of videocapillaroscopy as a method for evaluating disease activity, assessing treatment effectiveness and potentially facilitating the early diagnosis of PsA.

Pro-inflammatory cytokines, particularly tumor necrosis factor (TNF)-α, interleukin (IL)-23 and IL-17, are critical in the pathogenesis of PsA, where they markedly contribute to joint destruction. Notably, these pro-inflammatory cytokines lead to chronic systemic inflammation and organ damage associated with PsA. Early damage in PsA can result in irreversible joint damage and functional impairment, highlighting the critical importance of early diagnosis and appropriate therapeutic management to preserve joint function and improve long-term outcomes (2,3).

Chronic systemic inflammation in PsA can lead to a variety of complications and negative effects on the body. It is known that PsA is characterized by irreversible joint damage and destruction. Chronic inflammation of the joints can cause erosion of the cartilage and bone, leading to pain, stiffness and reduced mobility, resulting in deformities and disability. In addition to joint involvement, chronic inflammation in PsA can affect several organs and systems. PsA has been associated with an increased risk of developing cardiovascular disease,

as chronic inflammation has the potential to damage blood vessels, markedly increasing the risk of myocardial infarction and cerebrovascular accident. Research has indicated that individuals with PsA are at a greater risk of cardiovascular disease because of the higher rates of risk factors, such as hypertension, hyperlipidemia and obesity. One of the key consequences of chronic inflammation is the development of atherosclerosis and the impairment of endothelial cell function, leading to endothelial dysfunction and thrombosis (4,5). Furthermore, patients with chronic inflammation have a higher risk of osteoporosis and fracture risk; prolonged increases in pro-inflammatory cytokines have been shown to impact bone metabolism. Bone mass is also often decreased in patients with PsA due to additional variables, such as older age, disability or immobility (caused by disease activity) and menopausal status, and, less frequently, due to glucocorticoid therapy (6,7).

Microvascular abnormalities play a unique role in the pathological changes associated with PsO, notably contributing both to onset and disease progression. Although the mechanisms underlying neoangiogenesis are not yet fully understood, it has been considered that disruptions in the balance between pro-angiogenic and anti-angiogenic factors may have a crucial role (8). Angiogenesis, which refers to the formation of new blood vessels, serves a critical role in the pathogenesis of PsA. It is driven by various pro-inflammatory cytokines, such as vascular endothelial growth factor (VEGF), which are elevated in PsA (9). VEGF has a central role in this process, stimulating the proliferation of endothelial cells and their migration, ultimately leading to the formation of new capillaries. This angiogenic response is further modulated by other cytokines and growth factors, including IL-1 and IL-23, which contribute to the dysregulation of vascular homeostasis. Endothelial dysfunction is characterized by altered permeability and increased leukocyte adhesion, thus contributing to synovial inflammation and joint destruction (10). Notably, the examination of nailfold capillaries, which serve as a non-invasive view into the state of the microvasculature, may offer valuable insights into the vascular changes associated with PsA. Patients with PsA often exhibit alterations in capillary morphology, such as increased capillary density, enlarged capillaries and the presence of neoangiogenesis. These changes can be indicative of the underlying inflammatory process and vascular involvement in PsA.

Nailfold videocapillaroscopy (NVC) is a non-invasive technique that examines the microcirculation in the nailfold area; it uses a high magnification microscope and a video camera to visualize and analyze the nailfold capillaries through epiluminescence, which allows light to penetrate the surface of the skin. NVC is used to identify capillaroscopic abnormalities in Raynaud's phenomenon and systemic sclerosis, aiding in the early diagnosis, treatment monitoring and prognosis of disease (11-14). Notably, in the past few years, NVC has been a subject of interest in several other immune-mediated inflammatory diseases, such as rheumatoid arthritis (RA), PsA and Sjogren syndrome. NVC is a safe and quick technique, which is easily accepted by patients. A single drop of cedar oil is usually placed on the nailfold to enhance magnification. To minimize false-positive results, the subject needs to follow some basic rules: They must not remove fingernail cuticles or undergo cosmetic procedures in the month prior to NVC; they should avoid smoking and drinking caffeinated beverages in the previous 4 h; and they should be acclimated to room temperature (20-24˚C) for ≥15 min before the examination. Capillaroscopy can be performed on a number of anatomical locations; however, the nailfold offers a distinctive longitudinal view of the capillaries that run parallel to the surface of the skin (Fig. 1). This tool can provide information about capillary length, width, morphology and even red blood cell velocity (15). Magnification can vary from 50x to 500x, but the preferable magnification is 200x. The capillaroscope uses a cold light source (LED) to prevent vasodilatation, and the probe should be placed gently (not pressed) at an angle of 45-90˚. All fingers can be evaluated, but because the skin thickness varies between fingers, the best images are obtained from the fourth finger, whereas capillaries in the first finger are rarely analyzed due to poor visualization (16).

Normal capillaries have a hairpin configuration, and are uniform in shape and size, with minor morphological variations (Table I). Normal density is characterized as ≥7 capillaries/mm with no avascular areas. In addition, no microhemorrhages/ hemosiderin deposits or angiogenesis should be detected. Elongated capillaries exceed 300 μm. Tortuous capillaries can be normal; however, crossed capillaries are considered abnormal, as well as other shapes. An apical diameter of <20 μm is considered to be within the normal range, whereas dilated capillaries measure 20-50 μm and giant capillaries measure ≥50 μm.

Some factors, such as lifestyle choices, comorbidities and medication, can greatly impact capillary morphology. Smoking can cause microvascular damage and alter capillary morphology, which might complicate the interpretation of videocapillaroscopy results. Notably, changes in capillary structure due to smoking may be misattributed to underlying diseases, leading to misdiagnosis. Furthermore, patients with diabetes may exhibit specific microvascular changes, such as increased capillary loop density or altered capillary structure. The presence of diabetes can therefore make it challenging to differentiate between capillary changes due to diabetes and those due to other underlying conditions. Certain medications, such as vasodilators, can also influence microcirculation and capillary morphology (17).

Capillaroscopic abnormalities can be qualitatively categorized as 'scleroderma patterns' or 'non-scleroderma patterns'. The scleroderma pattern is defined by the existence of 'giant' capillaries (apical diameter ≥50 μm), low capillary density (<7/mm), and the presence of microhemorrhages and angiogenesis. Non-scleroderma patterns are non-specific abnormalities that can be visible in other rheumatic inflammatory diseases and even in some healthy individuals (18,19). Notably, a semi-quantitative assessment has been proposed, which analyzes >32 fields, consisting of four 1-mm fields in eight fingers (excluding the thumb). This assessment evaluates capillary density and diameter (enlarged/giant), microhemorrhages and abnormal capillaries. The rating scores are as follows: 0 (no alterations), 1 (<33% of capillaries are altered), 2 (33-66% are altered) and 3 (>66% are altered), and applies for each of the aforementioned parameters (20).

Nail PsO is regarded as a predictive sign for progression to PsA. Enthesitis, an early inflammatory alteration in PsA, is responsible for nail abnormalities. These alterations may

result from inflammation of the distal interphalangeal (DIP) extensor tendon enthesis, which is in close contact with the nail. Because clinical musculoskeletal symptoms appear with an estimated delay of 10 years, silent alterations may be detected early, using various methods that are nail-focused, such as capillaroscopy and ultrasound (21-25). Frequent abnormalities have been identified in PsA, including enlarged and tortuous capillaries, angiogenesis, microhemorrhages and even capillary loss. Image analysis can be performed manually, semi-manually or digitally (26,27).

Capillaroscopy has the potential to reveal subtle changes in the microcirculation that precede clinical manifestations of PsA. Detecting these changes could be crucial for early intervention, potentially delaying or preventing the onset of arthritis in susceptible individuals. Furthermore, capillaroscopic abnormalities in patients with PsO may correlate with inflammatory markers; this relationship could enhance the sensitivity of capillaroscopy as a diagnostic tool for identifying patients at risk for PsA. Barriers to early diagnosis often include a lack of awareness among healthcare providers about the signs and symptoms of PsA, misattribution of symptoms to other conditions and a variability in clinical presentation. Patients may also express apprehension regarding the necessity of medical procedures, often attributing their symptoms to aging or overexertion (28,29). Early diagnosis of PsA is vital for maximizing therapeutic success, preventing joint damage, managing comorbidities and improving the overall quality of life for patients. Patients diagnosed early tend to have an improved prognosis, with a higher likelihood of obtaining remission or low disease activity over time. Early intervention can help maintain joint function and reduce the likelihood of disability, enabling individuals to maintain their quality of life. Moreover, the healthcare costs associated with advanced disease management, surgeries and hospitalizations can be significantly reduced (30).

Patients with PsA often exhibit alterations in capillary morphology, such as decreased capillary density, enlarged capillaries and the presence of neoangiogenesis. These changes can be indicative of the underlying inflammatory process and vascular involvement in PsA.

Changes observed in NVC can be correlated with several biomarkers and tests to monitor or confirm disease activity and progression, such as serum inflammatory markers [C-reactive protein (CRP), erythrocyte sedimentation rate, fibrinogen and ferritin], imaging studies [ultrasound and magnetic resonance imaging (MRI) of the joints and entheses], patient-reported outcomes (questionnaires that assess quality of life and pain levels, such as Patient Global Assessment, Health-Related Quality of Life, Dermatology Life Quality Index, American College of Rheumatology joint count and Mander enthesis index, and composite measures, such as Disease Activity in PsA). While videocapillaroscopy is a useful tool for assessing microvascular changes, its limitations must be recognized. Operator dependency, the potential for false positives and negatives, and the influence of patient factors can all impact the accuracy of videocapillaroscopy findings. To mitigate these limitations, it is essential to standardize protocols, ensure operator training and proficiency, and consider patient factors when interpreting results.

Table I. Normal capillaroscopic pattern.

Parameters	Normal
Visibility	Good capillary visibility
Architecture	Uniform distribution Parallel distribution
Morphology	'Hairpin' appearance/reversed 'U' shape
Anomalies	None
Height	<300 μm
Capillary diameter	Afferent loop (arterial): 6-19 μm Efferent loop (venous): 8-20 μm
Venous/arterial ratio	<2:1
Capillary density	≥7 capillaries/mm
Flow	Continuous, no stasis

The present systematic review aimed to explore the capillaroscopic findings among patients with PsO (with or without joint involvement). Moreover, it was planned to determine whether capillaroscopy may be useful for differential diagnosis in early arthritis. Furthermore, the benefits, drawbacks and future of this imaging technique in PsA management were examined.

Materials and methods

Various medical databases, including PubMed (https://pubmed.ncbi.nlm.nih.gov/), Web of Science (Clarivate; www.webofscience.com), Scopus (https://www.scopus.com/) and Google Scholar (https://scholar.google.com/) were searched with a combination of related key words. The key words used included a combination of: 'PsA OR PsO AND Nailfold capillaroscopy', 'Videocapillaroscopy AND PsO OR PsA', 'Nailfold capillary changes AND PsO OR PsA'. Only articles written in the English language were considered. Databases were searched by the main author (OGP) until August 2024. The articles included were published between 2012 and 2024 with one exception, an article from 1982 (Zaric *et al*), which may have been the first to mention the use of nailfold capillaroscopy in patients with PsO and PsA. The articles were then analyzed and selected. After selection, data were verified by two co-authors (DA and AB). Information was extracted manually from selected papers by the main author (OGP). Several parameters were evaluated: Total number of patients ± controls; the presence of disorganized, tortuous, crossed, ramified, elongated, dilated and giant capillaries; angiogenesis; the presence of hemorrhages or hemosiderin deposits and low capillary density ± avascular areas.

The inclusion criteria were as follows: Population group consisting of a minimum of five patients diagnosed with PsA, utilizing nailfold capillaroscopy (with no restrictions on magnification) of at least one finger. The exclusion criteria were as follows: Articles written in languages other than English, articles that included patients with PsO with an undefined number of patients with PsA (Fig. 2). To minimize the risk of bias, the identified papers were assessed by the main author, and were then verified by co-authors DA

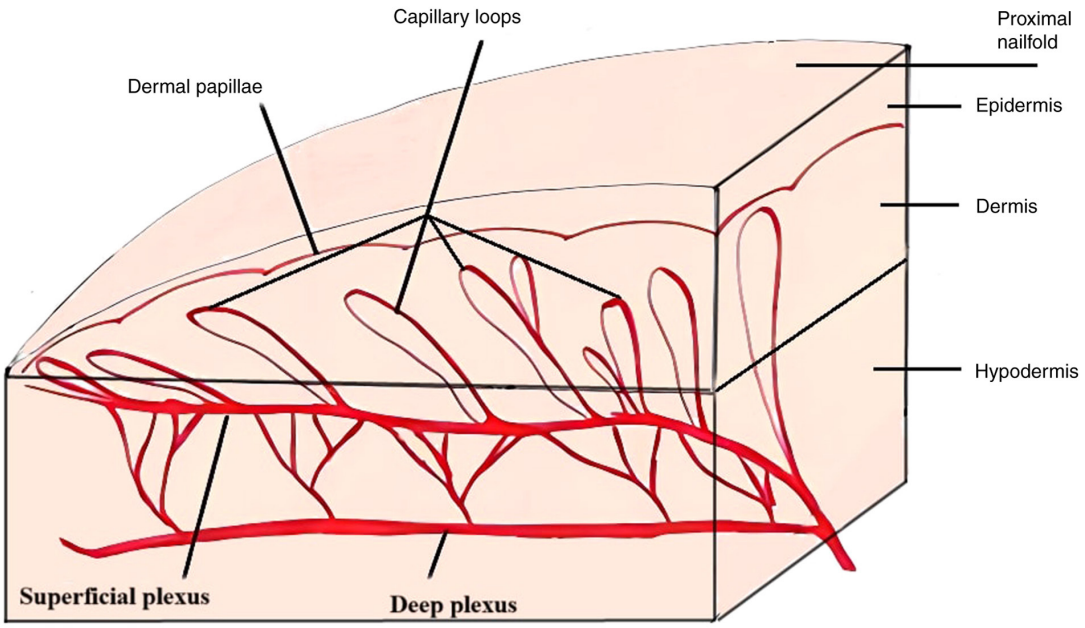

Figure 1. Normal nailfold capillaries display a dense network of capillary loops located within the dermal papillae, just beneath the epidermis. Usually, there are 1-3 capillaries in each dermal papilla. Afferent loops in nailfold capillaries are responsible for delivering blood to the capillary network, while efferent loops facilitate the return of deoxygenated blood. The efferent limb merges with the superficial subpapillary venous plexus and connects with the deep venous plexuses.

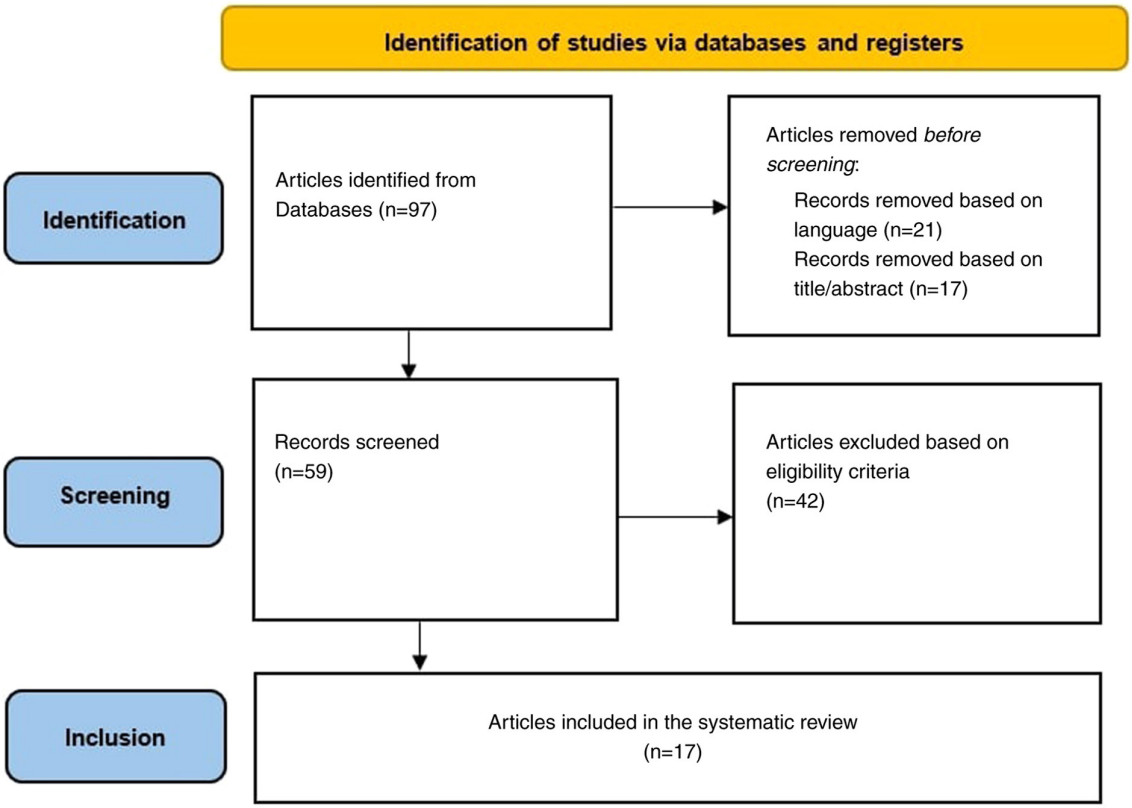

Figure 2. Process of article selection. A comprehensive search was conducted across multiple medical databases using specified keywords, identifying relevant articles published in English from 2012 to 2024. Inclusion criteria required a minimum of five patients with psoriatic arthritis and the use of nailfold capillaroscopy, while exclusion criteria eliminated non-English articles and those lacking clear patient classification. Ultimately, selected articles were analyzed for various capillary parameters, ensuring a robust dataset for review.

and AB. Capillaroscopy mainly uses a qualitative approach for data interpretation, meaning the presence of specific characteristics is indicated as either 'Yes' or 'No'. This method markedly reduces the potential for bias in data interpretation.

The present systematic review was registered in the INPLASY register under accession number INPLASY2024110112 (https://inplasy.com/inplasy-2024-11-0112/) (31).

Results

A total of 97 studies that focused on nailfold capillaroscopy in PsA were identified. A total of 21 articles were excluded that were written in languages other than English and 17 articles were excluded based on the title or abstract. Additionally, 42 articles were excluded after reviewing the full text, since they did not meet the inclusion criteria. Only 17 studies regarding nailfold capillaroscopic findings in PsA were found eligible and were included in the present review.

A study by Ali *et al* (32) examined Egyptian patients with PsO, PsA and RA. The findings revealed that patients with PsA had a lower density of capillaries, more hemorrhages and more dilated capillaries. Furthermore, patients with PsA had tortuous capillaries and frequent capillary disorganization. Moreover, a correlation between CRP titer and capillary diameter was observed. Regarding disease activity, a strong correlation was observed between tender joint count and capillary width, as well as with capillary density (negative correlations) (32).

Another study by Guldberg-Møller *et al* (33) identified some differences between PsO and PsA. Giant capillaries were observed in some of the patients with PsA and none of the patients with PsO. Low density was also observed more frequently in patients with PsA than in those with PsO. However, it was observed that patients with PsO had more dilated capillaries, ramifications and microhemorrhages compared with in patients with PsA (33).

Anghel *et al* (34) noted that patients with PsA had more giant capillaries, more elongated capillaries, more hemorrhages and more avascular areas than patients with RA. In patients with RA, the main capillaroscopic abnormalities were crossed, tortuous and dilated capillaries, as well as the presence of angiogenesis. No differences between capillary density were observed between patients with PsA and those with RA. Moreover, a correlation was observed between CRP titer and the arterial diameter of capillaries. Regarding reversibility with treatment, Anghel *et al* (34) observed that after 12 months of anti-TNF-α therapy, there was an improvement in capillaroscopic abnormalities, including angiogenesis, enlarged capillaries and avascular areas. However, they did not find significant changes tortuous, crossed or bushy capillaries (34).

Graceffa *et al* (35) conducted another study that observed the differences between patients with RA and PsA. Regarding the diameter of blood vessels, it was revealed that patients with PsA had larger diameters compared with those in patients with PsO, but smaller than in those with RA. Additionally, capillary density was smaller in PsA than RA, as was the height of the capillaries. Regarding the tortuosity of blood vessels, this was highest in patients with PsA and was smallest in the controls (35).

Rajaei and Dehghan (36) performed a study on patients with PsA and identified that capillary architecture was abnormal in 22% of patients, the venular plexus was visible in 98% of patients and capillary density was normal in all of the patients. Scleroderma pattern (the occurrence of the following findings: Tortuous capillaries, abnormal architecture, angiogenesis and enlarged loops) was observed in 27% of patients (36).

Molteni *et al* (37) noted in a study performed on patients with RA and PsA that the predominant structural changes were tortuous capillaries (with an occurrence of 90% in PsA and 100% in RA), as well as single crossed capillaries (90% in PsA and 86% in RA). Furthermore, multiple crossed capillaries were observed in 50% of patients with PsA compared with in 21% of patients with RA. By contrast, hemorrhages occurred more frequently in patients with RA than in those with PsA. No differences were found between those groups and healthy controls regarding capillary density, length and distribution (37).

Lambova and Müller-Ladner (38) observed that patients with PsA had a lower density compared with patients with other causes of inflammatory arthritis; no other differences were observed.

In a study by Zaric *et al* (39) regarding capillaroscopy findings in patients with PsA and PsO, it was observed that hemorrhages were more prevalent in patients with PsA, as well as the presence of subpapillary plexus in patients with PsO. Regarding capillary length, both groups showed smaller capillaries than controls (39).

Comparing patients with PsA to those with PsO, Bardehle *et al* (40) observed bushy capillaries (severe ramification) in patients with PsA; however, no other differences were observed between the groups.

Florea *et al* (41) observed that patients with early arthritis, which later developed into PsA, had longer, tortuous and dilated capillaries; however, no density abnormalities or microhemorrhages were observed (41). Elmesiry *et al* (42) performed a study on patients with PsA and PsO and highlighted that all patients with PsA had abnormal capillary morphology and >23% had hemorrhages (42). Fukasawa *et al* (43) noted that patients with PsA had more enlarged loops and hemorrhages compared with those in patients with PsO. Moreover, it was concluded that microhemorrhages and dilated capillaries may serve as notable indicators of the progression from PsO to PsA (43).

A study on patients with PsO and PsA conducted by Bhushan *et al* (44) observed that capillary density was reduced in those that had nail disease and associated DIP joint disease compared with those in the controls. Furthermore, limb diameters (venous and arterial) were decreased in patients with PsA that affected DIP joints (44).

Sivasankari *et al* (45) observed that patients with PsA had capillary disorganization (irregular and haphazard distribution). Ribeiro *et al* (46) reported no marked differences between patients with PsO and PsA regarding capillary density. However, avascular areas were more prevalent in patients with PsA, as well as tortuous capillaries (46). Relhan *et al* (47) observed that patients with PsA had more aberrant morphology, lower density and more avascular areas. No correlation was observed between sex, disease duration and the severity of PsO (47).

Kamboj *et al* (PsO) performed a study on 200 individuals (100 patients with PsO, of which 25 had PsA, and 100 healthy controls). It was noted that patients with PsA had a disorganized

Table II. Nailfold capillaroscopic abnormalities found in psoriatic arthritis.

First author/ year	Total no. of patients	Diagnosis	Controls (no.)	Disorganisation	Elongated	Tortuous	Crossed	Ramified	Dilated	Giant	Neovascularisation	Hemorrhages	Low density	(Refs.)
Ali *et a*l, 2019	40	PsA	Yes: 20	Yes	-	Yes	-	-	Yes	-	-	Yes	Yes	(32)
Guldberg-Moleler *et al*, 2021	75	PsA and PsO	Yes: 12 PsO and 13 osteoarthritis)	Yes	Yes	Yes	-	Yes	Yes	Yes	-	Yes	Yes	(33)
Anghel *et al*, 2023	92	PsA and RA	Yes: 34 RA and 24 healthy controls	-	Yes	Yes	-	-	Yes	Yes	-	Yes	No	(34)
Graceffa *et al*, 2013	60	PsA and RA	30: RA	-	-	Yes	-	-	No	No	-	-	Yes	(35)
Rajaei *et al*, 2016	54	PsA	No	Yes	-	Yes	-	-	No	No	Yes	-	No	(36)
Molteni *et al*, 2022	64	PsA -20 and RA - 14	Yes: 30	Yes	-	Yes	Yes	Yes	No	No	-	No	-	(37)
Lambova *et al*, 2012	105	PsA - 34 RA - 62 Early arthritis - 9	No	-	No	No	No	No	No	No	No	No	Yes	(38)
Zaric *et a*l, 1982	135	PsA-34 PsO-31	Yes: 70 HC	-	No	No	No	No	No	No	No	Yes	No	(39)

PsA, psoriatic arhtritis; Pso, psoriasis; RA, rheumatoid arthritis.

distribution of capillaries, with loss of the usual hairpin shape of capillaries detected; no other specific findings were noted.

The analysis of these 17 articles revealed a significant variability in the reporting of capillary characteristics. While certain features, such as disorganized capillaries (9/17), tortuous capillaries (12/17) and dilated capillaries (8/17), were reported with relative frequency, a considerable number of articles (ranging between 2 and 10) did not provide data on various findings, indicating a potential gap in the literature. Features such as elongated capillaries and neovascularization were particularly underreported, with only 3 and 2 articles mentioning them, respectively. Moreover, the presence of crossed and ramified capillaries also showed limited reporting. Hemorrhages were reported in 5/17 articles, whereas in 5/17 articles they remained underexplored. The aforementioned information is summarized in Tables II and III.

Discussion

PsA is a chronic rheumatic inflammatory disease, defined by rapid joint destruction. Early diagnosis and precise monitoring are crucial for patient outcome; notably, delayed diagnosis of PsA can lead to permanent joint deformities and poor physical function. In addition, due to prolonged systemic inflammation and endothelial dysfunction, delayed diagnosis can increase the risk of cardiovascular events (49).

Upon analyzing the gathered information (Tables II and III), the most prevalent findings in patients with PsA were disorganized and tortuous capillaries. Another predominant finding was the decreased capillary density in patients with PsA compared with that in patients with PsO. In addition, some authors reported the presence of dilated and giant capillaries, along with crossed and ramified capillaries; however, elongated capillaries were noted by only 2 authors.

A total of 5 authors reported a higher occurrence of hemorrhages, whereas 7 did not observe these characteristics in patients with PsA. The majority of the authors did not observe the presence of neovascularization; however, studies have shown an imbalance in angiogenic and anti-angiogenic factors in patients with PsA, resulting in a dysregulated angiogenesis (50,51). Microvascular abnormalities serve a distinctive role in the pathological changes associated with PsO, serving a crucial role in the onset and progression of disease. They supply essential nutrients for the proliferation of keratinocytes and surrounding tissues while facilitating the migration of inflammatory cells (52).

In PsA, inflammation activates processes that increase the permeability of blood vessels, allowing inflammatory cells (macrophages, T cells and mast cells) into the affected tissues. These cells release angiogenic factors (such as VEGF and TNF-α). These alterations result in the formation of abnormal or dysfunctional capillaries. The mechanisms behind neoangiogenesis are not yet fully understood; however, it is becoming increasingly clear that disruptions in the balance between pro-angiogenic and anti-angiogenic factors are critical (53-55).

Nailfold capillaroscopy has received notable interest in recent years for its potential to provide valuable insights into PsA. Videocapillaroscopy is an inexpensive clinical investigation, which is easily accessible to all patients with PsO. The investigation causes no discomfort and can be completed in a timely manner, making it easily accepted by patients (53-58). Dermatologists have a major role in the early diagnosis of PsA. NVC has gained marked interest, being used in a number of rheumatic autoimmune diseases (besides systemic sclerosis). Its use reflects the increasing recognition of its ability to offer key insights into the vascular changes of PsA (59-62).

Notably, evidence on the use of capillaroscopy specifically for monitoring vascular or systemic complications in PsA is limited, and not yet part of standard clinical practice. By utilizing capillaroscopy to analyze the capillary patterns of patients with PsO (with or without joint involvement), physicians may be able to identify distinctive patterns that help distinguish between the two conditions. This imaging technique can be used alongside ultrasonography and MRI to identify asymptomatic individuals who may progress to PsA (63,64). MRI provides comprehensive insights into joint pathology, but is limited by cost and accessibility. Ultrasound is excellent in assessing superficial structures and is less expensive and more portable than MRI; however, none of these imaging techniques can assess microvascular changes. A combined approach that leverages the strengths of each imaging technique may enhance diagnostic accuracy and improve outcomes for patients with PsA.

While there is emerging research on the use of NVC in PsA and other conditions, the evidence base is not yet as robust as it is for scleroderma (65). Videocapillaroscopy requires specialized training and expertise, which may not be available in all clinics, and thus this limits its accessibility and widespread use. However, artificial intelligence algorithms may be used in the future to analyze capillaroscopic images and detect abnormalities in capillary structure. Learning algorithms can be developed using extensive datasets to improve diagnostic accuracy, reducing the likelihood of human error and providing standardized assessments. The integration of these emerging technologies can potentially optimize diagnostic efficiency, notably decrease the duration of diagnosis, improve patient outcomes and optimize clinical procedures. As research progresses and these technologies become more widely adopted, they may lead to more precise and individualized patient care (66).

The establishment of standardized protocols for performing and interpreting nailfold capillaroscopy in PsA is imperative for enhancing diagnostic accuracy, ensuring consistency across practices and facilitating research. By implementing these protocols, the microvascular changes associated with PsA can be better understood, ultimately leading to improved patient care, and facilitating immediate intervention and efficient therapeutic approaches.

Overall, studies on capillaroscopic differences between patients with PsA and PsO are important as they aid in the early detection of PsA, which can help prevent severe joint deformities and improve patient outcomes. Although capillaroscopy offers valuable information about microvascular changes, it should not be used as a standalone diagnostic tool. For a thorough evaluation, it may work best alongside other imaging techniques, such as ultrasonography and MRI.

Although there are few available data supporting whether capillaroscopy can predict disease progression and joint damage, it remains a valuable tool for assessing microvascular changes. Long-term, large-scale (multicentric) prospective

Table III. Nailfold capillaroscopic abnormalities found in psoriatic arthritis-continuation.

First author/ year	Total no. of patients	Diagnosis	Controls (no.)	Disorganisation	Elongated	Tortuous	Crossed	Ramified	Dilated	Giant	Neovascularisation	Hemorrhages	Low density	(Refs.)
Bardehle *et al*, 2021	148	PsA- 24 PsO- 53	Yes: 71	-	Yes	Yes	Yes	Yes	Yes	-	-	-	Yes	(40)
Florea *et al*, 2015	21	PsA - 1 Other diseases -20	Yes	Yes	-	Yes	-	-	Yes	-	-	No	No	(41)
Elmesiry *et al*, 2021	225	PsA - 175	Yes: 25 RA + 25 SSc	-	-	Yes	-	-	No	No	No	No	No	(42)
Fukasawa *et al*, 2023	449	PsA - 213	Yes: 236 PsO	-	-	-	-	-	Yes	-	-	Yes	-	(43)
Bhushan *et al*, 2000	88	PsO - 31 PsA - 13	Yes: 44 HC	-	No	-	No	No	No ↓	No ↓	No	No	Yes (especially in DIP joint disease and nail disease)	(44)
Sivasankari *et al*, 2021	110	PsO	No	Yes	No ↓	Yes	Yes	No	Yes	No	No	No	No	(45)
Ribeiro *et al*, 2012	96	PsA - 7 PsO - 39	Yes: 50 HC	Yes	-	Yes	-	-	-	-	-	-	Yes + Avascular areas	(46)
Relhan *et al*, 2023	150	PsA - 18	Yes: 75 HC + 57 PsO	Yes	-	Yes	Yes	No	Yes	Yes	Yes	No	Yes + Avascular areas	(47)
Kamboj *et al*, 2024	200	25 PsA + 75 PsO	Yes: 100 HC	Yes	-	-	-	-	-	-	-	-	-	(48)

PsA, psoriatic arhtritis; Pso, psoriasis; RA, rheumatoid arthritis.

studies with clearly defined control groups (patients with PsO and healthy individuals) would allow for robust comparisons between patients with PsA, healthy individuals and those with other related autoimmune conditions. These would also help establish whether capillaroscopy can predict disease progression, joint damage and response to therapy (although they can sometimes lack coordination, leading to variations in data collection and analysis methods). Moreover, there is a lack of standardized protocols for performing and interpreting videocapillaroscopy. Variability in techniques can lead to inconsistencies in results and make comparisons across studies challenging. In addition, there is often a lack of appropriate control groups, such as individuals with other inflammatory arthritis conditions or healthy controls, making it difficult to distinguish specific capillaroscopic changes associated with PsA. Addressing these gaps in future research could enhance the understanding of the role of videocapillaroscopy in the diagnosis and management of PsA and improve patient care.

In conclusion, upon reviewing the use of videocapillaroscopy in patients with PsA, some key findings were observed: Disorganized and tortuous capillaries, along with a notable reduction in capillary density, were detected in patients with PsA compared with in individuals with PsO. Nailfold capillaroscopy may thus be considered a valuable tool, offering insights into both microvascular lesions and structural abnormalities of the nail. Based on these insights, it is increasingly clear that integrating microvascular assessments into the clinical management of PsA may enhance the ability to monitor disease progression, and could also aid in evaluating treatment efficacy, ultimately leading to improved patient outcomes.

Acknowledgements

Not applicable.

Funding

No funding was received.

Availability of data and materials

The data generated in the present study are included in the figures and/or tables of this article.

Authors' contributions

OGP conceptualized the study, developed methodology, provided resources, performed visualization, and wrote, reviewed and edited the manuscript. DA and AB performed formal analysis. OGP and AB conducted investigation and project administration. OGP and MLG curated data. OGP and VCB prepared the original draft. VCB and MLG supervised the study. All authors read and approved the final version of the manuscript. Data authentication is not applicable.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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